



# Lecture 3: History of Networking & Storage

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# It's Possible to Control New Technologies

- Extreme example:  
the Amish
  - “does it bring us together,  
or draw us apart?”
  - BBQ vs. telephone



- A more mainstream example of control over adoption
  - Nuclear power moratorium in United States
  - Nuclear power advances in rest of world
- Examples of control over rate at which technologies are developed
  - Intellectual property laws, tax structure designed to encourage technology development

# Technology and Values

- Dynamic between people, technology
  - People adopt technology
  - Technology changes society
- Different ways people are affected by technology
  - Physical changes (e.g., laptops)
  - Psychological changes (e.g., cell phones, bluetooth headsets)
- Technologies can solve problems, create new problems
  - Automobile
  - Refrigerator
  - Low-cost international communication

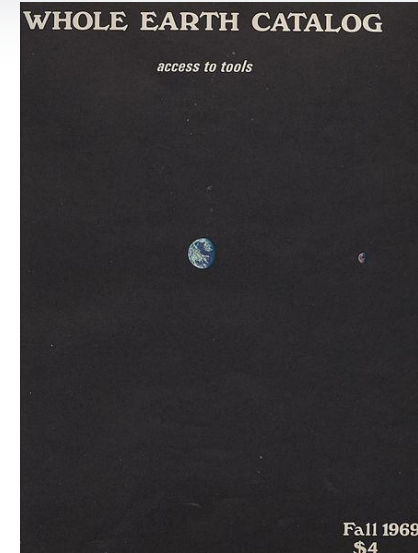
*Do you think that it is more the case that people's needs have driven the development of new technologies, or that technology has driven social changes?*

# Announcements

- Limitations in TurnItIn require us to change things a bit.  
Starting next week:
  - You can't submit an essay until you've taken a quiz
    - Remember, you get three tries, but **must get it perfect.**
  - You can't peer review unless you've submitted an essay
- I've made a course blog on Google+
  - If you find interesting articles about current events that are relevant to the course, send me a link
  - I'll also post what I find
  - Feel free to comment on posts

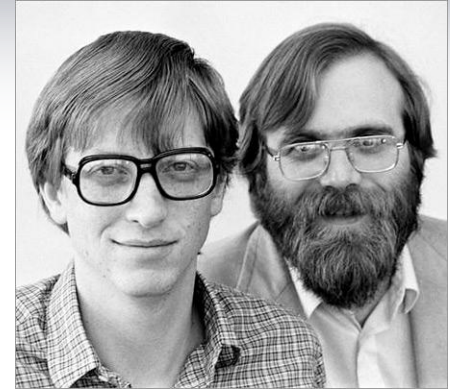
# Antecedents to the Personal Computer

- *Whole Earth Catalog*
  - “Sort of like Google in paperback form” (Steve Jobs)
  - Stewart Brand saw “technology as a tool for individual and collective transformation” (Fred Turner)
- People’s Computer Company
  - Educated people on how to use computers
  - People gathered around time-share computers
  - Culture promoted free exchange of software
- Homebrew Computer Club
  - Meeting place for hobbyists interested in building personal computers
  - Member Steve Wozniak created system that became Apple I



# Personal Computer

- Altair 8800
  - Gates and Allen create BASIC interpreter
  - Interpreter pirated at Homebrew Computer Club meeting
- Personal computers become popular
  - Apple Computer: Apple II
  - Tandy Corporation: TRS 80
- Developments draw businesses to personal computers
  - Computer spreadsheet program: VisiCalc
  - IBM launches IBM PC



# 1.3 Milestones in Networking

# Early Networking: Semaphore Telegraph Tower

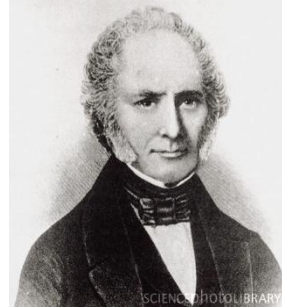
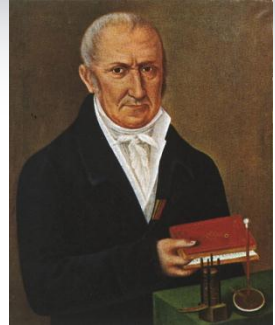


Coll. Musee de la Poste, Paris



# Electricity and Electromagnetism

- Volta invents battery (1799)
- Oersted: electricity  $\rightarrow$  magnetic field (1820)
- Sturgeon constructs electromagnet (1825)
- Henry: communication using electromagnets, one mile (1830)

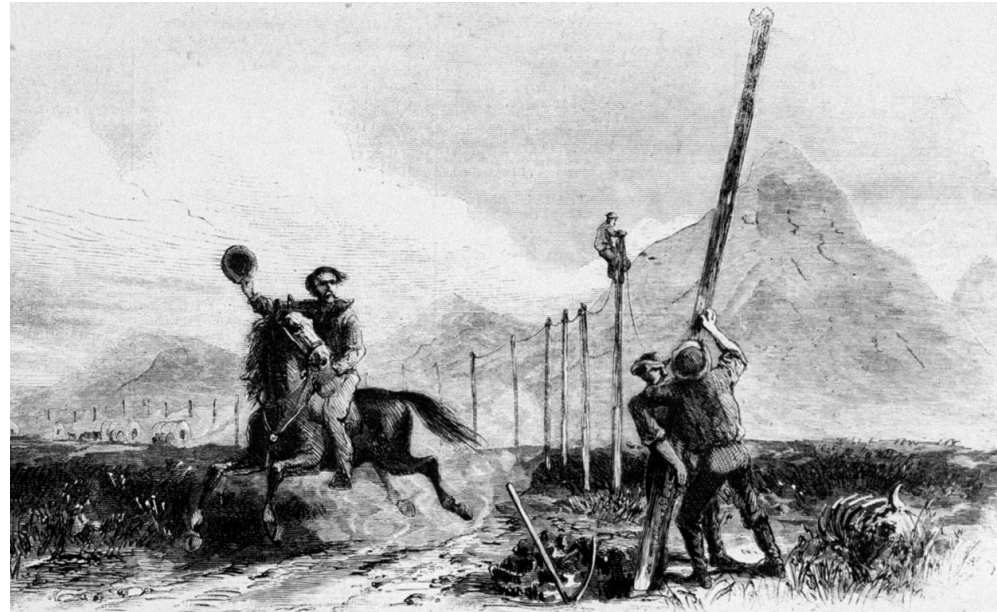


# Telegraph

- U.S. government funded first line
  - 40 miles from Washington, D.C. to Baltimore
  - Built by Samuel Morse in 1843-1844
- Private networks flourished
  - 12,000 miles of lines in 1850
  - Transcontinental line in 1861 put Pony Express out of business
  - 200,000 miles of lines by 1877

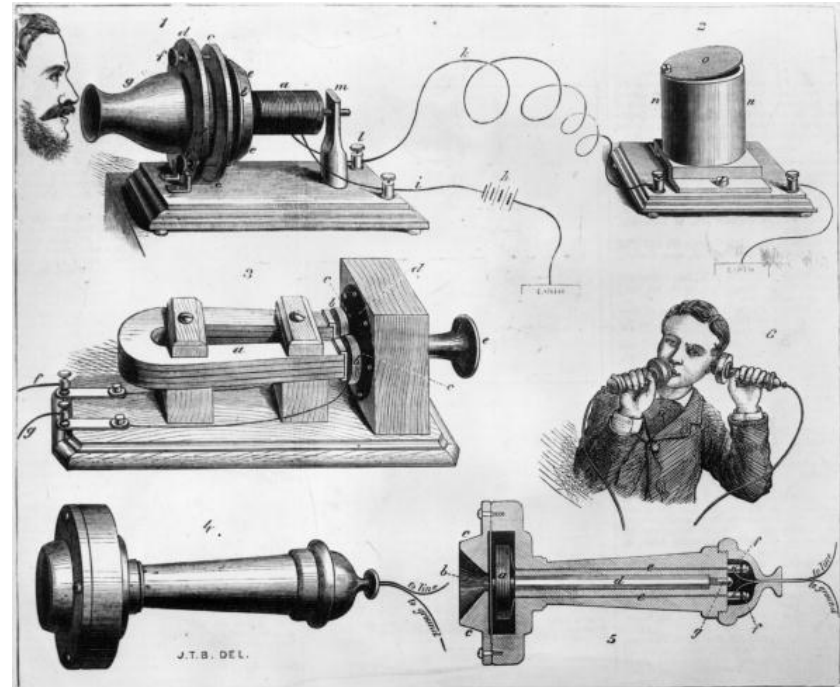
- Technology proved versatile

- Fire alarm boxes
- Police call boxes



# Telephone

- Alexander Graham Bell
  - Constructed harmonic telegraph
  - Leveraged concept into first telephone (1876)
- Social impact of telephone
  - Blurred public life / private life boundary
  - Eroded traditional social hierarchies
  - Reduced privacy
  - Enabled first “online” communities



# Typewriter and Teletype

- Typewriter
  - Individual production of “type set” documents
  - Common in offices by 1890s
- Teletype
  - Typewriter connected to telegraph line
  - Popular uses
    - Transmitting news stories
    - Sending records of stock transactions



*WACs assigned to the Eighth Air Force in England operate teletype machines. (DOD photograph)*

# Radio

- Pioneers
  - Hertz creates electromagnetic waves (1885)
  - Marconi invents radio (1895)
- First used in business
  - Wireless telegraph
  - Transmit voices
- Entertainment uses
  - Suggested by Sarnoff
  - Important entertainment medium by 1930s



Orson Welles:  
War of the Worlds  
© Bettmann/CORBIS

# Television

- Became popular in 1950s
  - Price fell dramatically
  - Number of stations increased
  
- Social effects
  - Worldwide audiences
  - Networks strive to be first to deliver news
  - Impact of incorrect information; e.g., 2000 presidential election



# Hundreds of Millions Watch Moon Landing in 1969

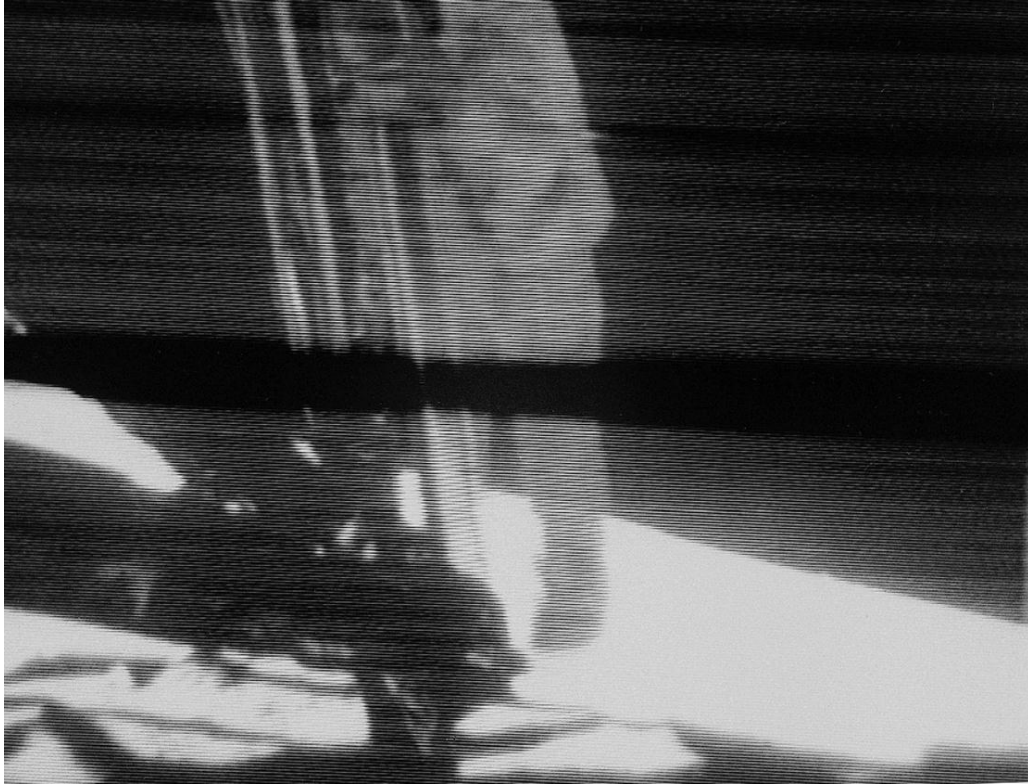


Image courtesy of NASA

# Remote Computing

- Stibitz and Williams build Complex Number Calculator at Bell Labs (1940)
- Bell Labs part of AT&T (phone company)
- Teletype chosen for input/output
- Allows operator to be distant from machine
- Long-distance demonstration between New Hampshire and New York City



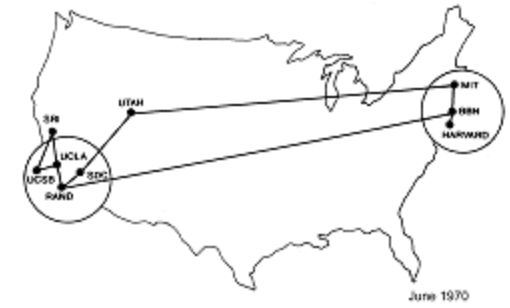


# ARPANET

- DoD creates ARPA in late 1950s
- Licklider conceives of “Galactic Network”
- Decentralized design to improve survivability
- Packet-switching replaces circuit switching



December 1969



June 1970

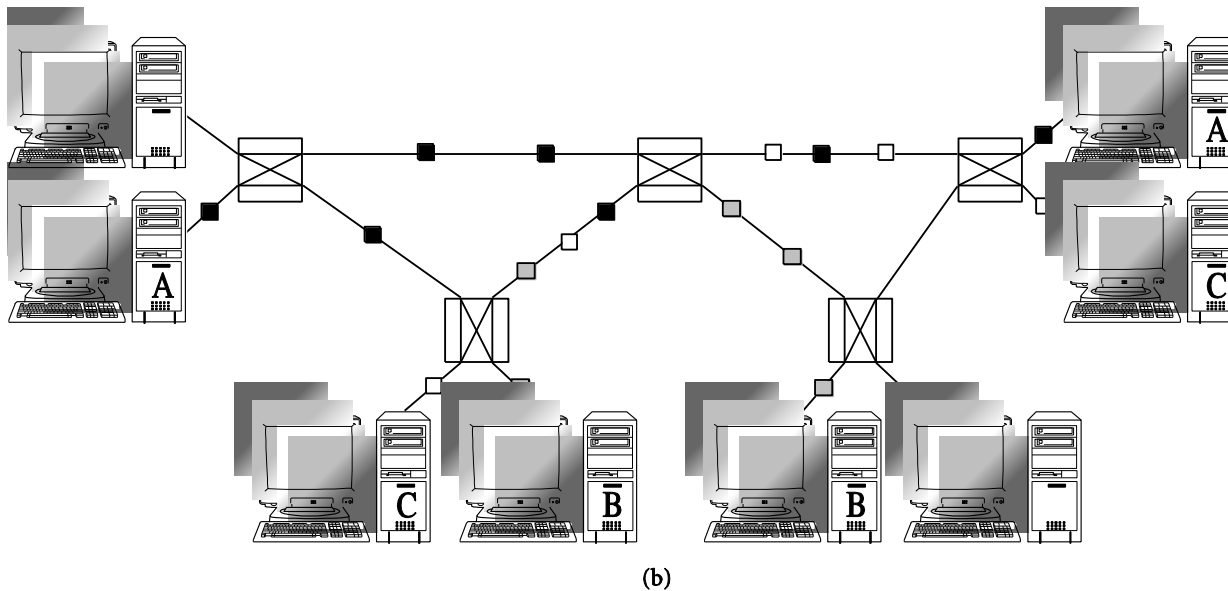
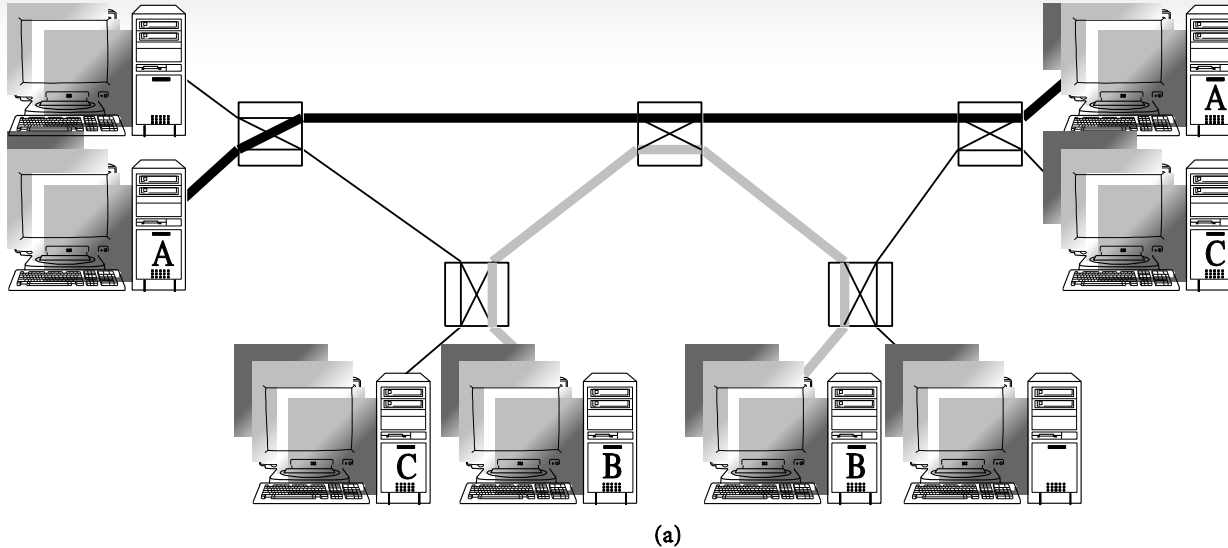


December 1970



September 1971

# Circuit-switched v. Packet-switched Networks



# Email

- Creation
  - Tomlinson at BBN writes software to send, receive email messages (1972)
  - Roberts creates email utility

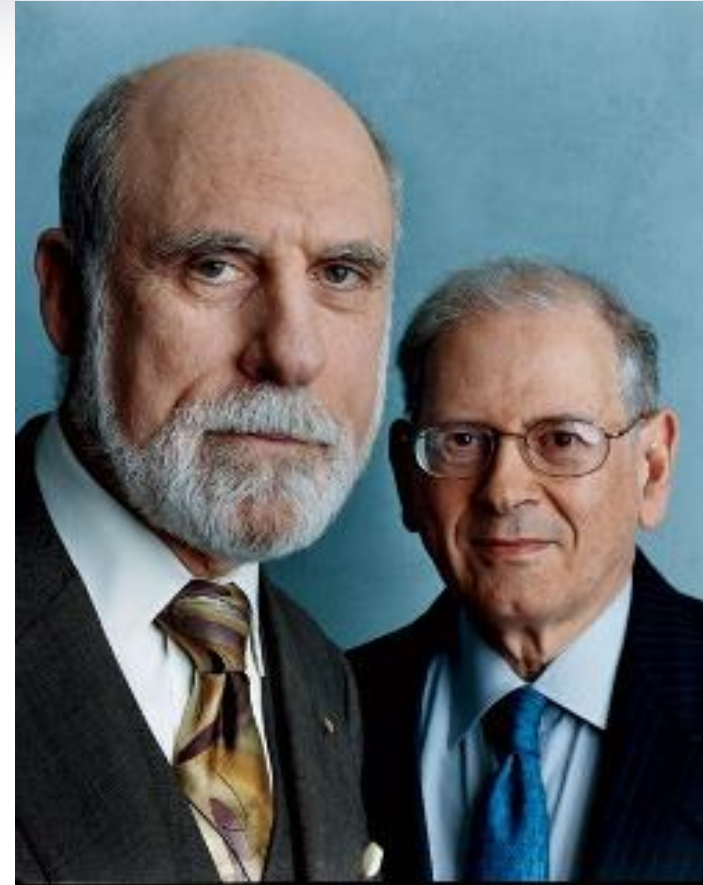


- Current status
  - One of world's most important communication technologies
  - Billions of messages sent in U.S. every day



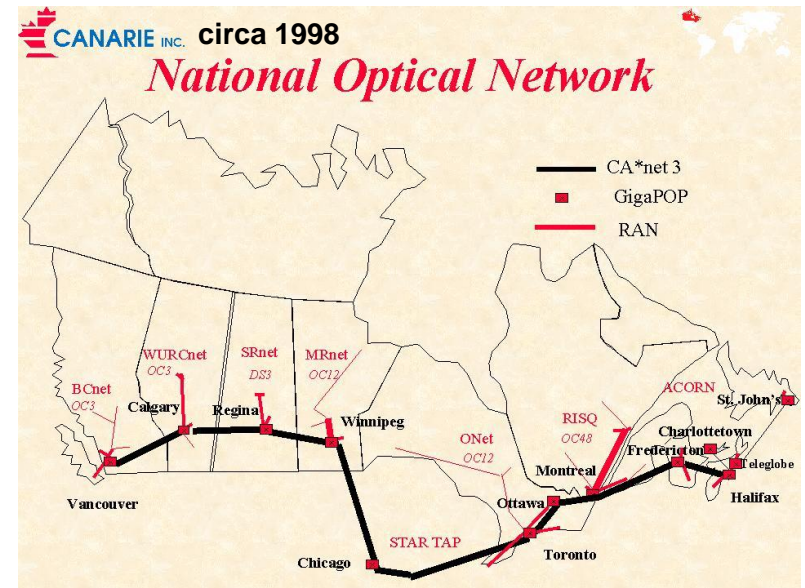
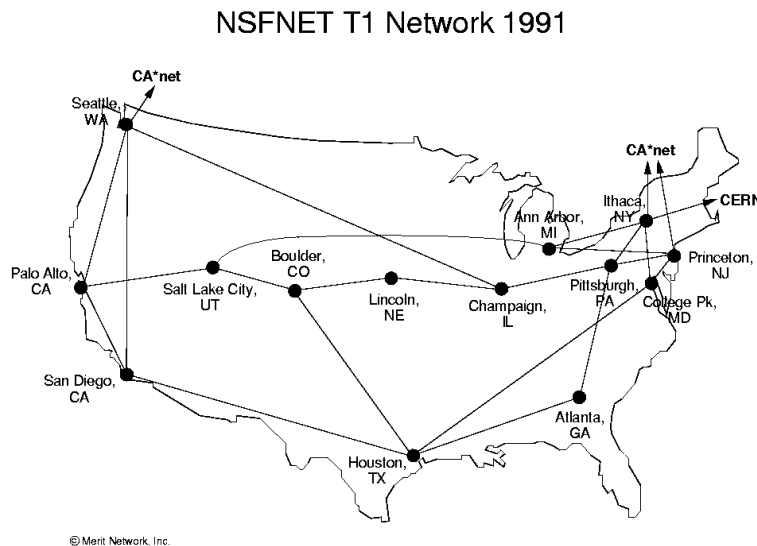
# Internet

- Kahn conceives of open architecture networking
- Cerf and Kahn design TCP/IP protocol
- Internet: network of networks communicating using TCP/IP
  - converted over in 1983



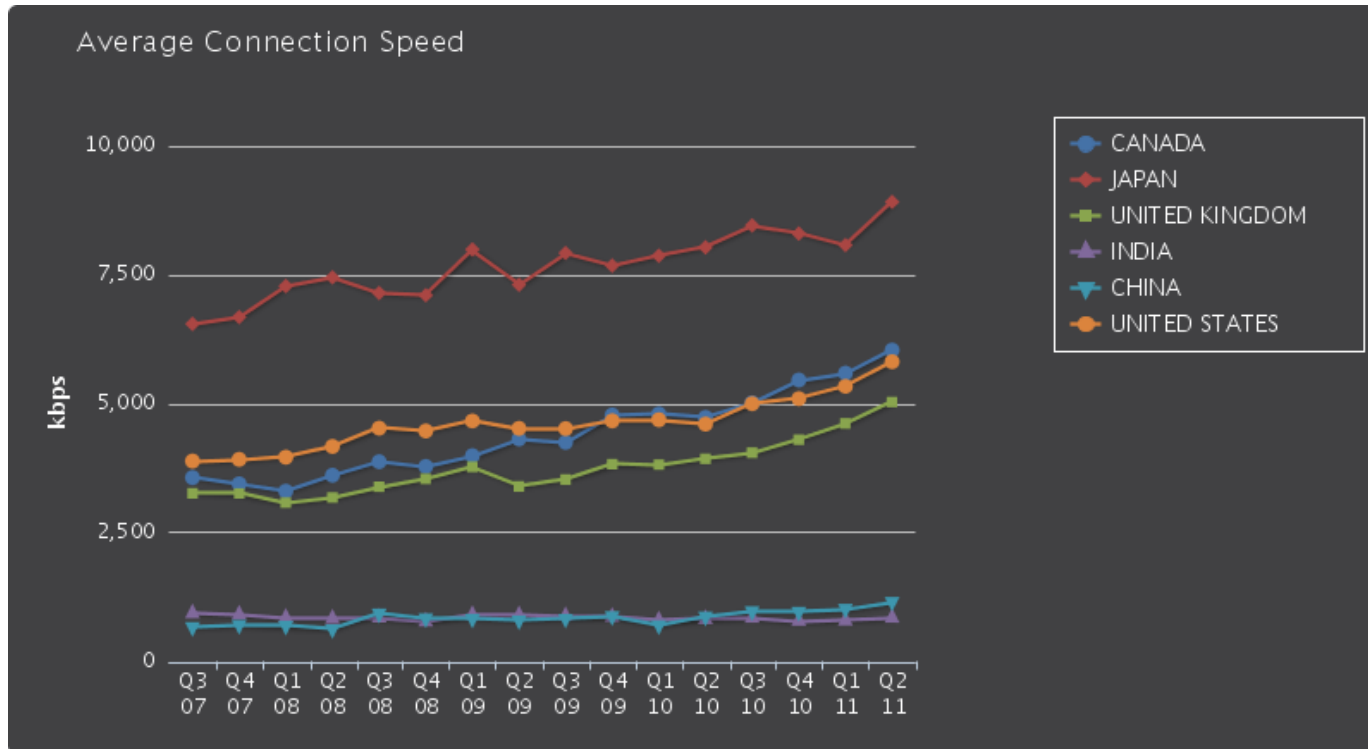
# NSFNET

- Created by National Science Foundation
- Provided access grants to universities
- Encouraged commercial subscribers for regional networks
- Banned commercial traffic on NSFNET Backbone
- Private companies developed long-distance Internet connections
- After private networks established, NSF shut down NSFNET Backbone



# Broadband

- Broadband
  - High-speed Internet connection
  - At least 10x faster than dial-up connection
  - Enhanced by fiber optic networks



# **1.4 Milestones in Information Storage and Retrieval**

# Codex

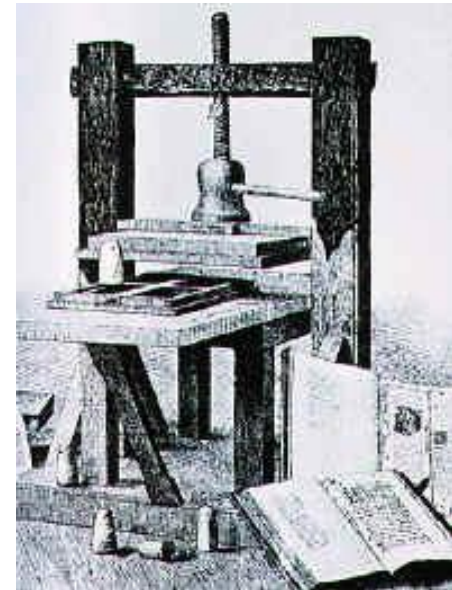
- Codex (became popular about 1900–1700 years ago)
  - Rectangular pages sewn together on one side
  - Replaced papyrus scrolls as way of storing books
- Advantages of codex over scroll
  - More durable
  - Allows quicker access to particular passages
- Manufacturing technologies
  - Copying by hand
  - Wood engraving





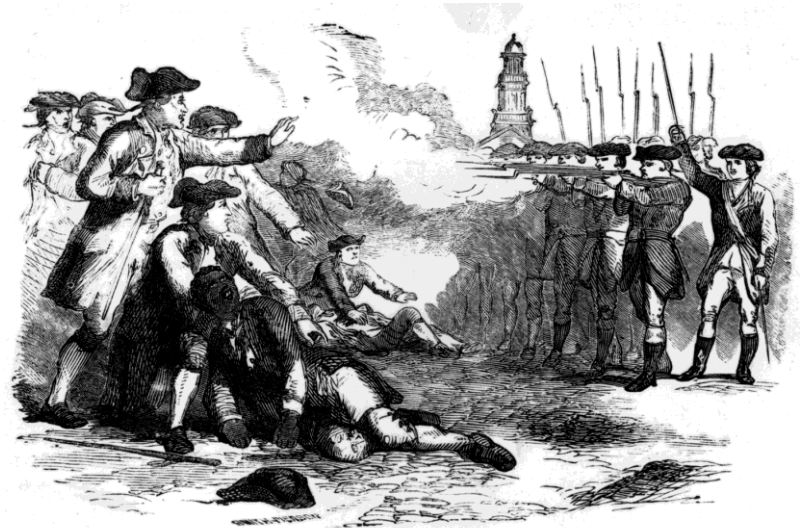
# Gutenberg's Printing Press (1436)

- Based on movable metal type
- Church principal customer of early publishers
- Powerful mass communication tool
- Printing press's impact on Reformation
  - More than 300,000 copies of Luther's publications
  - Protestants out-published Catholics by 10-to-1 in the middle 16<sup>th</sup> century



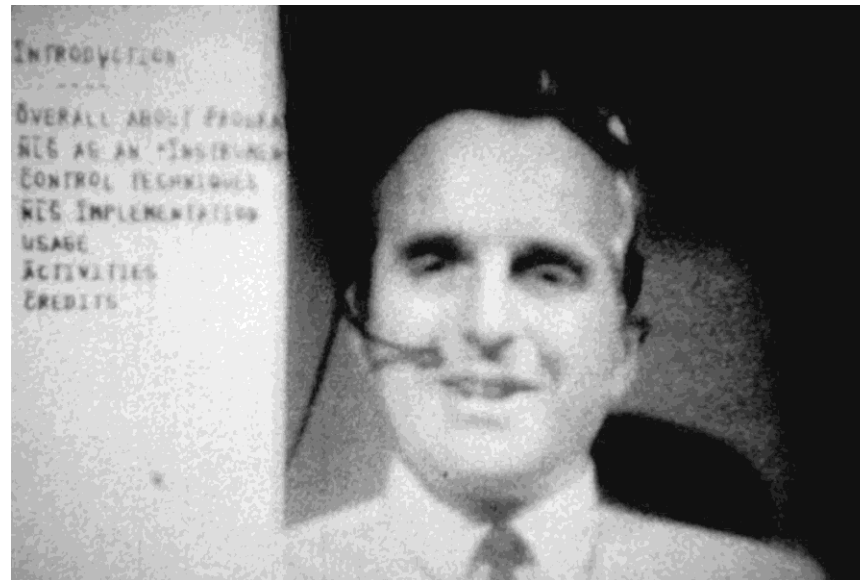
# Newspapers

- Newspapers
  - First emerged 1600
  - Picked up steam in the 1700s
- Stimulated free expression
- Governments responded
  - Licensing, censorship
- Impacted American Revolution
  - Newspapers helped unify colonies
  - Swayed public opinion toward independence



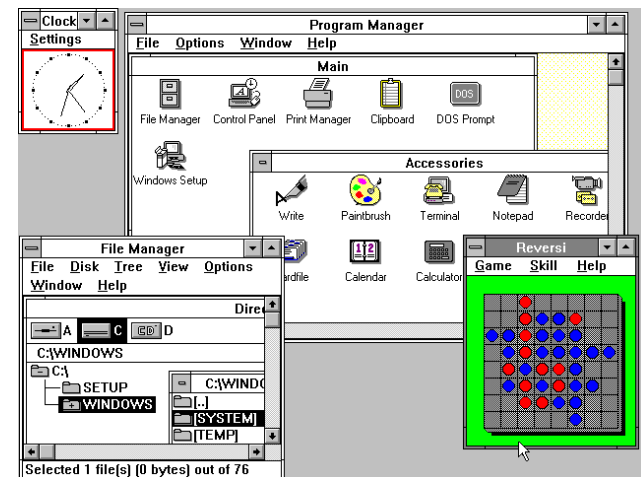
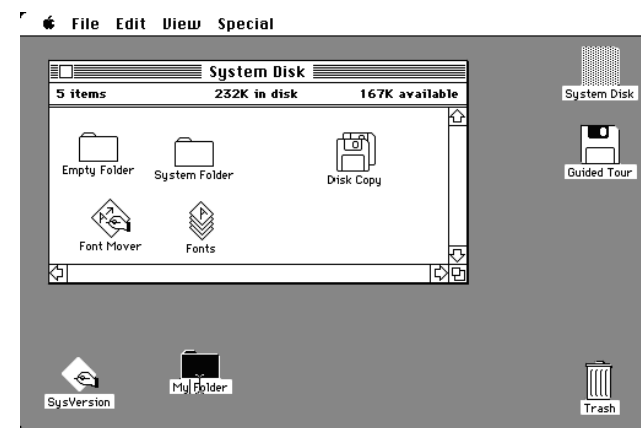
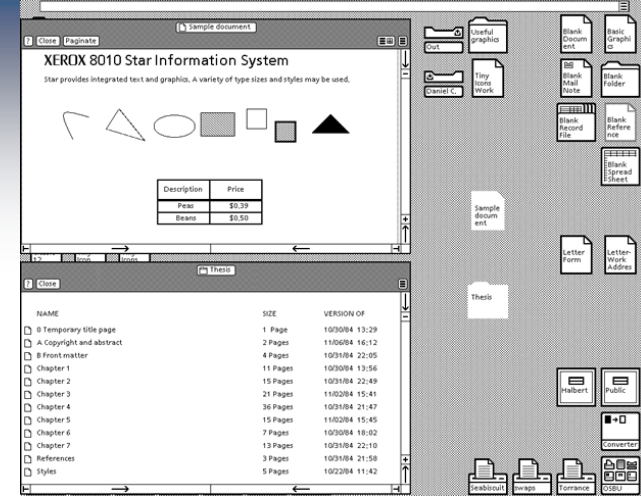
# Hypertext

- Vannevar Bush: Memex (1945)
- Ted Nelson (1965)
  - Coined word hypertext
  - Proposed creation of Xanadu
- Douglas Engelbart (1968)
  - Directed construction of NLS (oNLine System)
  - Demonstrated windows, email, mouse, videoconferencing



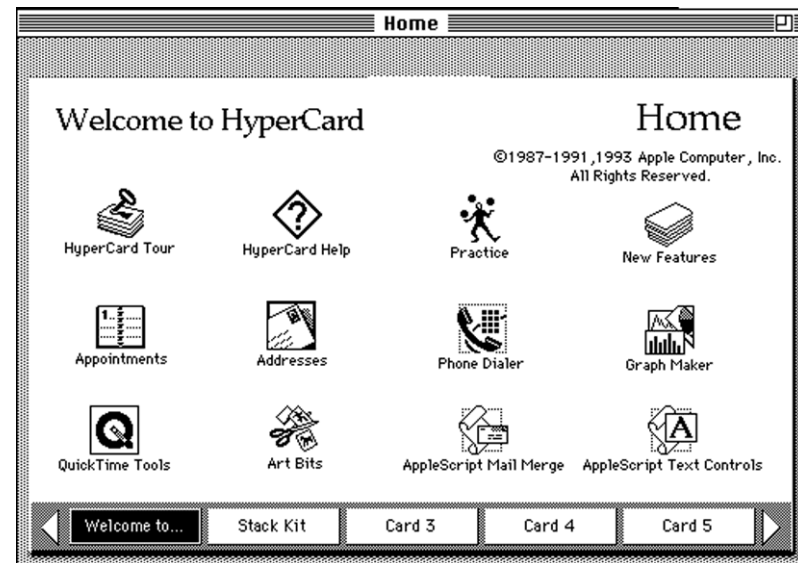
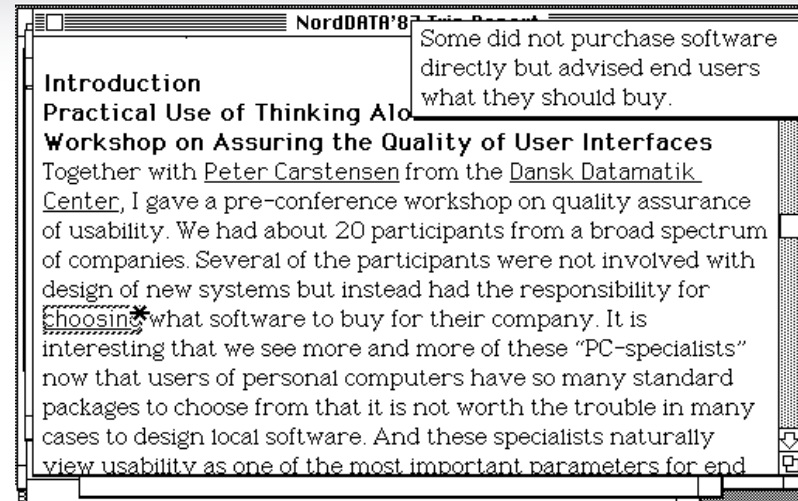
# Graphical User Interface

- Xerox PARC (Palo Alto Research Center)
  - Alan Kay sees Doug Engelbart demo in 1968
  - Alto personal computer (early 1970s)
  - Bit-mapped display, keyboard, and mouse
- Apple Computer
  - Steve Jobs visits Xerox PARC in 1979
  - Macintosh (1984)
  - Bit-mapped display, keyboard, and mouse
- Microsoft Windows (1985)
  - Version 3.0 released in May 1990
  - Quickly became dominant GUI



# Single-Computer Hypertext Systems

- Peter Brown at University of Kent
  - Guide (1982)
  - Released versions for Macintosh and IBM PC
  
- Apple Computer
  - HyperCard (1987)
  - Hypertext system based on “stacks” of “cards”
  - Links represented by buttons
  - Basis for best-selling games Myst and Riven



# World Wide Web

- First browser built at CERN in Switzerland
  - Tim Berners-Lee: WorldWideWeb (1990)
  - Berners-Lee created Web protocols
  - Protocols based on TCP/IP → general
- Later browsers
  - Mosaic
  - Netscape Navigator
  - Netscape Mozilla
  - Microsoft Internet Explorer (most popular)
  - Google Chrome



# Search Engines

- Crawler-based engines
  - Altavista: 1995
  - Google: 1998
  - Programs called spiders follow hyperlinks and visit millions of Web pages
  - System automatically constructs Web page database
- Human-assisted engines (Open Directory)
  - Humans build Web page database
  - Web page summaries more accurate
  - Far fewer Web pages in database
- Hybrid systems (MSN Search)

# **1.5 Information Technology Issues**



# Information Technology

- Definition: Devices used in creation, storage, manipulation, dissemination of data, sound, and/or images
- Examples: Computers, telephones, video cameras, MP3 players
- People making greater use of IT
  - Costs keep falling
  - Capabilities keep rising

# IT Issues

- Email
  - Easy way to keep in touch
  - Spam has become a real problem
  - *Has email made our lives better?*
- Web
  - Free access to huge amounts of information
  - Harmful consequences of some sites
  - *Has the web made our lives better?*
- CDs, MP3s
  - Free or cheap copies readily available
  - May be unfair to musicians
  - *Are musicians worse off now than before the Internet (1980s)?*
    - *Than 50 years ago (1960s)?*
    - *Than 100 years ago?*

# IT Issues

- Credit cards
  - Convenience over cash and checks
  - Increases possibility of identity theft
  - *Who owns information about transactions?*
- Telecommuting
  - Saves time, allows more flexible work hours
  - Can lead to longer work hours
  - May result in fewer chances for promotion
  - *Does telecommuting make our lives better?*
- Improved global communication network
  - Allow companies to sell to entire world
  - Allow companies to move jobs out of developed countries
  - *Have global communications made our lives better?*