CSE 574S
Wireless and Mobile Networking

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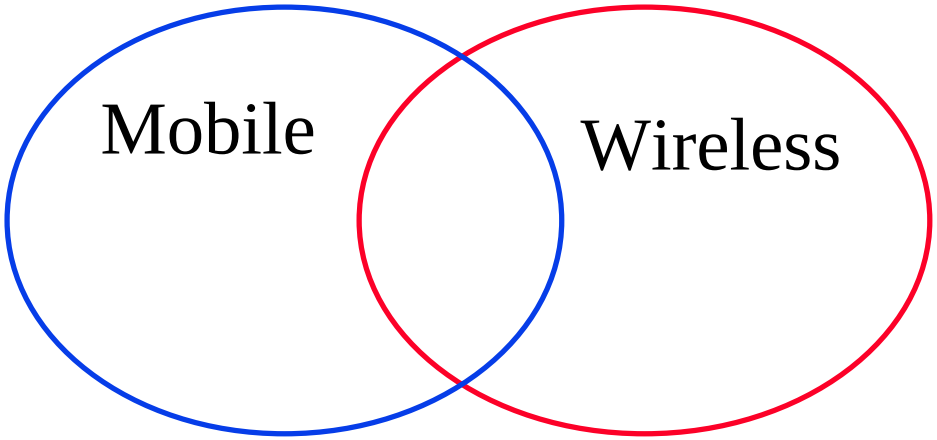
Audio/Video recordings of this lecture are available at:

http://www.cse.wustl.edu/~jain/cse574-10/

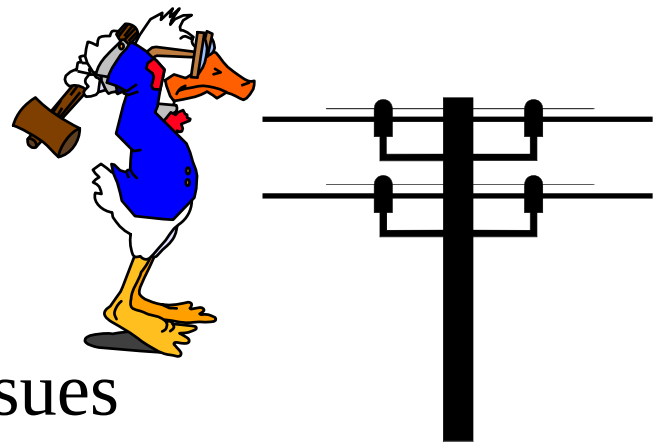
Overview

- Goal of this Course
- Grading
- Contents of the course
- Tentative Schedule

Mobile vs Wireless



- Mobile vs Stationary
- Wireless vs Wired
- Wireless ⇒ Media sharing issues
- Mobile ⇒ Routing, addressing issues



Goal of This Course

- Comprehensive course on wireless and mobile networking
- Broad coverage of key areas
- Intro to physical layer "Wireless Communication"
- Emphasis on Higher layers: Layers 2, 3, 4, …, 7
- Emphasize both present (Industry standards and products) and near future (Research)
- Graduate course: (Advanced Topics)
  ⇒ Less reliance on one textbook
  ⇒ Lot of independent reading and writing
  ⇒ Survey paper (Research techniques)
  ⇒ Peer-Reviews

Grading

- Midterm Exam (Best of 2) 30%
- Final Exam 30%
- Class participation 5%
- Homeworks 15%
- Project 20%

Supplementary Texts

All books are available in Olin Library as 2-hour Reserves.

Physical Layer:

- Farid Dowla (Ed), "**Handbook of RF and Wireless Technologies**," Elsevier, ISBN:0750676957.
- Andreas Molisch, "**Wireless Communications**," Wiley, Nov-05, 668 pp., ISBN:047084888X.
- Charles N. Thurwachter, "**Wireless Networking**," Prentice-Hall, Feb-02, ISBN:0130883662.

WLAN+WPAN+WMAN:

- Aura Ganz, ZviGanz, and Kitti Wongthavarawat, "**Multimedia Wireless Networks: Technologies Standards and QoS**," Prentice-Hall, ISBN:0130460990
- Bob O'Hara, Al Petrick, "**The IEEE 802.11 Handbook: A Designer's Companion**," Institute of Electrical & Electronics Engineers, Mar-05, 365 pp., ISBN:0738144495

Supplementary Texts (Cont)

WiMAX:

- Jeffrey G. Andrews, Arunabha Ghosh, Rias Muhamed, "**Fundamentals of WiMAX: Understanding Broadband Wireless Networking**," Prentice-Hall, ISBN:0132225522.
- Loutfi Nuaymi, "**WiMAX: Technology for Broadband Wireless Access**," Wiley, Mar-07, 310 pp., ISBN:0470028084.

Cellular Networks:

- Lawrence Harte, Richard Levine, Roman Kikta, "**3G Wireless Demystified**," McGraw-Hill, Aug-01, 500 pp., ISBN:0071363017.
- Erik Dahlman, et al, "**3G Evolution**," Academic Press, Jul-07, 496 pp., ISBN:012372533X.
- Savo G. Glisic, "**Advanced Wireless Communications: 4G Cognitive and Cooperative Broadband Technology**," Wiley, Sep-07, 888 pp., ISBN:047005977X.

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Sensor Networks:

- B. Krishnamachari, "**Networking Wireless Sensors**," Cambridge University Press, 2005, ISBN:0521838479

Supplementary Texts (Cont)

Ad-Hoc Networks:

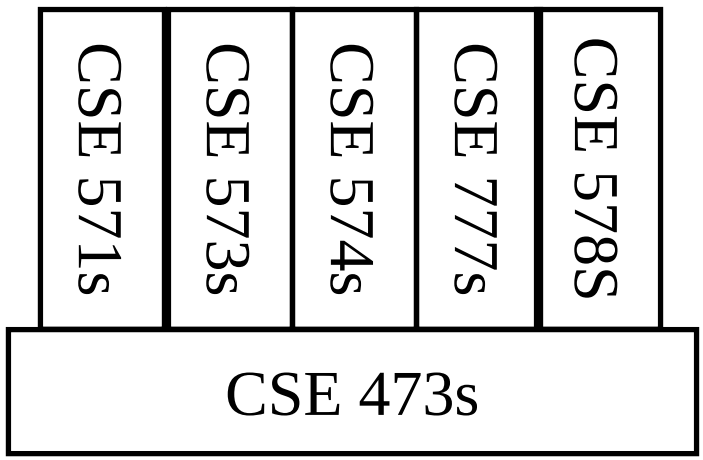
- C. Siva Ram Murthy, B.S. Manoj, "Ad Hoc Wireless Networks : Architectures and Protocols ," Prentice-Hall, 2004, ISBN:013147023X.

Security:

- Jon Edney, William A. Arbaugh, "**Real 802.11 Security : Wi-Fi Protected Access and 802.11I**," Addison-Wesley, 3-Jul, 356 pp., ISBN:0321136209.
- Thomas Hardjono, Lakshminath R. Dondeti , "**Security In Wireless LANS And MANS**," Artech House, ISBN:1580537553

Networking Courses at WUSTL

- CSE 473s: Introduction to Computer Networks
- CSE 571S: Network Security
- CSE 573s: Protocols for Computer Networks
- CSE 574s: Wireless and Mobile Networking
- CSE 578S: Multimedia Computing and Networking
- CSE 777s: Research Seminar in Networking



Prerequisite: CSE473S

- Protocol Layers: ISO/OSI reference model
- Physical Layer: Nyquist/Shannon theorems, Coding, Manchester
- Transmission Media: UTP, Cat 5, Microwave, Radio
- Data Communication: Asynchronous vs synchronous, Baud, bit, and Hz, Half-Duplex vs Full-duplex, Modulation/Demodulation
- Packet Transmissions: Framing, Bit stuffing, byte stuffing
- Flow Control: On-Off, Window
- Error Detection: Parity, Checksum, Cyclic Redundancy Check

Prerequisites (Cont)

- Error Recovery: Start and Stop, Go back *n*, Selective Reject
- LANs: Aloha, CSMA/CD, Ethernet, IEEE 802.3
- LAN Addressing: Unicast vs multicast, Local vs Global
- LAN wiring: 10Base5, 10Base2, 10Base-T, 100Base-T4, 100Base-TX, 100Base-FX
- Extended LANs: Hubs, Bridges, Routers, Switches
- Routing: Distance Vector vs Link State, Spanning tree, source routing
- Network Layer: Connectionless vs connection oriented

Wireless Networking

Impact of Wireless on Networking:

1. Not tied to walls/infrastructure
   ⇒ Ad-hoc networking
2. Error-prone ⇒ Traffic Management
3. Frequent Disconnections
   ⇒ Resource Management
   Quality of Service for multimedia
4. Battery operated
   ⇒ Media access and networking while sleep
   ⇒ Time synchronization
5. Broadcast ⇒ Security

Mobile Networking

Impact of Mobility on Networking:

- Location
- Addressing
- Handoff

Tentative Schedule

Class	Day	Date	Topic
1	Wednesday	1/20/2010	Course Overview
2	Monday	1/25/2010	Wireless Networking: Issues and Trends
3	Wednesday	1/27/2010	Wireless Physical Layer Concepts:Part I
4	Monday	2/1/2010	Wireless Physical Layer Concepts:Part II
5	Wednesday	2/3/2010	Wireless Local Area Networks: Part I
6	Monday	2/8/2010	Wireless Local Area Networks: Part II
7	Wednesday	2/10/2010	Wireless Metropolitan Area Networks: Part I
8	Monday	2/15/2010	Wireless Metropolitan Area Networks: Part II
9	Wednesday	2/17/2010	Wireless Personal Area Networks: Part I
10	Monday	2/22/2010	**Mid-Term Exam 1**

Tentative Schedule (Cont)

Class	Day	Date	Topic
11	Wednesday	2/24/2010	Wireless Personal Area Networks: Part II
12	Monday	3/1/2010	Wireless Cellular Networks: 1G and 2G
13	Wednesday	3/3/2010	Wireless Cellular Networks: 2.5G and 3G
	Monday	*3/8/2010*	*Spring Break (No Class)*
	Wednesday	*3/10/2010*	*Spring Break (No Class)*
14	Monday	3/15/2010	Wireless Cellular Networks: 4G
15	Wednesday	3/17/2010	The IP Multimedia Subsystem
16	Monday	3/22/2010	Femtocells
17	Wednesday	3/24/2010	Recent Advances in Cellular Networks: Part I
18	Monday	3/29/2010	**Mid-Term Exam 2**

Tentative Schedule (Cont)

Class	Day	Date	Topic
19	Wednesday	3/31/2010	Recent Advances in Cellular Networks: Part II
20	Monday	4/5/2010	Mobile IP Part I:IPv4
21	Wednesday	4/7/2010	Mobile IPv6
22	Monday	4/12/2010	Media Independent Handover
23	Wednesday	4/14/2010	TCP over Wireless
24	Monday	4/19/2010	Ad Hoc Networks: Issues and Routing
25	Wednesday	4/21/2010	Wireless Mesh and Multi-Hop Relay Networks
26	Monday	4/26/2010	Wireless Sensor Networks
27	Wednesday	4/28/2010	Radio Frequency Identifier (RFID)
28	Monday	5/3/2010	**Final Exam**

Project

- A survey paper on topic of your choice
  A list of topics will be provided in the class
- Stages:
  - Literature search
    - CD ROMs:Compendex, Books in Print, WWW
  - Reading
  - Writing
- Average 6 Hrs/week/person on project
- Average 9 Hrs/week/person on class

Projects Topics

- **Technologies**: Ultra-wideband, Smart Antennas, Optical Wireless, Software Defined Radios, Smart Antennas, Turbo Coding, RFID, Satellite Networks (What, Standards activities, Products, Features, Outlook, Applications)
- **Standards**: 802.11 WiFi, 802.15 PANs, 802.16 WiMAX, 802.20 Mobile Broadband, 802.21 Handover, 802.22 RAN, 4G, 3G, WiMAX (Standards Activities, MAC, Energy Management, QoS, Security, Packet Format, Products, Features, Outlook, Applications)
- **Wireless Products**: Wireless Access Points: Key features, Wireless Switches: Key features
- **Data link**: Energy Efficient MAC, MAC Protocols for Ad-hoc, MAC protocols for Sensor, Gigabit Wireless, QoS in Wireless, QoS in WiMAX, QoS in Wi-Fi, QoS in 3G, QoS in 4G

Project Topics (Cont)

- **Network Layer**: Mobile Ad-hoc Networks, Energy Efficient Routing, Multicast routing, IPv6 over PANs, Ad-hoc network auto-configuration, Mobility for IPv4, Mobility for IPv6, Network Mobility, Signaling and Handoff in IPv6, Localization in Wi-Fi Networks, Localization in 3G, Localization in 4G, Wireless Mesh Networks
- **Transport Layer**: TCP over Wireless
- **Applications**: WAP, Mobile TV, Voice over Wireless, Mobile Multimedia, IP Telephony over Mobile Networks, Wireless Games, Medical Applications of Wireless, Multimedia over 802.11, Inter-Vehicular Wireless Communication
- **Security**: 802.11 security issues, Wireless, Cellular, Ad-hoc, Sensor, Security Issues in Mobility, Security devices for Wireless
- **Management**: Radio Spectrum Management

Project Schedule

Mon 2/17/10	Topic Selection
Mon 3/01/10	References Due
Mon 3/15/10	Outline Due
Mon 4/05/10	First Draft Due
Mon 4/12/10	Reviews Due
Mon 4/19/10	Final Report Due

Project Requirements

- Recent Developments: Last 3 to 5 years
  ⇒ Generally not in books
- Comprehensive Survey:
  Technical Papers, Industry Standards, Products
- Will be published on my website,
  Better ones may be submitted to magazines or journals
- No copyright violations:
  ⇒ You need to re-draw all figures
  ⇒ You need to summarize all ideas in your *own* words
  ⇒ Cannot copy any part of text or figure unmodified
  ⇒ Short quotes ok
  ⇒ Any unmodified figures need permissions
  Any infringement will result in forfeiture of grades even after graduation.

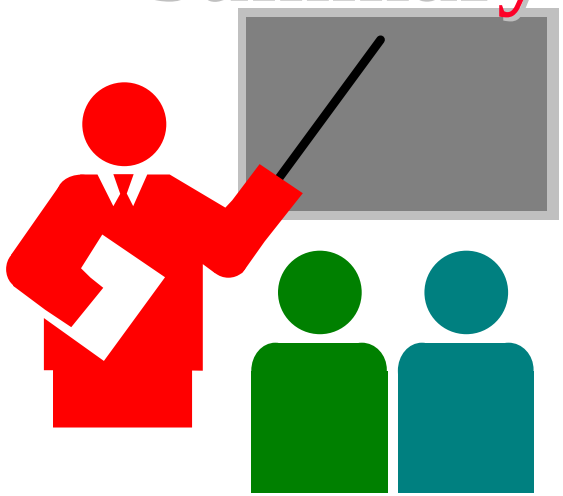
Office Hours

- Monday: 11:00 to 12:00 noon
  Wednesday: 11:00 to 12:00 noon
- Office: Bryan 523
- **Teaching Assistant**: Subharthi Paul, Jolly 509
  spaul@wustl.edu
  Thursday 12 noon-1PM in Jolly 509
  Sunday 5-6PM in Bryan 516

Frequently Asked Questions

- Yes, I do use "curve". Your grade depends upon the performance of the rest of the class.
- All homeworks are due on the following Monday unless specified otherwise.
- Any late submissions, if allowed, will *always* have a penalty.
- Exams consist of numerical as well as multiple-choice (true-false) questions.
- There is negative grading on incorrect multiple-choice questions. Grade: +1 for correct. -1/(n-1) for incorrect.
- Everyone including the graduating students are graded the same way.

Summary



- There will be a lot of self-reading and writing
- Goal: To prepare you for a career in wireless networking
- Get ready to work hard

Project Homework 1

- Search web pages, books, and journal articles from ACM Digital Library, Applied Science, Compendex, ABI/INFORM Complete, and Knovel databases at Olin Library for one of the following topics:
  - Networking Trends
  - Wireless Networking Trends
  - Mobile Networking Trends
- On the web try the following search points:
  - http://library.wustl.edu/findart.html
  - http://library.wustl.edu/fulltext/
  - http://scholar.google.com
  - http://books.google.com
  - http://a9.com/

Project Homework 1 (Cont)

- http://www.scirus.com/srsapp/
- http://searchnetworking.techtarget.com/bestWebLinks/
- See also http://www.searchengineguide.com/pages/Science/

- Ignore all entries dated 2005 or before. Also ignore all entries that do not indicate trends in the title. List others in the following format (up to 5 each):
  - Author, "Title," publisher, year. (for 5 books)
  - "Title," URL [One line description] (for 5 web pages)
  - Author, "Title," source (for 5 technical/magazine articles)
- Serially number the references and submit electronically to jain@cse.wustl.edu. The mail should have a subject field of "CSE 574S Homework 1" (Please note the subject carefully)
- Make a list of other interesting search points and share with the class.

Quiz 0: Prerequisites

True or False?

T F

- ❑ ❑ Datalink refers to the 2nd layer in the ISO/OSI reference model
- ❑ ❑ Cat 5 unshielded twisted pair cable is better than Cat 3 cable.
- ❑ ❑ Finding path from one node to another in a large network is a transport layer function.
- ❑ ❑ It is impossible to send 3000 bits/second through a wire which has a bandwidth of 1000 Hz.

Quiz 0 (Cont)

- ❑ ❑ Bit stuffing is used so that characters used for framing do not occur in the data part of the frame.
- ❑ ❑ For long delay paths, on-off flow control is better than window flow control.
- ❑ ❑ Ethernet uses a CSMA/CD access method.
- ❑ ❑ 10Base2 runs at 2 Mbps.
- ❑ ❑ The packets sent in a connection-oriented network are called datagrams.
- ❑ ❑ Spanning tree algorithm is used to find a loop free path in a network.

Marks = Correct Answers ___ - Incorrect Answers __

Student Questionnaire

- Name: _____
- Email: _____
- Phone: _____
- Degree: _____ Expected Date: _____
- Technical Interest Areas:

  _____

  _____
- Prior networking related courses/activities:

  _____

  _____
- Prior wireless networking related courses/activities:

  _____

  _____