Course Description: 6.885
Distributed Algorithms for Mobile Ad Hoc Networks

1 People and places

Instructor: Prof. Nancy Lynch, 32-G668, MIT extension 3-7225, lynch@theory.csail.mit.edu.
Available after class and by appointment.
Course is being taught simultaneously by Prof. Jennifer Welch at Texas A& M.

Teaching Assistant: Rui Fan, 32-G670, MIT extension 3-1922, rfan@theory.csail.mit.edu.

Course secretary: Joanne Talbot Hanley, 32-G672A, MIT extension 3-6054, joanne@theory.csail.mit.edu.

Webmaster: Calvin Newport, cnewport@mit.edu.

Class meetings: Mondays and Wednesdays, 11:00AM-12:30PM in room 2-136.

Web site and mailing list: We will set up a course mailing list. Please send email right away to Joanne, at joanne@csail.mit.edu, to join this list.

The course Web site is at URL http://theory.lcs.mit.edu/classes/6.885/spring06. This site will contain downloadable copies of course handouts and related research papers, and other information about the course.

2 What this course is about

This new course will cover distributed algorithms for mobile (and some non-mobile) wireless ad hoc networks, including networks with interesting interactions with the real world. We will focus on algorithms that can be described precisely, and that have relatively well-defined correctness, fault-tolerance, and performance requirements. Our aim is to understand the existing theory of wireless network algorithms and contribute to its further development. Thus, we would like to:

- Understand the nature of wireless ad hoc network settings. What are typical correctness, reliability, and performance properties that can be assumed? What are the "right" complexity measures to use for evaluating algorithms?
- Identify important, well-defined problems and subproblems that must be solved by distributed algorithms in wireless ad hoc networks. These will include problems of low-level and higher-level communication, time synchronization, localization, network configuration, resource allocation, tracking, and data management.
- Learn about the most important existing algorithms for many of these problems, and identify places where additional algorithmic work is needed.
- Identify some inherent limitations (lower bound and other impossibility results) on the solvability of problems in wireless networks.

- Identify useful abstraction layers for programming wireless networks.

The course is aimed at theory-of-computing graduate students with a strong interest in mobile ad hoc networks, and at graduate students working in systems and application areas who are interested in algorithms, analysis, and other theory.

We will proceed roughly through the "layers" of a wireless network design:

- MAC layer
- Localization, time synchronization
- Topology control
- Local infrastructure (local consensus, local leader election, local reliable broadcast, etc.)
- Global broadcast
- Point-to-point routing
- Location-based communication services (location services, location-based routing,
- Global infrastructure (spanning trees, clusters, maximal independent sets, etc.)
- Middleware services (token circulation, resource allocation, consensus, group membership, etc.)
- Virtual node layers
- Applications (data aggregation and maintenance, query-processing, environmental sensing, tracking, intelligent highways, motion coordination, etc.)

3 Prerequisites

6.885 is intended for graduates students who might carry out research in the general area of the course. Undergraduates should get permission of the instructor to sign up.

To take 6.885, you should have:

- "Mathematical maturity". In particular, you should be very good at understanding mathematical proofs and complexity analyses.
- General knowledge about some distributed systems. For instance, MIT's undergraduate course 6.033, Computer Systems Engineering, would be good background.
- Experience with sequential algorithms and their analysis. MIT's undergrad course 6.046 is sufficient.
- (Desirable, but not essential) Experience with distributed algorithms, as in MIT's course 6.852.

4 Source material

The course will be based on a collection of research papers, listed in Handout 3. We will put instructions for obtaining these on the course Web site.

The following book may provide useful background on the basics of mobile ad hoc networks. We are placing it on reserve in the Barker Library.

- Schiller, J. Mobile Communications. Addison-Wesley, 2003.

Prof. Nitin Vaidya, of the University of Illinois, is writing a set of notes for his spring course on (practical) wireless communications. He has agreed to make paper copies available to students in our class.

5 Course requirements

5.1 Readings and class participation

Readings that cover the material for each class will be announced ahead of time. These will be a collection of research papers on a particular topic, with one or two singled out as "must-read" and the others optional. We expect students to read the papers before class, and to come to class prepared with questions and discussion ideas.

Remember, the purpose of the course is to understand the existing theory for mobile ad hoc network algorithms and contribute to its advancement. We would like to reach consensus on some "design decisions" for this theory. Thoughtful class discussions will be critical to the success of this effort.

5.2 Presentations

Some of the classes will be presented by Prof. Lynch, perhaps some by outside guest lecturers. The remainder of the classes will be presented by students taking the course. The student presenting a topic will usually have to read more papers on that topic than the rest of the class will. We expect that presenters will prepare some kind of written notes, using Latex, covering the presentation—this may be in outline form rather than polished prose.

The presenter should not try to cover all details of the selected papers. Rather, he/she should try to understand what is important about the topic he/she is covering, and bring in material from the papers as needed to explain the main ideas. The presenter may end up focusing on particular small parts of the papers (e.g., a particularly interesting proof, or a crucial feature of the physical environment that affects the viability of assumptions make in the algorithmic work).

5.3 Scribe notes

For each class, someone other than the presenter will be appointed as scribe. The scribe should try to produce a good record of what was said in class. He/she should start with the presenter's notes (latex source), clarify confusing points, improve the prose, etc. He/she should also record all the interesting points made in the class discussion. Finally, he/she might want to include some personal perspective on the day's material.

5.4 Problem sets

We will assign questions and problems, mainly intended to make sure everyone keeps up-to-date with the the readings. We do not intend these problem sets to take massive amounts of time, nor to go much beyond the actual ideas in the papers.

Specifically, a few questions will be assigned approximately every Wednesday. The problems will be batched and due every two weeks, on alternate Wednesdays. (Note exceptions to these rules on the course schedule, Handout 2.) There will be a total of six problem set due dates. **No late homeworks will be accepted.** If you haven't finished, just hand in what you have completed.

Policy on homework collaboration: You are encouraged to discuss homework problems and possible solutions with other class members. However, *you must always write up the solutions entirely on your own.* You are also allowed to get help from anyone else you want on preparing for your presentations and in preparing scribe notes. Make sure all such help is properly acknowledged in the scribe notes.

Replacements for problem sets: Occasionally, you may have an interesting idea related to the course material for a particular week—a more interesting idea than what is covered by the problem assignment for that week. If this happens to you, please ask Prof. Lynch for permission to hand in a writeup of your ideas instead of solutions to the assigned problems for that week.

5.5 Exams

There will be no exams. No midterm, no final. You can go home after the last regularly scheduled class.

5.6 Course grade calculation

Your course grade will be based on participation in class discussions, quality of presentations, quality of scribe notes, and grades on mini-problem-sets. Here is how your grade will be calculated:

- Class participation (attendance, quality and quantity of participation): 20%
- Presentations: 25%
- Scribe notes: 20%
- Problem sets: 30% (5% for each problem set)