

CSE 574S

Advanced Topics in Computer Networking

Raj Jain
Washington University
Saint Louis, MO 63131
Jain@cse.wustl.edu

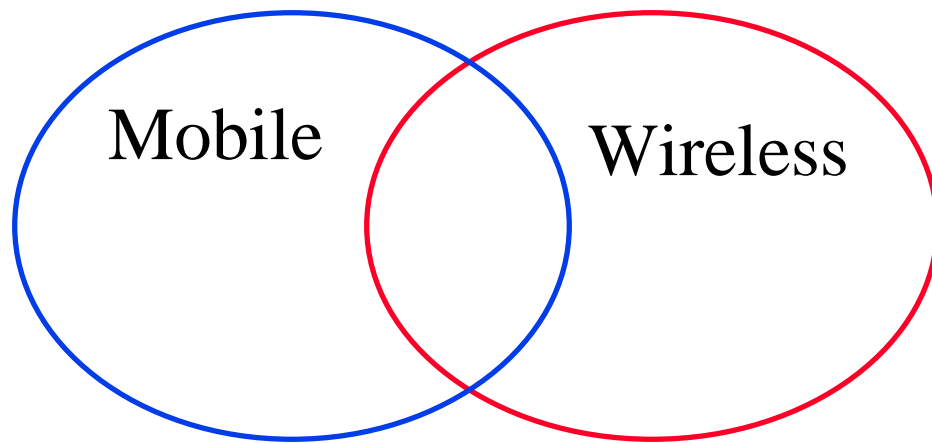
These slides are available on-line at:

<http://www.cse.wustl.edu/~jain/cse574-06/>

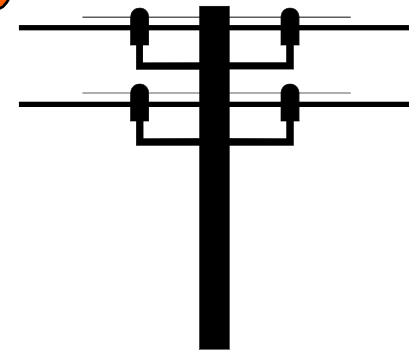


- ❑ For this semester:
Advanced Topics = Wireless and Mobile Networking
- ❑ Goal of this Course
- ❑ Grading
- ❑ Contents of the course
- ❑ Tentative Schedule

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
- ❑ Very brief 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

- ❑ Exams (Best 2 of 3) 45%
- ❑ Class participation 5%
- ❑ Homeworks 15%
- ❑ Project 35%
 - Homeworks 10%
 - Draft Report 5%
 - Final Report 20%

Text Books

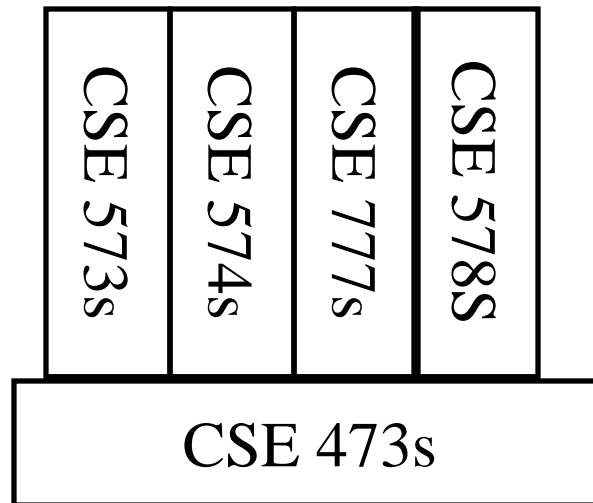
- ❑ C. Siva Ram Murthy and B. S. Manoj, “Ad-Hoc Wireless Networks: Architectures and Protocols,” Prentice-Hall, 2004, ISBN:0-13-147023-X
- ❑ S. Dixit and R. Prasad, “Wireless IP and building the mobile Internet,” Artech House, 2002, ISBN:158053354X
- ❑ Bulk purchase possible.

Supplementary Texts

- ❑ F. Dowlal (Ed), “Handbook of RF and Wireless Technologies,” Elsevier, 2004, ISBN:0750676957
- ❑ H. Karl and A. Willig, “Protocols and Architectures for Wireless Sensor Networks,” Wiley, 2005, ISBN:0470095105
- ❑ M. Cardei, et al, (Eds), “Resource Management in Wireless Networking,” Springer, 2005, ISBN:0387238077
- ❑ B. Krishnamachari, “Networking Wireless Sensors,” Cambridge University Press, 2005, ISBN:0521838479
- ❑ M. Ilyas and I. Mahgoub, “Handbook of Sensor Networks: Compat Wireless and Wired Sensing Systems,” CRC Press, 2004, ISBN:0849319684

Networking Courses at WUSTL

- ❑ CSE 473s: Introduction to Computer Networks
- ❑ 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	Wed	1/18	Overview
2	Mon	1/23	Trends
3	Wed	1/25	Wireless Physical Layer
4	Mon	1/30	LANs (Wi-Fi)
5	Wed	2/1	PANs (Bluetooth)
6	Mon	2/6	WAN (WiMAX)
7	Wed	2/8	Sensors (ZigBee)
8	Mon	2/13	Cellular Nets (1G, 2G)
9	Wed	2/15	Cellular Nets (3G, 4G)
10	Mon	2/20	Optical Wireless, RFID, Satellite
	Wed	2/22	Exam 1

Tentative Schedule (Cont)

Class	Day	Date	Topic
11	Mon	2/27	QoS in 802.11
12	Wed	3/1	QoS in Wireless Networks
13	Mon	3/6	Wireless TCP
14	Wed	3/8	TCP over Ad-hoc
	Mon	3/13	Spring Break
	Wed	3/15	Spring Break
15	Mon	3/20	Energy Management
16	Wed	3/22	Energy Management 2
17	Mon	3/27	Topology Control
18	Wed	3/29	Localization
19	Mon	4/3	Time Synchronization
	Wed	4/5	Exam 2

Tentative Schedule (Cont)

Class	Day	Date	Topic
20	Mon	4/10	Resource Allocation
21	Wed	4/12	Mobile IP
22	Mon	4/17	Handover
23	Wed	4/19	Application Layer Issues
24	Mon	4/24	Security Issues
25	Wed	4/26	Security 2
26	Mon	5/1	Security 3
	Wed	5/3	Exam 3
	Mon	5/8	Grades Meeting

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 2/06/06	HTML Writing Sample
Mon 2/13/06	Topic Selection
Mon 2/27/06	References Due
Mon 3/06/06	Literature Due
Mon 4/10/06	First Draft Due
Mon 4/17/06	Reviews Due
Mon 4/24/06	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: 3:30 to 4:30 PM
Wednesday: 3:30 to 4:30 PM
- Office: Bryan 405D

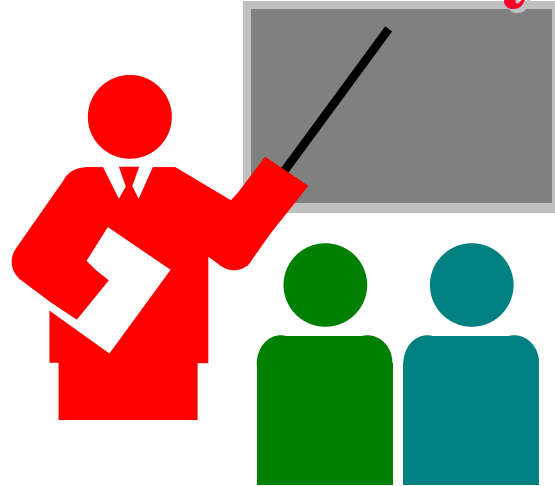
Why You Shouldn't take this course?

- ❑ 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.
- ❑ All exams are open-book and extremely time limited.
- ❑ 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://citeseer.ist.psu.edu/>
- <http://www.scirus.com/srsapp/>
- <http://searchnetworking.techtarget.com/bestWebLinks/>
- See also <http://www.searchengineguide.com/pages/Science/>
- ❑ Ignore all entries dated 2002 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 ____