Course name (English)	Wireless Sensor Networks

Course ID:	No of units:	Program:
Prerequisites:		Co-requisites:
Prepared by:		

Outline

1 INTRODUCTION & APPLICATIONS
2 FACTORS AFFECTING THE DESIGN OF SENSOR NETWORKS
3 APPLICATION LAYER, QUERIES AND NETWORK MANAGEMENT
4 TRANSPORT LAYER PROTOCOLS
5 ROUTING PROTOCOLS
6 MEDIUM ACCESS CONTROL PROTOCOLS
7 ERROR CONTROL TECHNIQUES AND OPTIMAL PACKET SIZE
8 CROSS LAYER PROTOCOL SOLUTIONS
9 LOCALIZATION ALGORITHMS
10 TOPOLOGY CONTROL
11 ACTOR/SENSOR NETWORKS
12 WIRELESS MULTIMEDIA SENSOR NETWORKS
13 UNDERWATER SENSOR NETWORKS
14 UNDERGROUND SENSOR NETWORKS
15 NANO SENSOR NETWORKS

Course Textbook

I. Wireless Sensor Networks, F. Akyildiz and M. C. Vuran, John Wiley and Sons Publ. Company, June 2010
II. Protocols and Architectures for Wireless Sensor Networks, H. Karl and A. Willig, John Wiley& Sons, June 2005.
III. Networking Wireless Sensors, B. Krishnamachari, Cambridge University Press, January 2006.

This class surveys the emerging field of wireless sensor networks, which consist of many tiny, low-power devices equipped with sensing, computation, and wireless communication capabilities. The course will cover a broad range of topics, including operating systems, radio communication, networking protocols, time synchronization, localization, energy management, programming abstractions, mobility, topology control, and applications.

http://www.eecs.harvard.edu/~mdw/course/cs263/

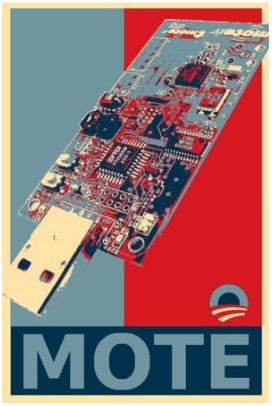
SCHOOL OF ENGINEERING AND APPLIED SCIENCES
HARVARD UNIVERSITY

CS 263r. Wireless Sensor Networks

Prof. Matt Welsh

Spring 2009

Lectures (Spring 2009): Tuesdays and Thursdays, 2:30-4
Location: Maxwell Dworkin Hall, Room 221



Harvard CS263 course blog

Course Description

Instructor: Prof. Matt Welsh
Office Hours: Thursdays 10-12, Maxwell Dworkin 233

Teaching Fellow: Bor-rong Chen
Office Hours: Wednesdays 10-12, Maxwell Dworkin 238

This class surveys the emerging field of wireless sensor networks, which consist of many tiny, low-power devices equipped with sensing, computation, and wireless communication capabilities. The course will cover a broad range of topics, including operating systems, radio communication, networking protocols, time synchronization, localization, energy management, programming abstractions, mobility, and applications.

This is a research seminar course that focuses on reading and discussion of papers from the scientific literature. Students will read 2-4 papers a week and write short summaries of each paper. Two assignments will provide hands-on experience with wireless networking and sensor networks using the MoteLab testbed environment. Students will learn to program TinyOS, an embedded operating system for sensor nets, and will develop protocols and applications in this environment. Finally, students will undertake a significant research project, working in pairs or individually. At the end of the term, students will present projects in class and prepare a written project report.

The class will be based on **in-class discussions of the papers** driven by the students own observations and questions about the assigned reading. There will be no formal lectures. Students are expected to come to lecture each day and be prepared to discuss the reading in depth.

Grading will be based on a weighted combination of class participation, paper summaries, the final project presentation, and the project report.

This course is intended for graduate students at all levels as well as advanced undergraduates (CS161 or CS143 are required).

Assignment #1 posted -- Due March 10

Project ideas and schedule

Assignments

This course will involve paper readings, a single programming assignment, and a research project. You are expected to read the papers for each lecture, and send a short summary -- several paragraphs at most -- on each paper to the course e-mail address before the lecture. (Send these as a single email with the current lecture date in the subject line, to cs263-staff@eecs.)

Finally, you will undertake a significant **research project** during the term. The goal is to design, implement, and evaluate a real system and write a report that could eventually lead to publication. At the end of the course we will have project presentations where each group gives a short talk on their work. You may be able to combine your project with another graduate course, subject to approval by the instructors.

Syllabus and Schedule -- Click on lecture topic for slides

Date	Topic	Readings	Blogger

Th 1/29/09	**Course Intro**	Intro slides here	
Tu 2/3/09	Intro to sensor networks	TinyOS (ASPLOS'00), Great Duck Island	Matt
Th 2/5/09	Understanding low-power wireless	B-MAC, Taming the underlying challenges	Bor-rong
Tu 2/10/09	Medium Access Control	Z-MAC, Component-based MAC architecture	Neil
Th 2/12/09	Operating system designs	NesC, Networking abstractions in TinyOS	Oliver
Tu 2/17/09	Operating system designs	t-Kernel, Pixie	Atanu
Th 2/19/09	Networking	Dozer, IP is Dead	Robin
Tu 2/24/09	Broadcast and dissemination	Trickle, RBP	Daniel
Th 2/26/09	Reliable transport	Flush, RCRT	Subhash
Tu 3/3/09	Time sync and localization	FTSP, Radio interferometric localization	CK
Th 3/5/09	*No class*		

Tu 3/10/09	Data aggregation	TinyDB, Synopsis diffusion, Beyond Average	Matt T.
Th 3/12/09	Storage	Capsule, FlashDB	Peter
Tu 3/17/09	Tracking	Line in the Sand, Tracking using binary sensors	Mike
Th 3/19/09	Dealing with sensor data	Macroscope in the Redwoods, Volcano monitoring	Kevin
Tu 3/24/09	*No class - spring break*		
Th 3/26/09	*No class - spring break*		
Tu 3/31/09	Programming models	Tenet, Declarative sensor network	Jason
Th 4/2/09	Programming models	Regiment, Macrolab	Robin
Tu 4/7/09	Energy management	Power locks, Triage	Oliver
Th 4/9/09	Mobile sensing systems	CarTel, Activity classification using cell phones	CK
Tu 4/14/09	Acoustic sensor networks	VoxNet, Shooter Localization	Mike

Th 4/16/09	Camera-based sensor networks	Distributed image search, camera-based object tracking	Subhash
Tu 4/21/09	Underwater sensor networks	Underwater MAC, Underwater optical and acoustical sensor net	Jason
Th 4/23/09	*No class*		
Tu 4/28/09	**In-class project presentations**		
Th 4/30/09	**In-class project presentations**		
Mo 5/11/09	**Final Project Reports Due**		

Other papers

These papers are provided here for your reference. Some of them will be discussed in class, but most are supplemental.

Ad hoc networking

- A review of current routing protocols for Ad Hoc mobile wireless networks, E. Royer and C.-K. Toh, IEEE Personal Communications, 1999.
- A High-Throughput Path Metric for Multi-Hop Wireless Routing, Douglas De Couto, Daniel Aguayo, John Bicket, and Robert Morris, Mobicom'03
- Analysis of TCP Performance over Mobile Ad Hoc Networks, G. Holland and N. Vaidya, Wireless Networks 8, 2002.
- Link-level Measurements from an 802.11b Mesh Network, Daniel Aguayo, John Bicket, Sanjit Biswas, Glenn Judd, Robert Morris, SIGCOMM 2004.
- DSR: The Dynamic Source Routing Protocol for Multi-Hop Wireless Ad Hoc Networks, David B. Johnson, David A. Maltz, and Josh Broch, in *Ad Hoc Networking*, edited by Charles E. Perkins, 2001.

- Geometric Spanner for Routing in Mobile Networks, Jie Gao, Leonidas J. Guibas, John Hershburger, Li Zhang, and An Zhu, MobiHoc'01.
- ATP: A Reliable Transport Protocol for Ad-hoc Networks, Karthikeyan Sundaresan, Vaidyanathan Anantharaman, Hung-Yun Hsieh, Raghupathy Sivakumar, MobiHoc'03.

Sensor networks general

- System Architecture for Wireless Sensor Networks, Jason Hill, Ph.D. Thesis, UC Berkeley, May 2003.
- System architecture directions for networked sensors, Jason Hill, Robert Szewczyk, Alec Woo, Seth Hollar, David Culler, and Kristofer Pister, ASPLOS'00.

Sensor network applications

- Monitoring Volcanic Eruptions with a Wireless Sensor Network, Geoff Werner-Allen, Jeff Johnson, Mario Ruiz, Jonathan Lees, and Matt Welsh, EWSN'05.
- Analysis of a Large Scale Habitat Monitoring Application, Robert Szewczyk, Joseph Polastre, Alan Mainwaring, John Anderson, and David Culler, SenSys'04.
- Design and Deployment of Industrial Sensor Networks: Experiences from a Semiconductor Plant and the North Sea
- Lessons from a Sensor Network Expedition, Robert Szewczyk, Joseph Polastre, Alan Mainwaring, and David Culler, EWSN'04.
- Implementing Software on Resource-Constrained Mobile Sensors: Experiences with Impala and ZebraNet, Ting Liu, Christopher Sadler, Pei Zhang and Margaret Martonosi, MobiSys 2004.
- Wireless Sensor Networks for Habitat Monitoring, Alan Mainwaring, Joseph Polastre, Robert Szewczyk, David Culler, and John Anderson, WSNA'02.
- An Energy-Efficient Surveillance System Using Wireless Sensor Networks, Tian He, Sudha Krishnamurthy, John A. Stankovic, Tarek Abdelzaher, Liqian Luo, Radu Stoleru, Ting Yan, Lin Gu, Jonathan Hui, and Bruce Krogh, MobiSys'04.
- Two-Tiered Wireless Sensor Network Architecture for Structural Health Monitoring, Venkata A. Kottapalli, Anne S. Kiremidjian, Jerome P. Lynch, Ed Carryer, Thomas W. Kenny, Kincho H. Law, Ying Lei, SPIE'03.
- A Line in the Sand: A Wireless Sensor Network for Target Detection, Classification, and Tracking, Anish Arora et al., Journal of Computer Networks, 2004.

Sensor network operating systems

- The Emergence of Networking Abstractions and Techniques in TinyOS, Philip Levis, Sam Madden, David Gay, Joe Polastre, Robert Szewczyk, Alec Woo, Eric Brewer and David Culler, NSDI'04.
- The nesC Language: A Holistic Approach to Networked Embedded Systems, David Gay, Phil Levis, Rob von Behren, Matt Welsh, Eric Brewer, and David Culler, PLDI'03.

Sensor networks: communications and routing

- SCALE: a tool for Simple Connectivity Assessment in Lossy Environments, Alberto Cerpa, Naim Busek and Deborah Estrin. Tech report, 2003.

- Taming the Underlying Challenges of Reliable Multhop Routing in Sensor Networks, Alec Woo, Terence Tong, and David Culler, SenSys'03.
- A Unifying Link Abstraction for Wireless Sensor Networks, Joe Polastre et al., Sensys'05.
- An Energy-Efficient MAC Protocol for Wireless Sensor Networks, Wei Ye, John Heidemann and Deborah Estrin, INFOCOM'02.
- Energy-efficient Communication Protocols for Wireless Microsensor Networks (pdf), Wendi Rabiner Heinzelman, Anantha Chandrakasan, Hari Balakrishnan, HICSS'00.
- Building Efficient Wireless Sensor Networks with Low-Level Naming, John Heidemann, Fabio Silva, Chalermek Intanagonwiwat, Ramesh Govindan, Deborah Estrin, and Deepak Ganesan, SOSP'01.
- Topology Management for Sensor Networks: Exploiting Latency and Density, Curt Schurgers, Vlasios Tsiatsis, Saurabh Ganeriwal, and Mani Srivastava, MobiHoc'02.
- ESRT : Event-to-Sink Reliable Transport in Wireless Sensor Networks, Yogesh Sankarasubramaniam, Ozgur Akan, Ian Akyildiz, MobiHoc'03.

Programming abstractions

- Programming Sensor Networks Using Abstract Regions, Matt Welsh and Geoff Mainland, NSDI'04.
- Active Sensor Networks, Philip Levis, David Gay, and David Culler, NSDI'05.
- Maté: A Tiny Virtual Machine for Sensor Networks, Philip Levis and David Culler, ASPLOS'02.
- Bridging the Gap: Programming Sensor Networks with Application Specific Virtual Machines, Philip Levis, David Gay, and David Culler, Tech Report, 2004.
- The Design of an Acquisitional Query Processor for Sensor Networks, Samuel R. Madden, Michael J. Franklin, Joseph M. Hellerstein, and Wei Hong, SIGMOD'03.
- GHT: A Geographic Hash Table for Data-Centric Storage, S. Ratnasamy, B. Karp, L. Yin, F. Yu, D. Estrin, R. Govindan, and S. Shenker, WSNA'02.
- An evaluation of multi-resolution search and storage in resource-constrained sensor networks, Deepak Ganesan, Ben Greenstein. Denis Perelyubskiy, Deborah Estrin and John Heidemann, SenSys'03.
- Beyond Average: Towards Sophisticated Sensing with Queries, Joseph M. Hellerstein, Wei Hong, Samuel Madden, and Kyle Stanek, IPSN'03.
- Query Processing in Sensor Networks, Yong Yao and J. E. Gehrke, CIDR'03.
- Cache-and-Query for Wide Area Sensor Databases, A. Deshpande, S. Nath, P. Gibbons, and S. Seshan, SIGMOD'03.

Distributed data processing

- Collaborative Signal and Information Processing: An Information Directed Approach F. Zhao, J. Liu, J. Liu, L. Guibas, and J. Reich, Proc. IEEE, 2003.
- Scalable information-driven sensor querying and routing for ad hoc heterogeneous sensor networks, M. Chu, H. Haussecker, F. Zhao, Int'l J. High Performance Computing Applications, 16(3):90-110, Fall 2002.

Localization and time synchronization

- RADAR: An In-Building RF-Based User Location and Tracking System, P. Bahl and V. N. Padmanabhan.
- The Cricket Location-Support SystemThe Cricket Location-Support System, Nissanka B. Priyantha, Anit Chakraborty, and Hari Balakrishnan, MobiCom'00.
- The Flooding Time Synchronization Protocol, Miklos Maroti, Branislav Kusy, Gyula Simon, Akos Ledeczi, SenSys'04.
- Fine-Grained Network Time Synchronization using Reference Broadcasts, Jeremy Elson, Lewis Girod and Deborah Estrin, OSDI'02.
- Localization from Mere Connectivity, Yi Shang, Wheeler Ruml, Ying Zhang, and Markus Fromherz, MobiHoc'03.
- Optimal and Global Time Synchronization in Sensornets (pdf), Richard Karp, Jeremy Elson, Deborah Estrin, and Scott Shenker, CENS Technical Report 0012.

Security

- TinySec: A Link Layer Security Architecture for Wireless Sensor Networks, Chris Karlof, Naveen Sastry, David Wagner, SenSys'04.
- Analyzing and Modeling Encryption Overhead for Sensor Network Nodes, Prasanth Ganesan, Ramnath Venugopalan, Pushkin Peddabachagari, Alexander Dean, Frank Mueller, Mihail Sichitiu, WSNA'03.

Other

- Path Optimimzation in Stream-Based Overlay Networks, Peter Pietzuch et al., Harvard technical report, 2004.
- Sensor network-based countersniper system, Gyula Simon et al, SenSys'04.

http://www.stanford.edu/class/cs344a/syllabus.html

STANFORD UNIVERSITY

1. **CS344A: Sensor Network Systems**

Syllabus

The purpose of the work in CS 344A is to introduce the fundamental research in wireless sensor networks in order to enable you to work on a research project of publishable quality. This requires reading deeply on a wide range of topics. Each student is therefore responsible for writing a short summary of each paper, which must be sent to the instructor and TA before the beginning of the class in which the paper is discussed. The summary should answer these three questions:

1. Based on the assumptions the paper makes, when is the technical approach advocated suitable and when is it not? Do the author's claims match?
2. What further evaluation would best support the conclusions of the paper (assuming it agreed)? If you have doubts about the claims in the paper, what experiment would you perform to test them?
3. Give a specific example of how you might apply these results to a similar but different problem.

For some papers, one or more of the questions might not be directly applicable. Use your own judgement. Each student can miss one writeup; when you do this, still send email, but say that you're taking your freebie.

Date	Topic	Assignment Due
4/4	**Wireless Sensor Networks**	**No writeup needed**
	M. Weiser. "The Computer for the Twenty-First Century," Scientific American, pp. 94-10, September 1991. [PDF]	
	D. Estrin, R. Govindan, J. Heidemann, S. Kumar. "Next Century Challenges: Scalable Coordination in Sensor Networks, " Proceedings of MOBICOM 1999. [PDF]	

4/6 Application Drivers

- R. Szewczyk, J. Polastre, A. Mainwaring, J. Anderson, and D. Culler. "Analysis of a Large Scale Habitat Monitoring Application," SenSys 2004. [PDF]

- P. Juang, H. Oki, Y. Wang, M. Martonosi, L. Peh, D. Rubenstein. "Energy-Efficient Computing for Wildlife Tracking: Design Tradeoffs and Early Experiences with ZebraNet," ASPLOS 2002. [PDF]

4/11 Hardware Profiles

- Martin Leopold, Mads Bondo Dydensborg, and Philippe Bonnet. "Bluetooth and Sensor Networks: A Reality Check," SenSys 2003. [PDF]

- P. Dutta, M. Grimmer, A. Arora, S. Bibyk, and D. Culler. "Design of a Wireless Sensor Network Platform for Detecting Rare, Random, and Ephemeral Events," IPSN/SPOTS 2005. [PDF]

4/13 Operating Systems

- J. Hill, R. Szewczyk, A. Woo, S. Hollar, D. Culler and K. Pister. "System Architecture Directions for Network Sensors." ASPLOS 2000. [PDF]

- J. Koshy and R. Pandey. "VM*: A Scalable Runtime Environment for Sensor Networks." SenSys 2005. [PDF]

4/18 Network Behavior **Discovery**

- J. Zhao and R. Govindan. "Understanding packet delivery performance in dense wireless sensor networks," SenSys 2003. [PDF]

- D. Son, B. Krishnamachari, and J. Heidemann. "Experimental Analysis of Concurrent Packet Transmissions in Low-Power Wireless Networks." USC-ISI Technical Report ISI-TR-2005-609, November 2005. [PDF]

4/20 Failure

- J. Regehr. "Randomized testing of interrupt-driven software." EMSOFT 2005.[PDF]

- G. Candea and A. Fox. "Recursive Restartability: Turning the Reboot Sledgehammer into a Scalpel." HotOS 2001.[PDF]

4/25 **Network Protocols I**

- A. Woo, T. Tong, and D. Culler. "Taming the Underlying Challenges of Reliable Multihop Routing in Sensor Networks." SenSys 2003. [PDF]
- C. Intanagonwiwat, R. Govindan and D. Estrin. "Directed diffusion: A scalable and robust communication paradigm for sensor networks." MobiCom 2000. [PDF]

4/27 **Network Protocols II**

- P. Levis, N. Patel, D. Culler, and S. Shenker. "Trickle: A Self-Regulating Algorithm for Code Propogation and Maintenance in Wireless Sensor Network." NSDI 2004. [PDF]
- S. Nath, P. Gibbons, S. Seshan, and Z. Anderson."Synopsis diffusion for robust aggregation in sensor networks." SenSys 2004. [PDF]

5/2 **Application-level Programming** **Project Proposal**

- S. Madden and M. Franklin and J. Hellerstein and W. Hong. "TinyDB: An Acquisitional Query Processing System for Sensor Networks." Transactions on Database Systems (TODS) 2005. [PDF]
- B. Greenstein, E. Kohler and D. Estrin. "A sensor network application construction kit (SNACK)." SenSys 2004. [PDF]

5/4 **Presentations of Assignment 1 Solutions** **Transport**

- No writeups required
- P. Levis, D. Gay, and David Culler. "Active Sensor Networks." NSDI 2005. [PDF]
- I. Vasilescu, K. Kotay, D. Rus, P. Corke, and M. Dunbabin. "Data Collection, Storage and Retrieval with an Underwater Optical and Acoustical Sensor Network," SenSys 2005. [PDF]

5/9 **Media Access I, Guest Lecturer:** Prabal Dutta

- V. Bharghavan, A. Demers, S. Shenker and L. Zhang. "MACAW: A Media Access Protocol for Wireless LANs." SIGCOMM 1994. [PDF]
- W. Ye, J. Heidemann, and D. Estrin. "An Energy-Efficient MAC Protocol for Wireless Sensor Networks." INFOCOM 2000. [PDF]

5/11 **Media Access II**

- No class meeting
- J. Polastre, J. Hui, P. Levis, J. Zhao, D. Culler, S. Shenker, and I. Stoica. "A Unifying Link Layer Abstraction for Wireless Networks." SenSys 2005. [PDF]

5/16 **Projects** **Project Presentation**

No reading due.

5/18 **Simulation**

- V. Shnayder, M. Hempstead, B. Chen, G. Allen, and M. Welsh. "Simulating the power consumption of large-scale sensor network applications". SenSys 2004. [PDF]
- L. Girod, T. Stathopoulos, N. Ramanathan, J. Elson, D. Estrin, E. Osterweil, and T. Schoellhammer. "A system for simulation, emulation, and deployment of heterogeneous sensor networks." SenSys 2004. [PDF]

5/23 **Network Architecture**

- R. Govindan, E. Kohler, D. Estrin, F. Bian, K. Chintalapudi, O. Gnawali, S. Rangwala, R. Gummadi, and T. Stathopoulos. "Tenet: An Architecture for Tiered Embedded Networks." CENS Technical Report 56, 2005. [PDF]
- D. Culler, P. Dutta, C. T. Eee, R. Fonseca, J. Hui, P. Levis, J. Polastre, S. Shenker, I. Stoica, G. Tolle, and J. Zhao. "Towards a Sensor Network Architecture: Lowering the Waistline." HotOS 2005. [PDF]

5/25 **Storage**

- S. Ratnasamy, B. Karp, L. Yin, F. Yu, D. Estrin, R. Govindan and S. Shenker. "GHT: a geographic hash table for data-centric storage." WSNA 2002. [PDF]

5/30 **No class meeting**

- No writeups required.
- D. Moore, J. Leonard, D. Rus, and S. J. Teller. "Robust distributed network localization with noisy range measurements." SenSys 2004. [PDF]

6/1	**Time Synchronization**
	J. Elson, L. Girod, D. Estrin. "Fine-Grained Network Time Synchronization using Reference Broadcast." OSDI 2002. [PDF]
6/6	**Open Problems**
	No reading.
Final Week	**Poster**

http://ceng.usc.edu/~bkrishna/teaching/EECS652Syllabus_Fall04.pdf

USC Course Syllabus:
EE 652/CSCI 652 Wireless Sensor Networks
Fall 2004

Instructor

Bhaskar Krishnamachari
Assistant Professor, Electrical Engineering
Joint Appointment in Computer Science
EEB 342, (213) 821-2528
bkrishna@usc.edu

Catalogue Description

Sensor network applications, design, and analysis. Deployment; energy-efficiency; wireless communications; data-centric operation; capacity and lifetime; collaborative signal processing; reliability, fault-tolerance and security.

Enrollment & Prerequisites

The size of the class will be limited to about 25 students, and admission is based on prior instructor approval. The prerequisite for this course is EE/CS 450 (Intro to Networks). It is recommended (but not required) that students have taken EE 465 and that they have good programming skills (C/C++/Java) as well as skills in mathematical analysis. The course is meant primarily for Ph.D. students in EE and CS as well as second year M.S. students with motivation and a particular interest in research.

Course Goals

From this course, students will gain a thorough introduction to the area of wireless sensor networks. Wireless sensor networks are unattended distributed systems consisting of large numbers of inexpensive devices – each capable of a combination of sensing, communication and computation. Such sensor networks are expected to be deployed in high densities in order to obtain detailed information about the operational environment. Applications range from environmental monitoring and seismic studies to mobile target tracking.

Sensor networks provide a fundamentally new set of research challenges – involving design and analysis of self-configuration protocols and distributed algorithms that are energy-efficient, faulttolerant and scalable. This is a new and rapidly developing research area with many open problems of cross-disciplinary interest. The course will provide students with a comprehensive introduction to this area through readings of a large number of recent papers (more than 70) on different topics spanning the subject and through talks by guest speakers. Students will also have an opportunity to contribute to this area through the publication of results from the required group research project for this class.

Students will critically examine recently proposed mechanisms for the deployment and configuration of sensors, energy-efficient data gathering, handling challenging wireless link conditions, data-centric querying, routing, and storage, maximizing network lifetime and capacity, collaborative signal processing, reliability, fault-tolerance and security. Through this course students will learn how to design and analyze such mechanisms for different applicationspecific contexts.

This course also aims to train students in the craft of academic research. Substantial emphasis will be placed on reading research papers in a critical and analytical manner. Students will be required to turn in weekly written critiques of the papers that they read. They will be required to make at least one in-class presentation during the semester on papers from the assigned readings as well

as a group presentation pertaining to the project. The group projects will be closely guided on a weekly basis through out-of-class meetings and emails, and will span the full research cycle – from problem formulation to obtaining & analyzing results to paper writing. Guest speakers from academia and industry will give talks on different aspects of sensor networks to the class.

Course Outline and Readings

The following is an outline for the course, describing the topics we will be covering through the lectures and readings in this course, about one topic every week or two. In each class, typically, the instructor will provide a lecture, and one or two students will make presentations to the class, together covering the readings for that week. Guest speakers will make presentations as well.

Topic 1 The Sensor Network Concept

- Introduction
- Applications

Topic 2 Deployment & Configuration

- Localization and calibration
- Coverage and connectivity

Topic 3 Wireless Communications

- Link quality, shadowing and fading effects

Topic 4 Medium Access

- Scheduling sleep cycles

Topic 5 Data Gathering

- Tree construction algorithms and analysis
- Asymptotic capacity
- Lifetime optimization formulations

Topic 6 Routing and Querying

- Publish/Subscribe mechanisms
- Geographic routing
- Robustness
- Storage and retrieval

Topic 7 Collaborative Signal Processing and Distributed Computation

- Detection, estimation, classification problems
- Energy-efficient distributed algorithms

Topic 8 Security

- Privacy issues
- Attacks and countermeasures

Research Project

Besides the weekly readings, critiques, presentations and discussion, a large component of the course will be a semester-long research project on sensor networks. The following are some guidelines concerning the project:

The research projects are to be conducted in groups of 2-3 students, working closely with the instructor.

It is expected that the project groups will be formed and the projects commenced no later than four weeks after the start of classes.

During the course of the research project, the students will identify an open problem, formulate a concrete proposal for addressing the problem, research prior and related work, propose a new scheme or develop a novel analysis, and obtain results to evaluate their ideas.

The projects may vary in approach from analysis, to computer simulations to experimental implementation, or preferably a combination of these. Students will have the freedom to

identify the topic and choose an approach based on their own background and interests.
Students will be required to submit a short 4-page mid-term project report due around week 8, which will describe the research topic, related and prior work relevant to the problem, the methodology to be followed, and preliminary results, if available.
Students will be required to document the full project in the form of a high-quality final report, about 10-15 pages in length, and make a final presentation to the class. The final presentations from all groups will be made during the final two weeks of class. Other researchers or faculty in the area may be invited to attend these final project presentations.
The projects will be graded on the basis of both team success and individual effort, the midterm and final project reports, and the final project presentations.

Grading Policy

Weekly assignment/paper critiques (best 10): 40%
In-class reading-based presentation 10%
Research project: 50%

Statement for Students with Disabilities

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to the instructor (or to TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m. – 5:00 p.m., Monday through Friday. The phone number for DSP is (213) 740-0776.