

CSE 574S

Wireless and Mobile Networking

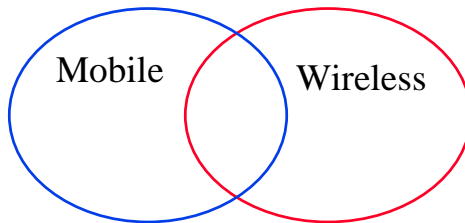
Raj Jain
Washington University in Saint Louis
Saint Louis, MO 63130
Jain@cse.wustl.edu

These slides are available on-line at:
<http://www.cse.wustl.edu/~jain/cse574-08/>

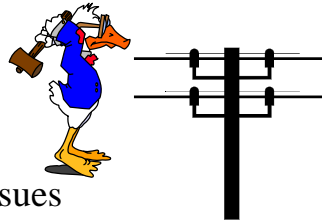


- ❑ For this semester:
Advanced Topics = Wireless and Mobile Networking
- ❑ Goal of this Course
- ❑ Grading
- ❑ Contents of the course
- ❑ Tentative Schedule

Mobile vs 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)
 - \Rightarrow Less reliance on one textbook
 - \Rightarrow Lot of independent reading and writing
 - \Rightarrow Survey paper (Research techniques)
 - \Rightarrow 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. Thurwacher, "[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 Engineer, 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.

Supplementary Texts (Cont)

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.

Sensor Networks:

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

Supplementary Texts (Cont)

Ad-Hoc Networks:

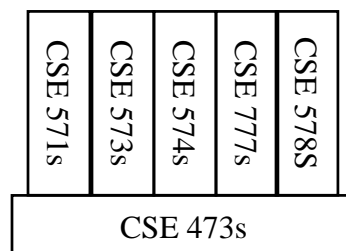
- ❑ C. Siva Ram Murthy, B.S. Manoj, "[Ad Hoc Wireless Networks : Architectures and Protocols](#)," Prentice-Hall, 2004, ISBN:013147023X.

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



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	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
 - ⇒ 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 permissionsAny 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

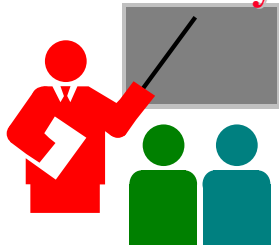
Why You Shouldn't take this course?

- ❑ 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 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.techtargget.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:

