15.561

Information Systems: *From Information Infrastructure to the Networked Corporation*

15.566

Information Technology as an Integrating Force in Manufacturing

Session 2
Smaller World

OBJECTIVES

- Smaller World
- Layering of Communications
- Digital Convergence
- Information Infrastructure & Networks
- Packet Switching Technology
- Internet
- World-Wide Web
- Impact on Business

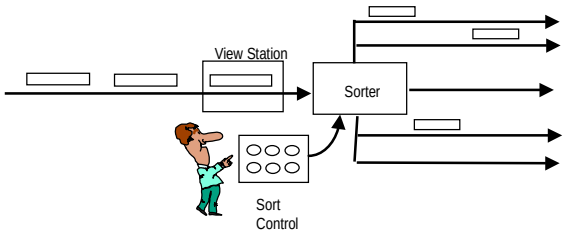
Acknowledgment: Some of the material is based upon lecture notes prepared by Prof. David Tennenhouse of the MIT Laboratory for Computer Science.

Smaller World - Impact of Technology

- **Physical transportation**
  - Walk, horse, train, car, plane
  - Socioeconomic impacts: suburbs, malls, highways, gas stations
- **Communication**
  - Mechanical: smoke signals, carrier pigeons
  - Electronic: telegraph, telephone, radio, television

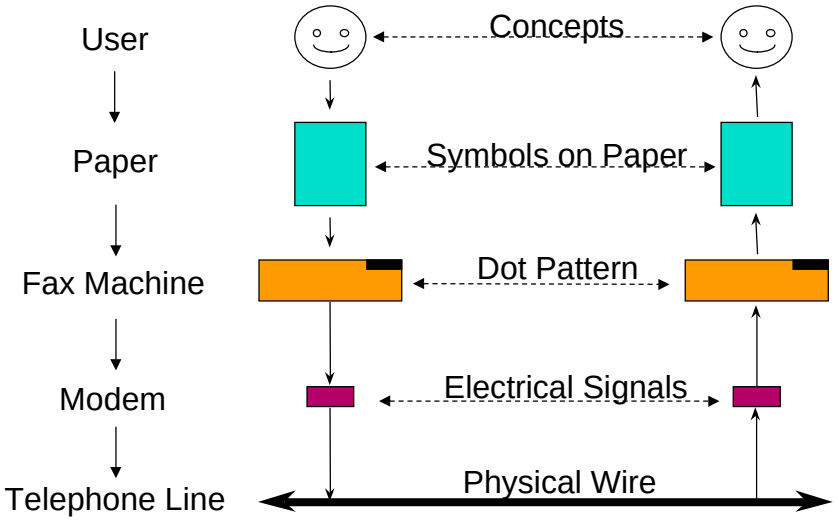
SMALLER WORLD

- **Re-think assumptions about space and time**
- ***Example:*** **Letter-sorting at Post Office in NYC**



- **How can this be improved?**

LAYERING OF COMMUNICATIONS
Example: Sending a fax



MORE FORMALLY…

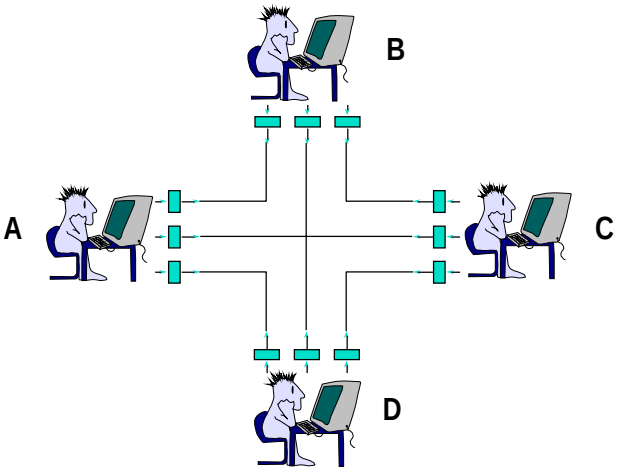
- **Layering**
  - Telecommunication is achieved through layered exchange of symbols**.**
- **Digital Coding/ Conversion**
  - At each lower layer, information is *coded* in a more primitive language.
  - The upper layers don't care what language is used by the lower layers, and vice versa!
- **Digital is the common denominator = <u>digital convergence</u>**

- Data	- Video (broadcast)	- Meter reading
- Voice	- Video (multi-media)	- etc.

- **Everything is going digital!**
  - Thus, everything can share the same communication channels.

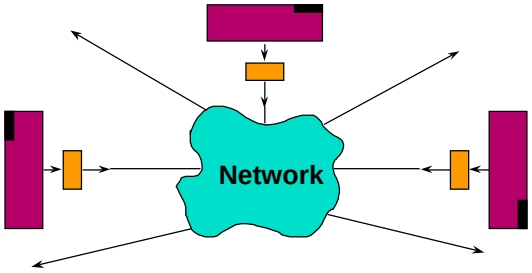
WHY BUILD NETWORKS?

- How does one person communicate with multiple others?



Full Connectivity doesn't scale!

NETWORKS ARE ABOUT SHARING!



- **The network allows an entity to switch its attention among a large number of others**
- **Permits sharing of resources attached to the network, including the resources of the network itself.**

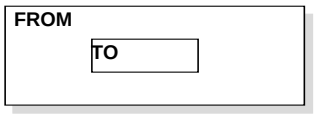
LOCAL AND WIDE AREA NETWORKS

- **Local Area Networks (LANs)**
  - **Short distances**
  - **Within organizations**
  - **Typical technology: Ethernet or Token Ring**
- **Wide Area Networks (WANs)**
  - **Long distances**
  - **Across organizations**
  - **Typical technology: Public Switched, Leased Line, Third Party VAN**
- **Need flexible ways to move within and between networks**

VIRTUAL MODEL OF COMMUNICATION

- **Traditional model (telephony) - "Circuit Switching"**
  - Communication is between individuals
  - People do one thing at a time
  - Like using a "private road"
- **Virtual / software model - "Packet Switching"**
  - Communication is mediated by computers
  - *Appearance* of doing many things at one time
  - Like using a "shared highway"
- **Requires a major shift in thinking about:**
  - Networks
  - How they are used

PACKET-BASED COMMUNICATION



- **Applications exchange packets**
  - Envelopes of data with To / From addresses
  - Packet size / length is fixed
- **Networks support packet forwarding / relaying**
  - Computers are connected to switches, routers, etc.
  - Switches sort and forward packets, like post offices
  - Lots of different physical layers can be used
  - Networks can be interconnected

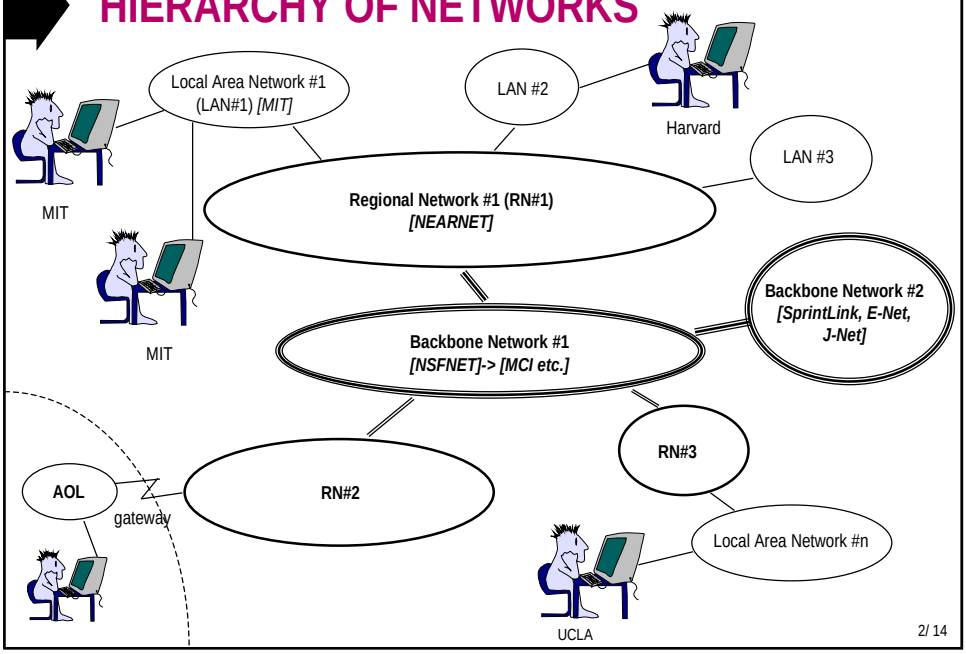
VIRTUAL NETWORK CHARACTERISTICS

- ***Appearance*** **of high speed connectivity**
  - Each computer sends to many others
  - Packets can be generated in bursts.
- **Standard protocols**
  - TCP/IP (Transmission Control Protocol/Internet Protocol)
  - Frame Relay and ATM
- **Heterogeneous / scalable**
  - Computers may operate at different rates
  - Specifications are independent of speed / technology / application
  - Software adapts to faster processors and networks
- **Problems**
  - Rush hour bursts (congestion)
  - Large packets delay small packets

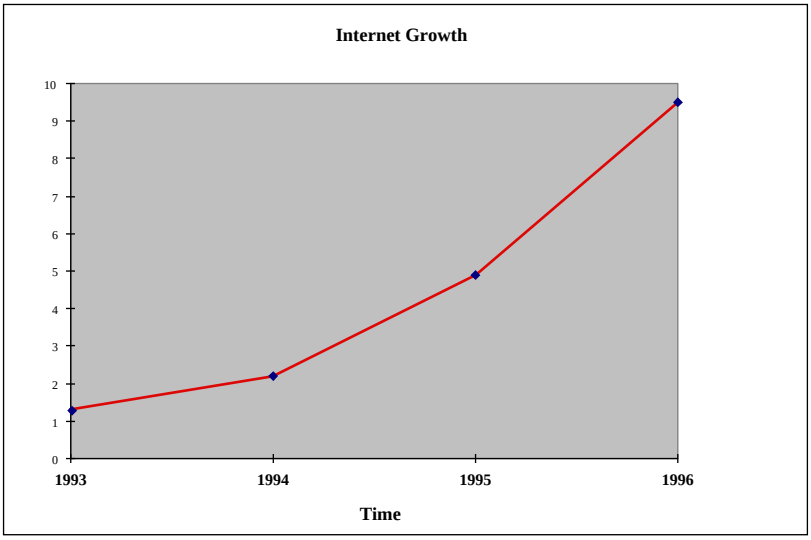
THE INTERNET

- **What is the Internet?**
  - A collection of interconnected networks.
  - Provides *appearance* of widespread connectivity.
- **What is it used for?**
  - E-mail, file transfer, terminal access, client-server traffic, information browsing (aka Web), distributed work, electronic commerce, etc.

HIERARCHY OF NETWORKS



COMPUTERS ATTACHED TO THE INTERNET



Source: Matthew Grey of net.Genesis and MIT

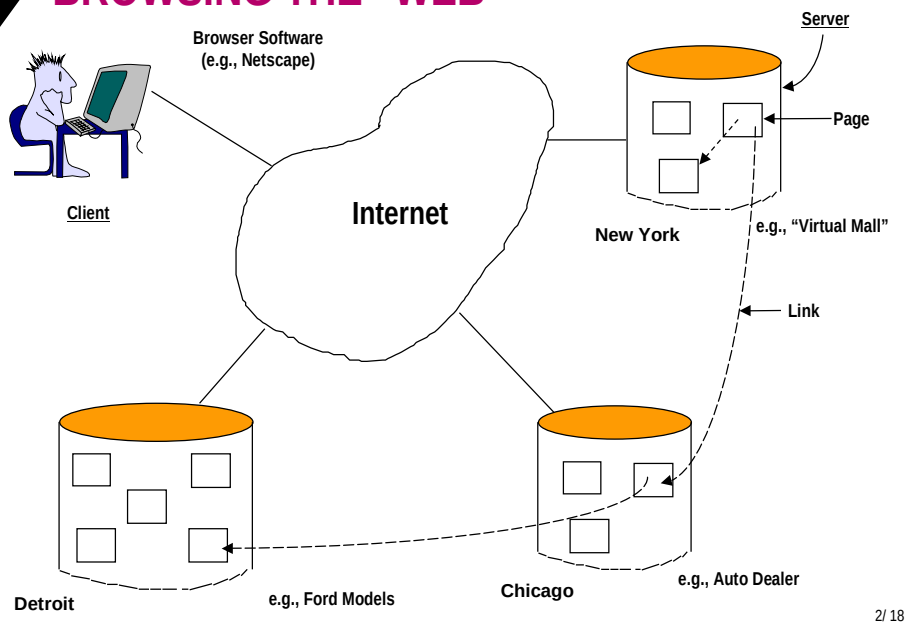
INTERNET CONTROL

- **Who controls the Internet?**
- **Impact?**

WHAT IS THE WORLD WIDE WEB?

- **Hypertext, on a world wide basis**
  - Traditional hypertext followed links to other parts of the same file, e.g., footnotes in a document
  - WWW links lead to files, databases, etc., anywhere in the world!
- **Highly decentralized and very flexible**
  - People and organizations make their files available
- **Uses**
  - Publication, entertainment, reference, transactions, interaction, etc.
- **How do you find anything?**
  - *Pull:* you reach out over the network
  - *Push:* information is delivered to you, e.g., "webcasting"

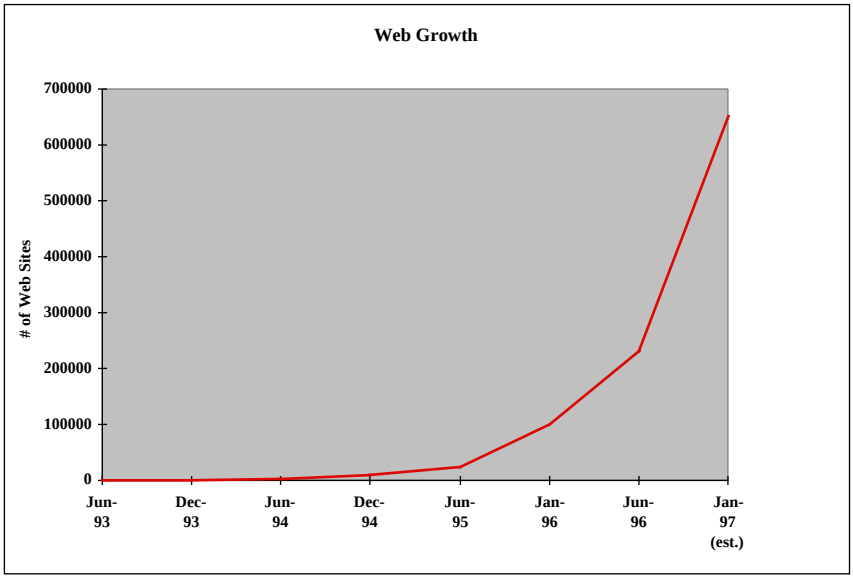
BROWSING THE "WEB"



BROWSER USAGE & EXAMPLE (NETSCAPE)

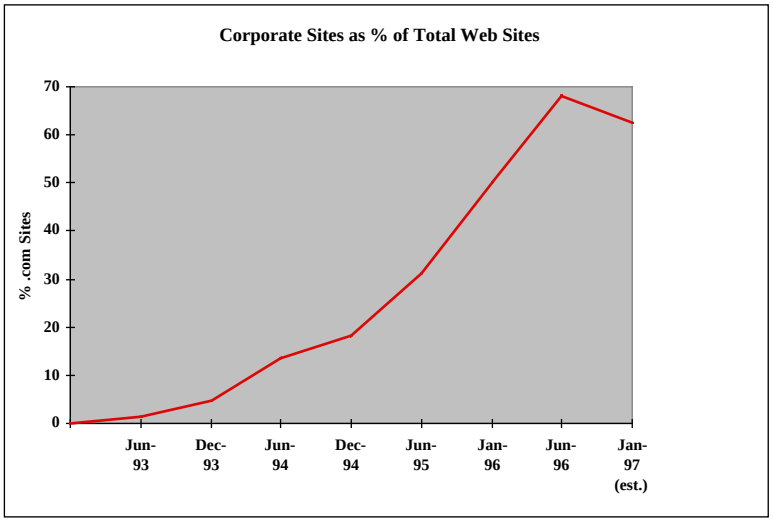
- **Universal Resource Locator (URL)**
  - http://www.ai.mit.edu/stocks.html
  - http://web.mit.edu/15.561/www/97pages/
- **Navigating**
  - Direct reference using URL's
  - Indirect reference via hypertext links
  - Bookmarks
  - Go (History)/Forward and Back
  - Search engines
- **Caution**
  - Slow sometimes (especially traffic or large files)
  - Can use "STOP"

WWW SITE GROWTH



Source: Matthew Grey of net.Genesis and MIT

WWW CORPORATE SITE GROWTH



Source: Matthew Grey of net.Genesis and MIT

WWW – LOWERING THE BARRIERS TO INFORMATION FLOW

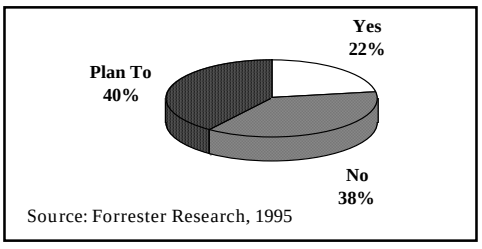
- **Across organizational boundaries**
  - No (or minimal) inter-organizational set-up costs
  - Builds on wide-spread infrastructure
  - Dramatic reduction in transaction costs
  - "Gain scale without mass"
- **Issues**
  - Can produce enormous network load (e.g., video)
  - Security fire walls
  - Privacy
  - Liability
  - Authorization, billing and settlement
  - Pricing

WWW – LOWERING THE BARRIERS TO INFORMATION FLOW

- **Within and Between Organizations**
  - Intranets and Extranets
    - Reduce internal transaction costs
    - Share/leverage Internet investments
    - Access to huge quantities of information
    - Interface to legacy applications
- **Issues**
  - Applications
  - Incentives

INTRANETS

- Netscape claim:
  - 70% sales of server software are for internal corporate networks
- Forecast by Zona Research:
  - By 1998, Intranet server business will be four times the size of the Internet server business
- Survey by Forrester Research:
  - Use of Web servers for internal applications in 1,000 major firms:



Source: Forrester Research, 1995

IMPACT ON ALL FORMS AND ASPECTS OF BUSINESS

- Shopping/catalogs
- Marketing
- Sales and ordering
- Support
- Service
- Publishing/News
- Coordination
- ???

IT IS JUST BEGINNING ...