Today’s topics

Computer Applications
  Computer Communications

Upcoming
  Computer Security
    (Great Ideas, Chapter 11)

Reading
  Great Ideas, Chapter 12
Computer Communications

- **One of the GREAT Ideas**
- **Modes of Communications**
  - Computer and humans communicate
    - Early “time sharing”
  - Computers talk to each other
    - ARPA Net (predecessor of Internet)
  - Now, Humans use computer to talk to other humans
    - Email, chat, ..
    - News: started at Duke Computer Science
    - IRC
    - Voice
    - Video
Computer Communications

- Like most computing, Layers Upon Layers
  - Hardware Layer
  - Software Layers (several)

- Basic Communications
  - In binary
  - Represented by *something* over some *medium* by *something*
  - Started with terminals connect to computers
  - Communicated by voltages (currents) on wires (teletype)
  - Then *modems* allowed communication over phone lines
    - Turn binary representing voltage into *audio tones*
    - Dial-up computer communications
    - Time sharing systems
    - Bulletin boards
    - USENET (first at *Duke, UNC*, then Bell Labs … the *world!*)

CPS 001
Basic Communications

- **Medium**
  - Fixed (hard wired)
  - Telephone (dial up)
  - Broadband Wired (phone: DSL, cable, LAN)
  - Wireless (local, cell, satellite)

- **Topography**
  - Star
  - Point to Point
  - Ring
  - Bus
  - Network
Connection Modes

- **Circuit Switched**
  - Connection made
  - E.g., telephone system
  - *Exclusive use* of part of medium
  - Interactive use possible

- **Message Switched**
  - Store and forward (email)
  - Batch
  - *Shared* facilities

- **Packet Switched**
  - *Shared* medium
  - Interactive use possible
Ethernet (Bus Example)

- Also loosely called Local Area Network (LAN)
- Many *nodes* (hosts, computers, stations…) on same *bus*
- Each node has an *address*
  - Called machine or Mac address
  - Guaranteed to be unique!
- All messages “broadcast” in packets with destination (dest) and source (src) address
  - (See diagrams on web)
- Everyone “listens” for their address
  - Potential security problem!
- Collisions possible
  - *Random* back-off on collision
Internets – Networks of LANs

- Can interconnect multiple LAN’s using a “LAN”
  - Could be a WAN (wide area network)
- Interconnected LAN’s result in internet
  - Note: not the same as the Internet
  - (See diagrams on web)
- Packets: the currency of the Internet
  - At all levels, packets allow
    - Sharing of bandwidth
    - Discrete units of work
    - Error checking and correction
  - Each packet includes destination and source address
TCP/IP: The Layers of the Internet

- TCP/IP is the family of *protocols* used on the Internet
- Multiple Layers are Defined
  1. The Physical Layer
     - Hardware (e.g., Ethernet - - - other used)
     - The Ethernet packet
  2. The IP (Internet Protocol) Layer
     - The IP Packet
     - Provides hardware independence
  3. The TCP (Transmission Control Protocol) Layer
     - The TCP packet
     - Value added (connections, guaranteed results, …)
  4. The Application Layer
     - E.g., email, news, …
TCP/IP: Nesting of Packets

- Use of the TCP/IP layers requires *nesting* of packets
- Each packet on one layer carries the info of the next layer(s) as data
  - (See the diagram on the web)
- **Reliability**
  - Checksums to verify correctness
  - Acknowledgements
    - Handshaking protocols
  - Resends as required on error detection
    - Errors cut down effective bandwidth
    - Errors increase response time
TCP/IP: Addressing

- **Hardware Address (Ethernet Address)**
  - Unique 6 octet (8 bit byte) number
  - Usually 6 groups of two hex digits: e.g., `b3 fe 13 21 a5 41`
    - (Hexadecimal numbers ...)
  - Centrally administered

- **IP Address data**
  - 4 octet number: e.g., `152.3.141.45`
  - Usually 4 decimal numbers separated by periods
  - 2 parts
    - Network part
    - Host part
    - Variable dividing line between network and host portion
  - Centrally administered
TCP/IP: Addressing (continued)

- **Domain Name**
  - Hierarchical system
  - Root:
    - \( \text{edu, com, gov, mil, net, org or country code} \)
  - \( \text{host-name.sub-organization.organization.} \ldots \)
  - E.g., \( \text{dollar.cs.duke.edu} \)
  - Person on host is, e.g., \( \text{ramm@dollar.cs.duke.edu} \)
  - Centrally administered

- **Use of these addresses**
  - Eventually need hardware address
  - Most address automatically located
  - Handling changes ...
Applications

- Store and Forward
  - Email
  - News

- Interactive Utilities
  - ftp (big before web)
    - Anonymous
    - Archives
    - Free software
    - Weather maps
  - telnet (secure form is ssh)
    - Use a remote computer interactively
Applications

- **Interactive Communications**
  - Talk (many variations: chat, AIM, ...)
  - IRC
  - LD Telephone replacements
  - Amateur radio links

- **Information services**
  - WWW
  - Older Predecessors: gopher, WAIS

- “Sharing” systems
  - Legality?
Client / Server Model

- **Print Servers**
  - Share Expensive (was once) Printer
    - Machine with printer provides *server*
    - Other machines with *clients* can use remote printer

- **File Servers**
  - UNIX: remote file systems
    - Network File System (NFS): Computer Science uses this
    - Andrews File System (AFS): OIT uses this

- **Name Server**
  - Supports domain addressing

- **Web Servers**
  - The basis for all web access
  - Clients like Netscape, Internet Explorer, new ones …

- **IRC**