# CS410 Networks and Networking

Fall 2012

Beenish Chaudhry

1:00pm – 2:20pm, Tuesday & Friday

1: Introduction

# Introductions

- Name
- Major
- Year
- Number of computer science courses taken previously?
- Comfort level with programming/ mathematics?
- Why taking this course?
- What do you hope to learn?
- How many courses you are taking this semester?
- Other extra curricular activities?
- Anything else you want to tell me

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Course Objectives
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- Course Objective: Have some fun, and learn about how modern networks work, with emphasis on the practical applications that most of you see and use every day.
- Not a study of the OSI model, or older technologies and protocols.
- Not a certification course for Network Specialists.
- Not a study of network hardware or data communications equipment

## Preliminaries

- Instructor: Beenish Chaudhry
- Email: (bchaudhry@cs.earlham.edu)
- Required Text: <u>Computer Networking A Top-Down Approach</u> <u>Featuring the Internet</u>, 5<sup>th</sup> edition, Kurose-Ross (ISBN: 0-321-22735-2)
- Reference Texts: (interesting supplements, but not required): <u>Computer Networks</u>, 5<sup>th</sup> Edition, Tanenbaum (0-13-066102-3), and <u>Network Security Essentials – Applications and Standards</u>, 3<sup>rd</sup> Edition, Stallings (0-13-035128-8)

### **Web Site:**

http://cs.earlham.edu/~bchaudhry/teaching/cs410.html

Schedule, Syllabus, Class Materials/Information, Home works

## • Email - will be used for time-critical info

## Schedule

- Ambitious... and may be modified... check web site frequently
- Attendance... <u>expected</u>, but not explicitly graded.
  - Attendance may be taken at any time.

## Make-Up Policy

- □ Homework, Programs/Projects: 10%/day, <u>max of 40%</u>, then zero
- Quizzes and Exams: <u>NO</u> make-ups. <u>NO</u> early quizzes/exams, <u>Absence = zero</u> grade.

## Grading Policy

- No. of Homework Assignments: 5-10
- Homework: 50%
- Midterm: 10%
- Quizzes: 15%
- Final: 25%

### Final Grade Assignment (guideline only)

- Based on final numeric score out of 100% possible:
  - A 100-90
  - ▶ B 89-80
  - C 79-70
  - D 69-60
  - F 59 & below
- Probable final grade curve based on class performance

- Honesty... expected, dishonesty will not be tolerated
  - Discussions, brainstorming are encouraged, <u>HOWEVER</u>
  - Homework, Programming Assignments, Quizzes etc. are to be solely <u>YOUR individual work</u>
  - See the Earlham Academic Honesty Policy

### **Office Hours**

- General Rule: Open office hours unless I have a note on my door
- Individual grades or questions on grading of individual quizzes, exams, etc. are discussed only during office hours (i.e. NOT at the end of the class period or over email)

### Various Other "Stuff"

- Quizzes and exams will cover topics from classroom discussion, presentation slides (unless specifically eliminated, whether covered in class or not), and assigned reading.
- Policy for letters of recommendation/reference only after end of the semester (final grades assigned), and must rank in top 10 - 15% of class.

## Disclaimer

- Material will be liberally taken from the textbook, Wikipedia, and other online sources
- Material for the slides is taken from slides that come with the textbook, Jim Rogers, Omprakash Gnawali, Mike O'Dell, and many others

# What's this all about??

- What really happens when I.....?
- How does my email get from point a to point b?
- What do all these network "buzzwords" mean to me?
- Why does my browser respond slowly at times?
- How does an IP address actually find a web site?



# Learning Approach: Top-Down

- Computer Networks and the Internet (Ch. I)
  - Overview of network components and the Internet
- The Application Layer (Ch. 2)
  - How you get work done in the network
- The Transport Layer (Ch. 3)
  - Why your data gets there
- The Network Layer & Routing (Ch. 4)
  - How your data finds its way
- The Data Link Layer & LANs (Ch. 5)
  - What ties the network pieces together
  - IEEE 802.11 Wireless LANs (Ch. 6)
    - Connectivity on the go
  - Network Security (Ch. 8)
    - Who's out there? Meet Bob, Alice & Trudy



Brief overviews

## Chapter 1: Introduction

### Our goal:

- get context, overview, and the general "feel" of networking
- Sets the stage for future topics, details *later* in course
- approach:
  - descriptive
  - use Internet as example and basis for learning

## Roadmap:

- What is the Internet?
- What's a protocol?
- network edge
- network core
- access net, physical media
- performance: loss, delay
- protocol layers, service models

## What's the Internet: a service view

- Infrastructure for providing services to distributed applications such as
  - Email, instant messaging, web surfing, remote login
- instructs one piece of software to deliver data to another piece of software on another end-system)
  - API: set of rules that sending piece of software must follow so that the internet can deliver the data to the destination software



# What's the Internet: a nuts & bolts view

- millions of connected computing devices running network apps
- communication links
  - Types: fiber, copper, radio, satellite
  - transmission rate = bandwidth
- routers/switches: forward packets (chunks of data) between networks
- Examples of connected devices:
  - Desktops and Laptops
  - Servers
  - TV/ Refrigerator
  - Cellphones



## What's the Internet: a nuts & bolts view

- protocols control sending, receiving of msgs
  - e.g., **TCP**, **IP**, HTTP, FTP, PPP
- Protocol design standards (RFC: Request for comments) developed by IETF: Internet Engineering Task Force



## What's a protocol?



# What's a protocol?

#### human protocols:

- "What time is it?"
- "I have a question"
- Introducing people to each other
- ... specific messages sent
  ... specific actions taken
  when messages received,
  or other events

### network protocols:

- machines rather than humans
- all communication activity in the Internet is governed by protocols

protocols define format, order of messages sent and received among network entities, and actions taken on message transmission and/or receipt

# A closer look at network structure

- network edge: applications and hosts
- access networks, physical media: communication links
- network core:
  - routers
  - network of networks



# What is a network edge?

# end systems (hosts): desktop, laptops, servers

- run application programs
- e.g.,WWW, email
- at "edge of network"

## Types of Network Edge

- client/server model
  - client host requests, receives service from server
  - e.g., WWW client (browser)/Web server; email client/mail server
- peer-peer model:
- both parties send and receive data
- host interaction symmetric
- e.g.: internet telephony, groupware, file sharing



- Physical links that connect an end system to the first router (edge router) on the path to another end system
- Various Types
  - Residential access nets
  - institutional access networks (school, company, organization)
  - mobile access networks

### Key considerations:

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- bandwidth (bits per second) of access network?
- shared or dedicated?



## Dial Up

- Residential Access
- User's software dials an ISP's phone number to make a connection
- Uses analog phone line for transmission
- Digital output -> analog output
- Disadvantages:
  - Very slow
  - Either phone or internet access

## DSL

- Teleco is also ISP
- Splitter separates data and telephone signals on the user's side
- Telephone lines are used to exchange data and carry both data and telephone signals
- Digital Subscriber Line Access Multiplexer (DSLAM)
- Faster transmission (dedicated)
- Use phone and internet simultaneously
- Ideal for short distances

### Cable

- Residential Access
- Makes use of cable television company's infrastructure
- Shared medium (several end systems are served)
- Faster than DSL according to some

#### <u>Ethernet</u>

- Access technology for LANs (corporate and university campuses)
- Users can have data for up to 100 Mbps

## ► <u>WIFI</u>

- <u>wireless LANs</u> (packets transmitted to access point connected to a wired Internet)
- wireless WAN (packets transmitted to a base station over the cellular phone infrastructure) 1: Introduction

### WIFI

- <u>wireless LANs</u> (packets transmitted to access point connected to a wired Internet)
- <u>wireless WAN</u> (packets transmitted to a base station over the cellular phone infrastructure)
- Many homes combine broadband residential access with wireless LANs

### WAN

- Teleco have invested in 3G wireless which provides packet switched WAN at speeds excess of IMbps
- Use cellular phone infrastructure
- Read <u>Fiber to the Home</u>

# Physical Media

- physical link: transmit data bit from source to destination through many intermediaries
- guided media:
  - signals propagate in solid media: copper, fiber
- unguided media:
  - signals propagate in atmosphere and in outer space, such as wireless LAN or digital satellite channel

#### Twisted Pair (TP)

- two insulated copper wires
  - Traditional telephone lines
  - Wireless twisted together to reduce electrical interference
  - Used for LANs, residential access
  - Data rates: thickness, length



# Physical Media: coax, fiber

## Coaxial cable:

- Consists of two concentric copper conductors
- High bit rates (I Mbps)
- Cable internet coupled with cable television (carry two signals at the same time)
- Guided shared medium (number of end systems can be directly connected)

## Fiber optic cable:

- glass fiber carrying light pulses
- high-speed operation
- low error rate (immune to electromagnetic interference)
- Limited use due to high cost





# Physical media: radio

- signal carried in electromagnetic spectrum
- Advantages:
  - Penetrate walls
  - No physical wire
  - Connectivity to mobile user
  - Carry signals for a long distance
- Propagation environment:
  - Path loss and shadow fading
  - Decrease signal strength
  - Multipath fading
  - Interference

## Terrestrial Radio Channels

- LAN (Span ten to a few hundred meters)
- ✓ WAN (e.g., cellular)

# Satellite Radio Channels

 Geostationary or low earth orbiting satellites link two or more earth based microwave transmitter/receivers