CSE 574S
Wireless and Mobile Networking

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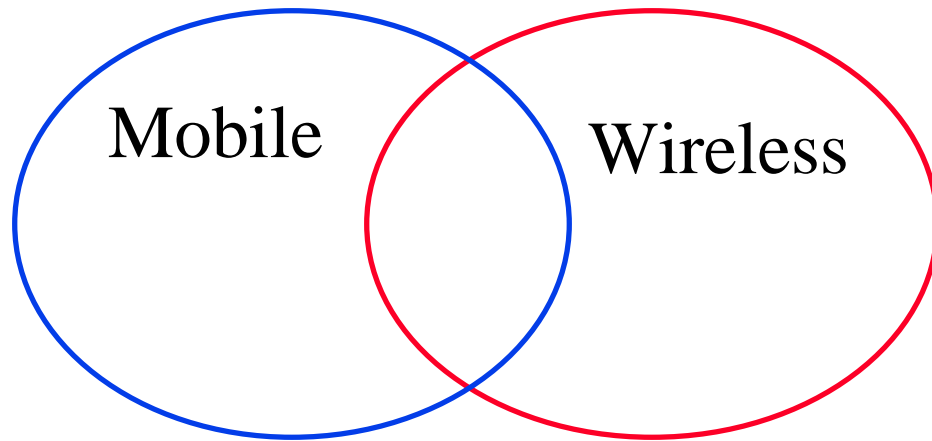
These slides are available on-line at:

http://www.cse.wustl.edu/~jain/cse574-08/

Overview

- For this semester:
  Advanced Topics = Wireless and Mobile Networking
- Goal of this Course
- Grading
- Contents of the course
- Tentative Schedule

Mobile vs Wireless

Mobile   Wireless

❑ Mobile vs Stationary

❑ Wireless vs Wired

❑ Wireless $\Rightarrow$ Media sharing issues

❑ Mobile $\Rightarrow$ Routing, addressing issues
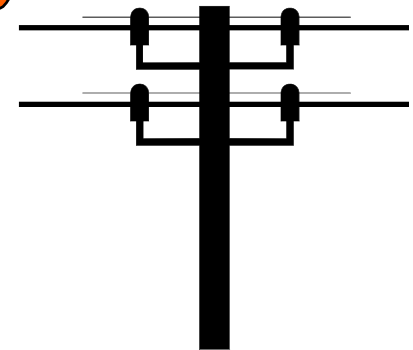
Goal of This Course

❑ 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

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 Enginee, 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:0470028087.

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: Advanced Topics in Networking

❑ CSE 777s: Research Seminar in Networking

CSE 571s	CSE 573s	CSE 574s	CSE 777s	CSE 578S
CSE 473s				

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
    $\Rightarrow$ Ad-hoc networking

2. Error-prone $\Rightarrow$ Traffic Management

3. Frequent Disconnections
    $\Rightarrow$ Resource Management
   Quality of Service for multimedia

4. Battery operated
    $\Rightarrow$ Media access and networking while sleep
    $\Rightarrow$ Time synchronization

5. Broadcast $\Rightarrow$ Security

Mobile Networking

Impact of Mobility on Networking:

❑ Location

❑ Addressing

❑ Handoff

Tentative Schedule

Class	Day	Date	Topic
1	Monday	1/14/2008	Overview
2	Wednesday	1/16/2008	Networking Trends
3	Monday	1/21/2008	Wireless Physical Layer
4	Wednesday	1/23/2008	Wireless Physical Layer
5	Monday	1/28/2008	Wireless Physical Layer
6	Wednesday	1/30/2008	Wireless Local Area Networks (WLANs)
7	Monday	2/4/2008	WLANs
8	Wednesday	2/6/2008	WLANs
9	Monday	2/11/2008	Wireless Personal Area Networks (WPANs)
10	Wednesday	2/13/2008	WPANs
11	Monday	2/18/2008	Exam 1

Tentative Schedule (Cont)

Class	Day	Date	Topic
12	Wednesday	2/20/2008	Wireless Metropolitan Area Networks (WMANs)
13	Monday	2/25/2008	WMANs
14	Wednesday	2/27/2008	WMANs
15	Monday	3/3/2008	Media Independent Handover: IEEE 802.21
16	Wednesday	3/5/2008	Wireless Regional Area Networks IEEE 802.22
	Monday	3/10/2008	Spring Break
	Wednesday	3/12/2008	Spring Break
17	Monday	3/17/2008	Cellular Networks (1G, 2G)
18	Wednesday	3/19/2008	2.5G
19	Monday	3/24/2008	3G
20	Wednesday	3/26/2008	Midterm Exam 2

Tentative Schedule (Cont)

Class	Day	Date	Topic
21	Monday	3/31/2008	4G
22	Wednesday	4/2/2008	Cellular Applications: IMS
23	Monday	4/7/2008	Cellular Applications: IMS
24	Wednesday	4/9/2008	Mobile IPv4
25	Monday	4/14/2008	Mobile IPv6
26	Wednesday	4/16/2008	Handover
27	Monday	4/21/2008	Ad-Hoc Networks
28	Wednesday	4/23/2008	Sensor Networks
29	Monday	4/28/2008	Mesh Networks
30	Wednesday	4/30/2008	Final Exam
	Monday	5/5/2008	Grades Due

Project

❑ A survey paper on topic of your choice

❑ 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 2/20/08   Topic Selection

Mon 3/03/08   References Due

Mon 3/17/08   Outline Due

Mon 4/07/08   First Draft Due

Mon 4/14/08   Reviews Due

Mon 4/21/08   Final Report Due

Project Requirements

- Recent Developments: Last 3 to 5 years
  $\Rightarrow$ 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:
  $\Rightarrow$ You need to re-draw all figures
  $\Rightarrow$ You need to summarize all ideas in your *own* words
  $\Rightarrow$ Cannot copy any part of text or figure unmodified
  $\Rightarrow$ Short quotes ok
  $\Rightarrow$ 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 405D

Why You Shouldn't take this course?

❏ You aren't ready for the hard work

❏ You don't have 15 hours/week

❏ You don't have the background

❏ You just want to sit and listen

❏ You were expecting an introductory course

❏ You are not ready to take the initiative
Only key concepts will be covered in the class.
Students are expected to research and read.

❏ This does not cover what you want

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
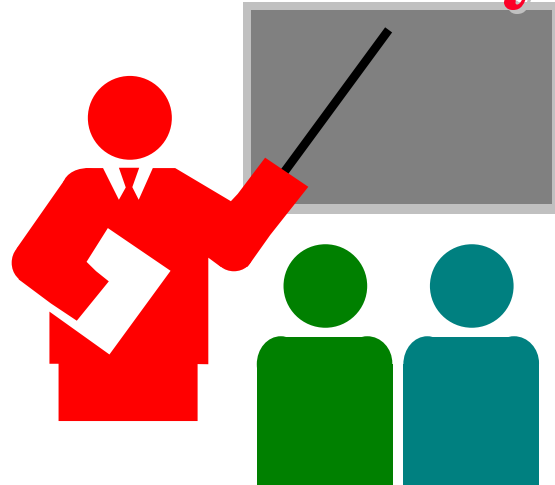
❑ There will be a lot of self-reading and writing

❑ 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 <u>one</u> 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 2003 or before. 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:

  _____

  _____