Computer Science 1400: Part #5

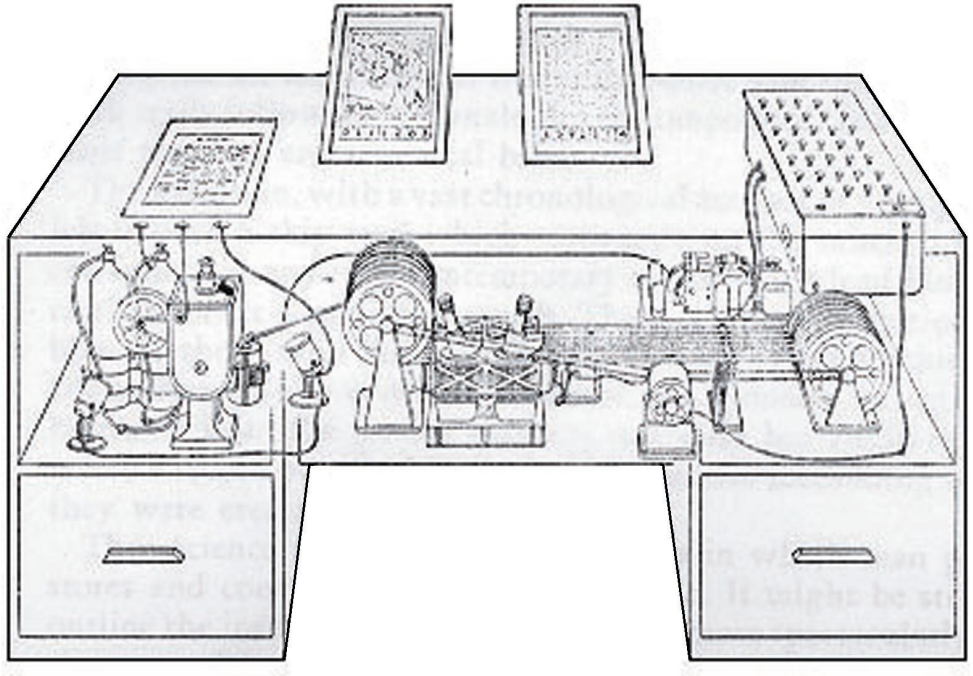
Getting Here:
The Networked Society (1990–now)

COMPUTER NETWORKS

THE WORLD-WIDE WEB

NEW TYPES OF PERSONAL COMPUTING

Computing for the People (Take III)

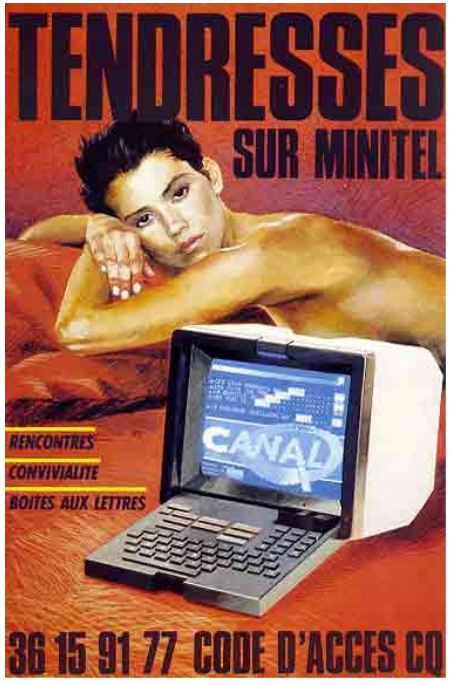


Memex (1945)

- Proposed by Vannevar Bush in 1945 *Atlantic Monthly* article “As We May Think”; gave access to all of world’s knowledge via networked memex machines.

Computing for the People (Take III) (Cont'd)

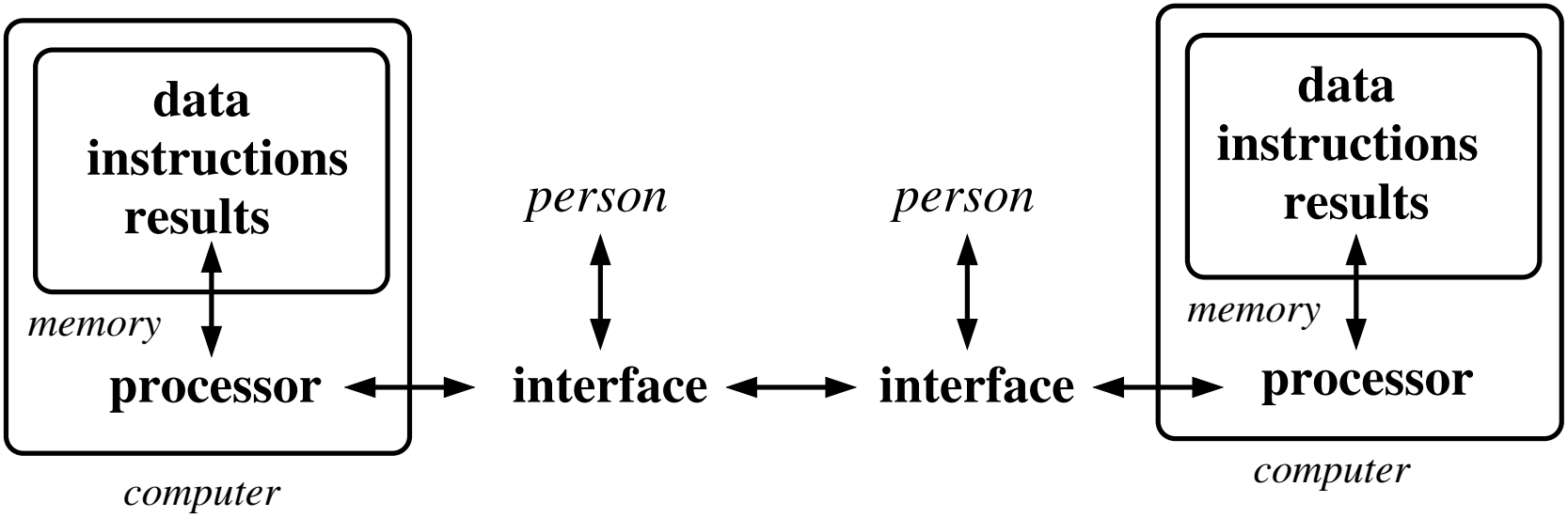
Telidon (Canada)



Minitel (France)

- Based on 1960s videotex technology for interactive two-way video-based communication over telephone lines.
- Subsidized starting in 1970s by various governments; most successful of these was Minitel because of sufficient financial support and permissiveness on content.

What *is* a Computer? (Take IV)



Computer Networks : Beginnings

J.C.R. Licklider
(1915-1990)

Bob Taylor
(1932–2017)

Larry Roberts
(1937–)

- “Intergalactic Computer Network” proposed by Licklider in 1963; ARPAnet project proposed officially by IPTO director Taylor in 1968, with Roberts as chief engineer.
- ARPAnet built to share data and computing resources – communication between human users not important.

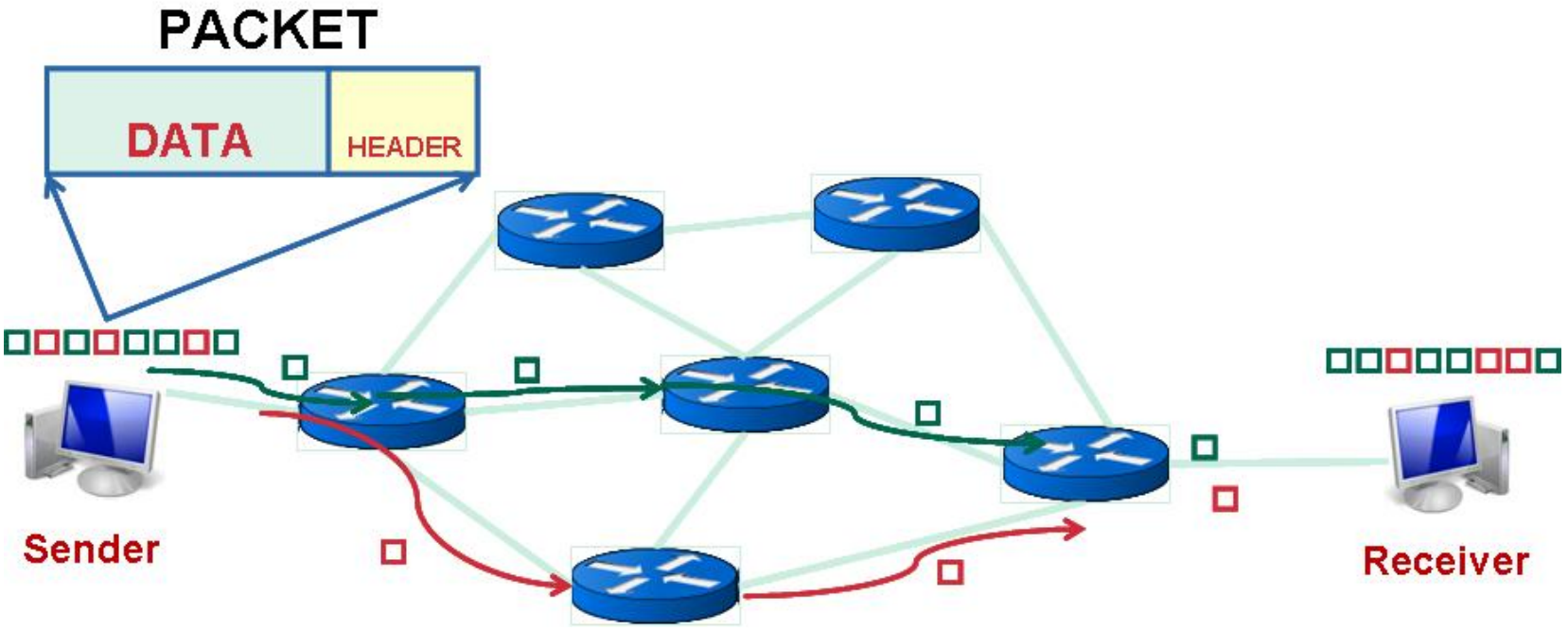
Computer Networks: Beginnings (Cont'd)

Len Kleinrock
(1934–)

- Kleinrock invented and analyzed behavior of adaptive multi-route packet switching, *cf.*, static single- route dedicated communication line.
- Characteristics:
  - Distributed vs. centralized control.
  - Any packet can go anywhere regardless of origin or destination .
  - Message costs distributed over all network nodes.

- Independently developed by Paul Baran (1926-2011) at RAND and Don Davies (1924-2000) at NPL in Britain; called "packet switching" by Davies.

Computer Networks : Beginnings (Cont'd)



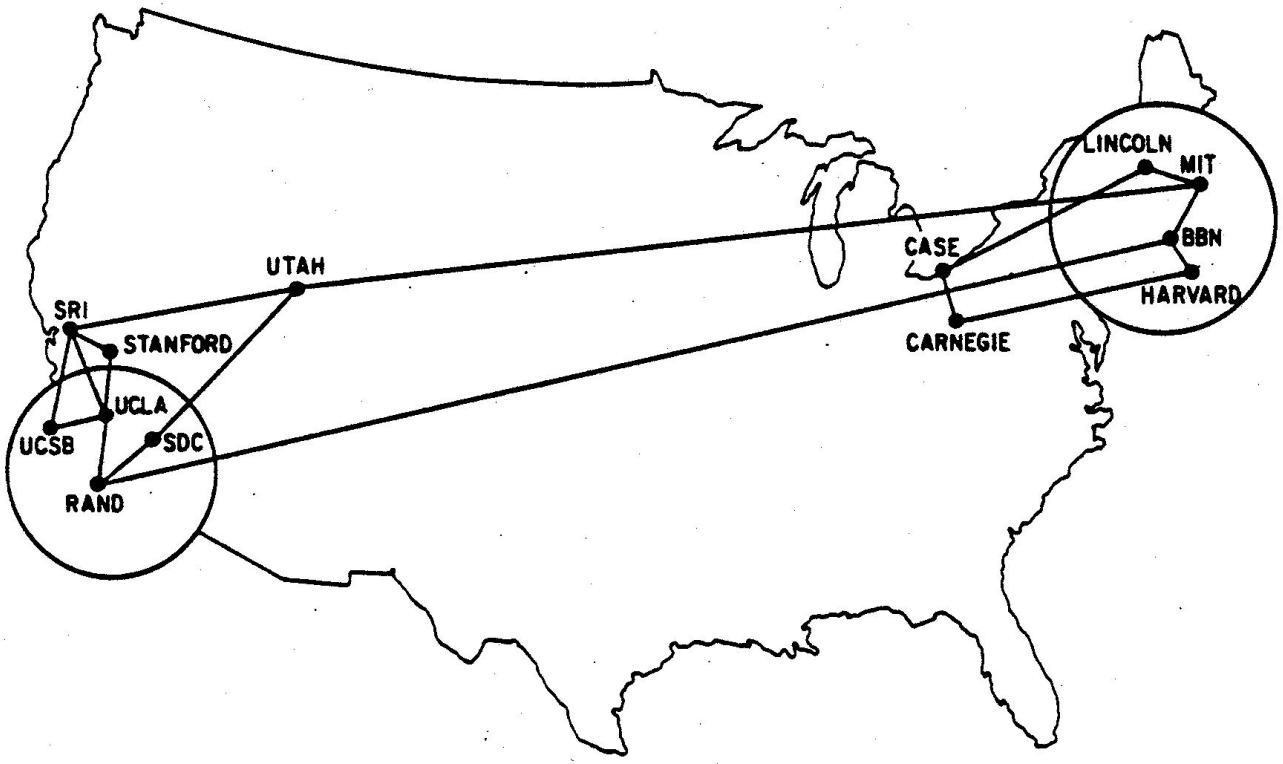
Computer Networks : Beginnings (Cont'd)

Interface Message Processor (IMP) (1969)

Computer Networks : Beginnings (Cont'd)

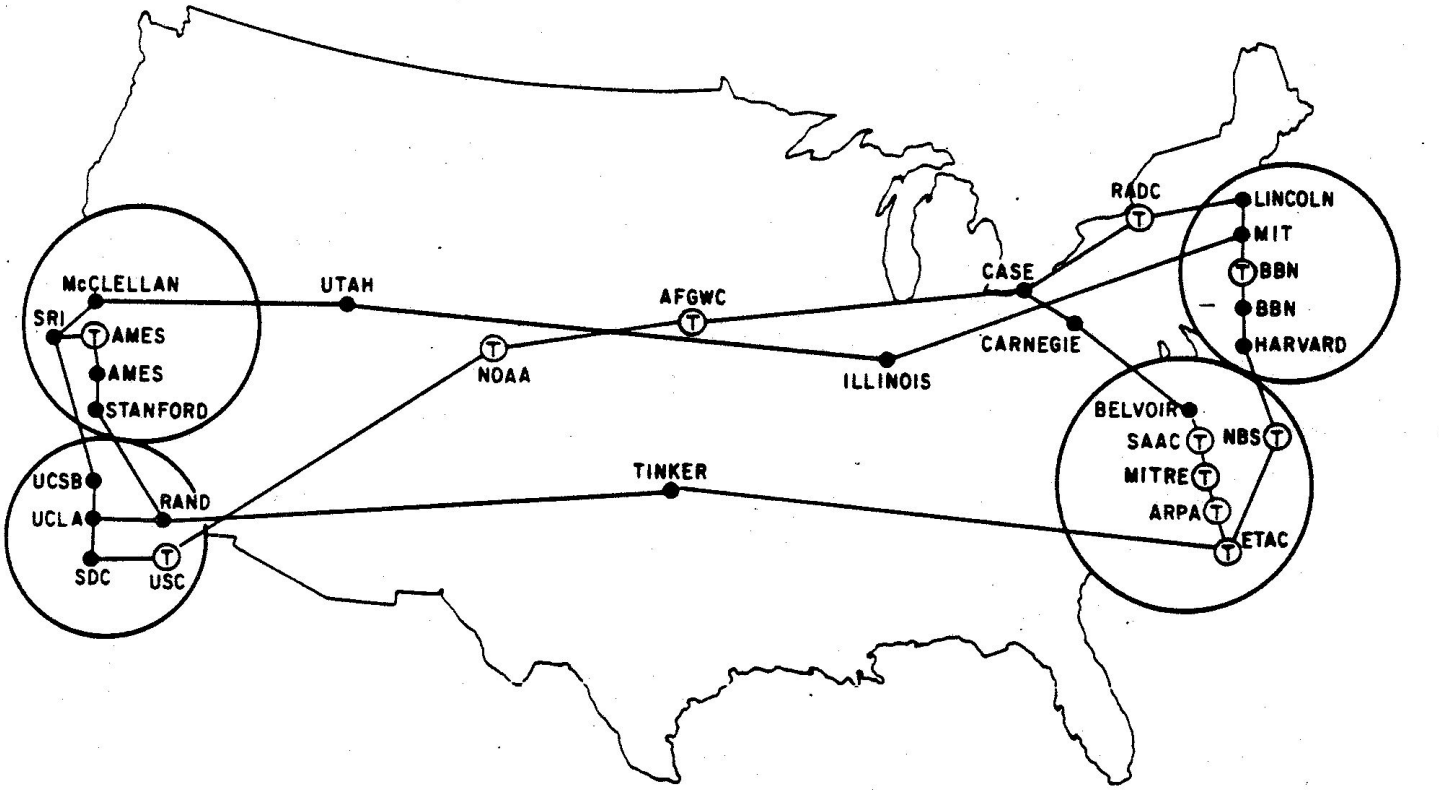
ARPAnet (1969)

Computer Networks : Beginnings (Cont'd)



ARPAnet (1971)

Computer Networks : Beginnings (Cont'd)



ARPAnet (1972)

Computer Networks : Beginnings (Cont'd)

- ARPAnet constructed by BBN in 1969 based on 50 kB/s lines linking four nodes (UCLA, SRI, UCSB, U. Utah). All network traffic at each node handled by an Interface Message Processor (IMP) which links network to one or more host computers.
- First IMP-host testing done at UCLA in September 1969; first node-node testing done between UCLA and SRI in October 1969. Network testing and tuning follows, led by Kleinrock's Network Measurement Center at UCLA.
- BBN node added in March 1970; pioneers remote machine debugging and software uploading.
- First public display of ARPAnet capabilities in Washington, DC at the International Conference on Computer Communications in 1972.

Computer Networks : Beginnings (Cont'd)

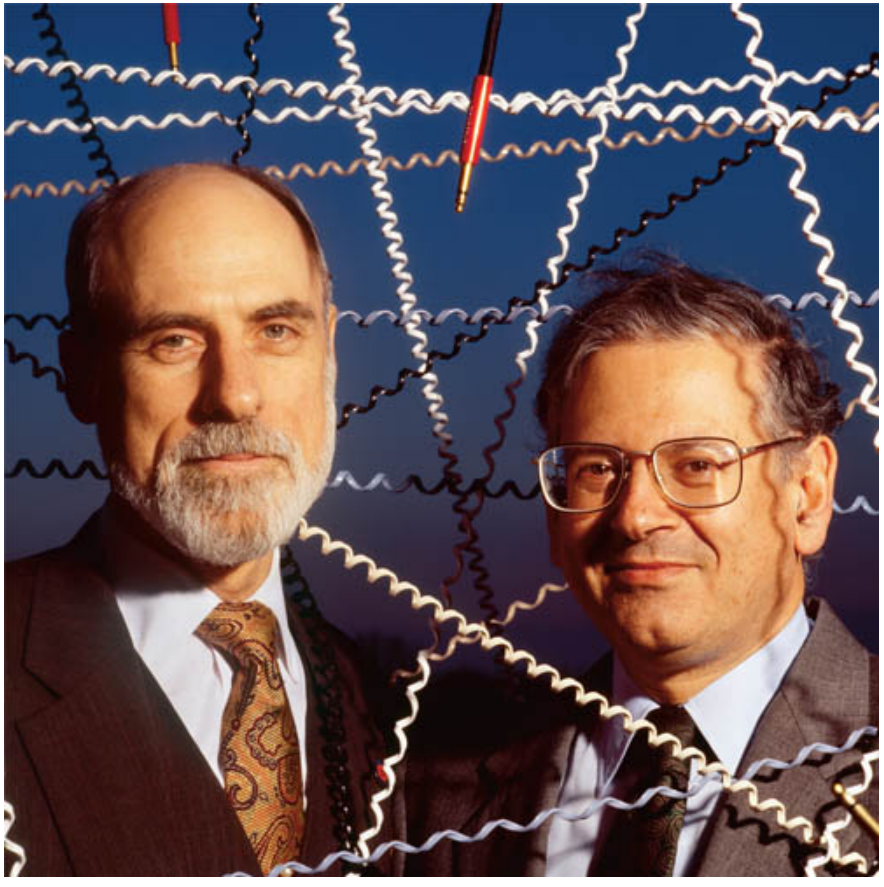
Ray Tomlinson
(1941–2016)

- Resource-sharing proves too difficult for people to do; focus shifts to sharing files of data.
- First e-mail software created by Tomlinson in 1971 as a "hack" combining cross-system file-sharing program and system-internal user mail program.
- E-mail rapidly becomes dominant source of traffic on ARPAnet (75% by 1973).

Computer Networks : Beginnings (Cont'd)

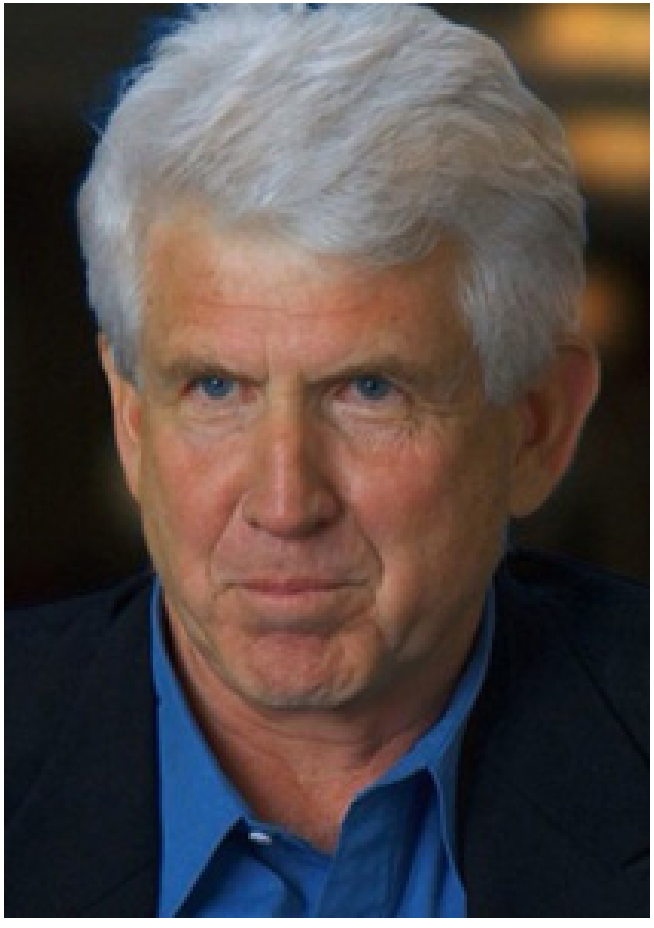
- Wireless networking pioneered by Norm Abrahamson (1932–) in Hawaii as AlohaNet (operational in 1971).

Computer Networks : Beginnings (Cont'd)



- Vint Cerf (1943–) and Bob Kahn (1938–) propose TCP/IP in 1974; allows easy communication between networks.

Computer Networks : Commercialization



Bob Metcalfe (1946–)

- Initial focus on ARPAnet-like Wide-Area Networks (WANs) quickly turned to Local-Area Networks (LANs).
- Initial LANs based on IMPs connecting host computers to ARPAnet.
- Metcalfe creates Ethernet LAN mechanism at PARC in 1974; leaves PARC to co-found 3COM in 1979.

Computer Networks : Commercialization (Cont'd)

- Initial commercial LANs designed for network-enabled computers like the SUN Workstation (1982; see above); subsequent LANs connected PCs via special hardware.

Computer Networks : Commercialization (Cont'd)

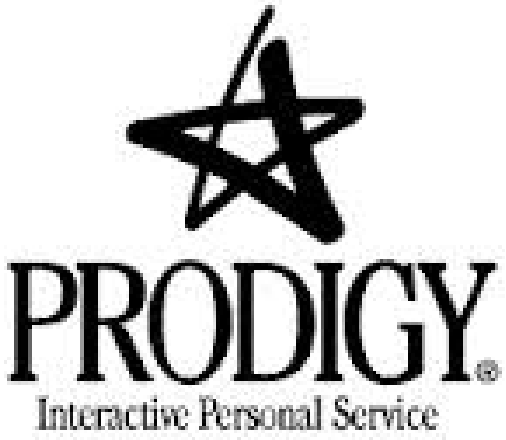
Acoustic Modem (late 1980s)

Computer Networks : Commercialization (Cont'd)

- Local or regional commercial networks consisting of one or more central servers connected via modem to subscriber PCs emerged in the late 1970s.
- Initial networks such as MicroNet (1978) and the Whole Earth 'Lectronic Link (WELL; 1984) relied on fanatic core subscribers (hobbyists and Deadheads, respectively).

Computer Networks : Commercialization (Cont'd)

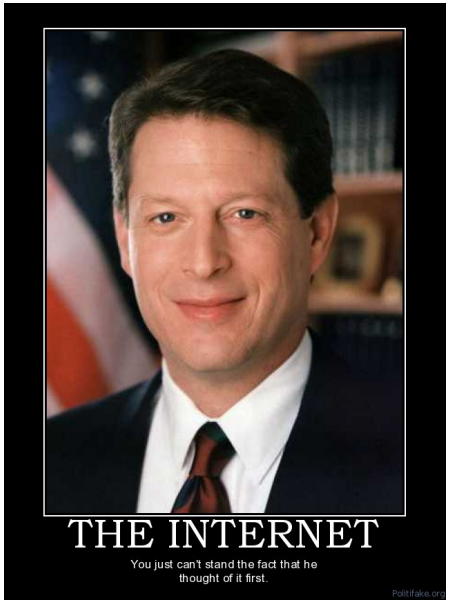
Computer Networks : Commercialization (Cont'd)



- National commercial networks established starting in early 1980s. Some like Compuserve (1969) based on surviving business-oriented computer utilities from the late 1960s; others like Prodigy (1984) created by retail and computer business partnerships (Sears / IBM).
- Initial networks joined by subscriber-purchased "starter kits"; later networks like America On-Line (AOL) (1989) pioneered free trial periods.

Computer Networks : Commercialization (Cont'd)

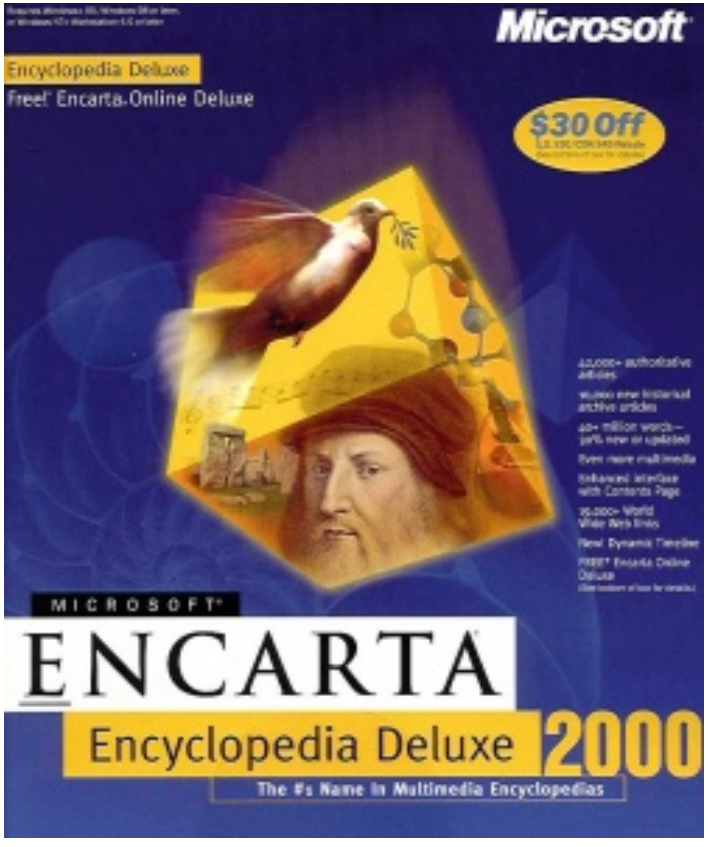
Rick Boucher (1946–)



Al Gore (1948–)

- Effective commercial national network usage enabled by government-funded high-performance national network upgrades (Gore; 1991; "information superhighway") and amended commercial-usage rules of government- created networks (Boucher; 1992).

Computer Networks : The World Wide Web



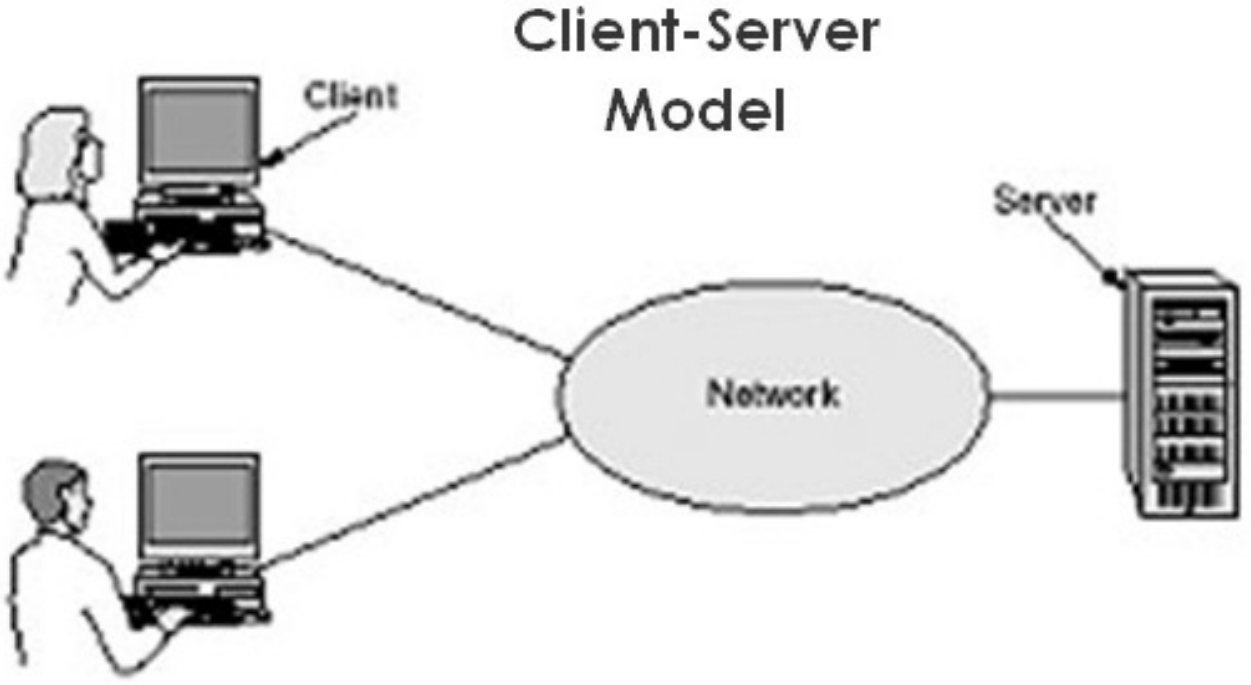
- Access to text content very slow and hence expensive for computer users in 1980s; multimedia “access gap” filled by CD-ROMs.
- Initial high cost of CD-ROM drives ($1K) led to focus on high-end products, *e.g.*, encyclopedias; fall in drive costs to $200 by 1992 led to explosion in available content (particularly game-based).
- Established widespread appreciation of and market for high-end multimedia content on personal computers.

Computer Networks : The World Wide Web (Cont'd)

Tim Berners-Lee (1955–) and Robert Cailliau (1947–)

- Berners-Lee and Cailliau develop first version of World-Wide Web (WWW) system in 1989–1991 at CERN in Switzerland; designed for sharing large-scale multimedia particle physics datasets.

Computer Networks : The World Wide Web (Cont'd)

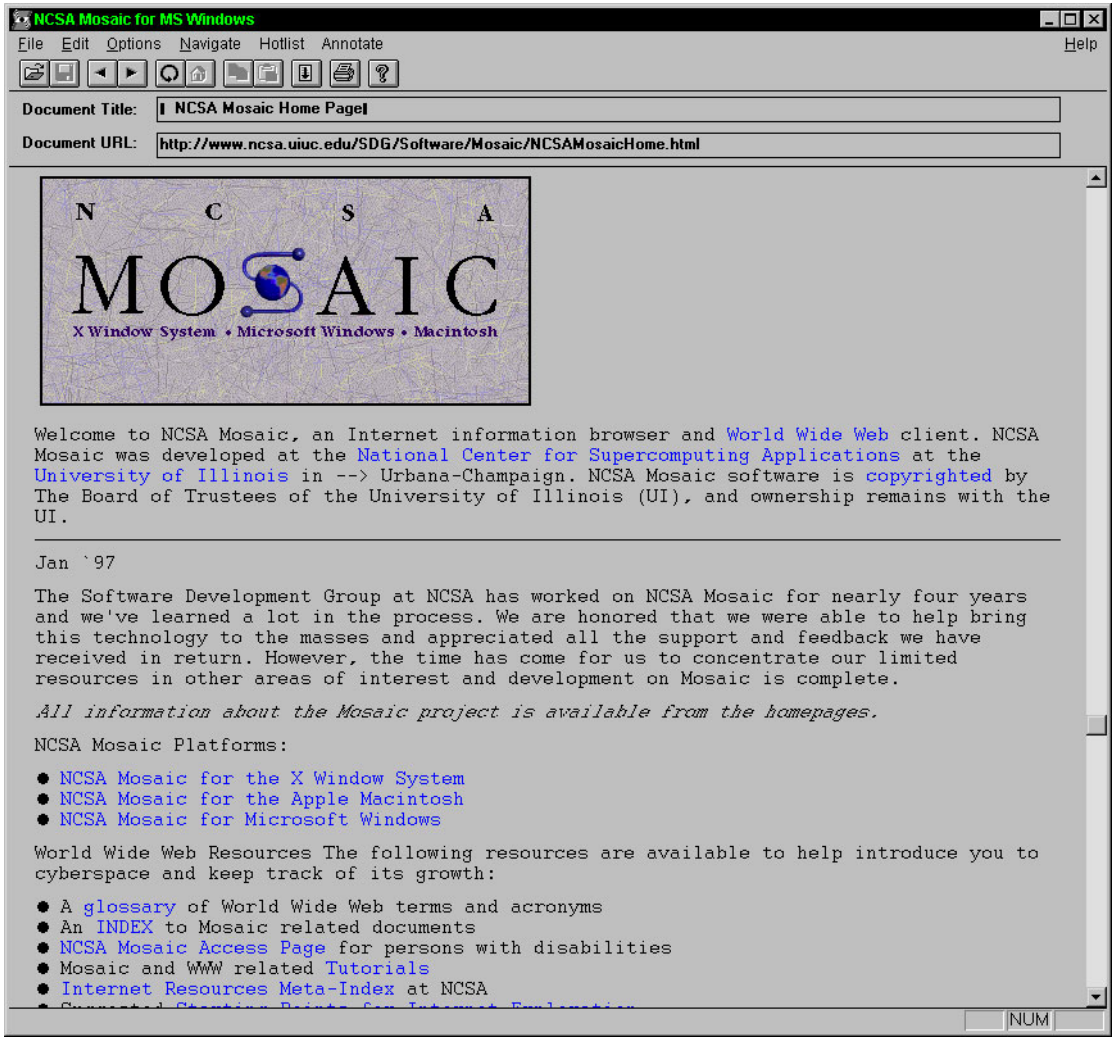


- Five components of WWW system: (1) content location specifier (URL), (2) web page creation language (HTML), (3) web page transmission protocol (HTTP), (4) web page distribution (server software), and (5) web page display (client-based web browser software).

Computer Networks : The World Wide Web (Cont'd)

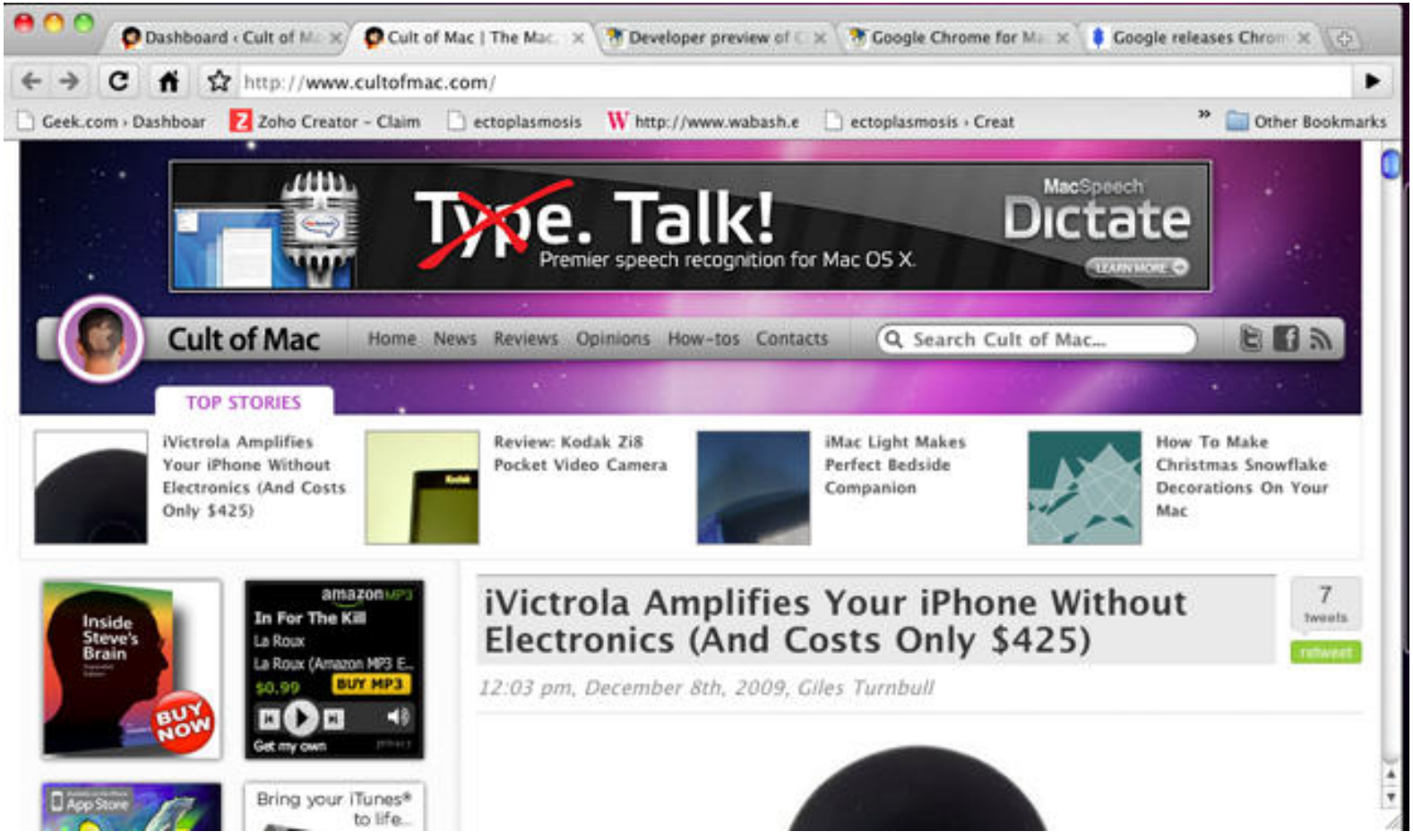
- Basic WWW software available by free download from CERN starting in 1991.
- First commercial-grade web browser (Mosaic) created at UIUC in 1993; spun off as Navigator to Netscape (by creators) and Spyglass / Microsoft Internet Explorer (IE) (by UIUC) in 1994.
- Navigator free for individuals but sold for commercial use; IE bundled for "free' starting with Windows 98, prompting (successful) US federal anti-trust lawsuit in 1998.

Computer Networks : The World Wide Web (Cont'd)



Mosaic Web Browser (1993)

Computer Networks : The World Wide Web (Cont'd)



Google Chrome Web Browser (2008)

Computer Networks : The World Wide Web (Cont'd)

- First commercial web services are web content catalogs created by human indexers (Yahoo!; 1993); superseded by automated indexing services (Google; 1998).
- To make money, Yahoo! displays advertisements; Google pioneers search-triggered sponsored links.

- Many retail web services emerge in mid-1990s (Amazon (1995); eBay (1996)); companies provide 95%+ content.
- Overconfidence in technical and financial potential of first-generation web services and their business models results in Dot-Com Crash in early 2000.

Computer Networks : The World Wide Web (Cont'd)

- Improved web tools allowing users to add and publish their own web content appear in late 1990s, creating Web 2.0.
- Applied by retail sites to add user reviews of products; in tandem with user purchase data, allows automated recommendations.

- Web 2.0 allows user-run enterprises like encyclopedia creation (Wikipedia (2001)) and open-source software development; also underlies explosion in social media services (Facebook (2005); Twitter (2006)).

New Types of Personal Computing

- First true “laptop” PCs (GRiD Compass 1101 (1982) [$8K]; see above left) appear in 1980s, *cf.*, portable “desktop” PCs like the Osborne I; expense of display and memory technologies limits market severely.
- Laptops finally surpass desktops in sales in 2008.

New Types of Personal Computing (Cont'd)

- Hand-held personal computing appears first as Personal Digital Assistants (PDAs) in early 1990s.
- Early PDAs (Palm Pilot, Newton) were typically too too expensive and based on technologies of limited user interest, *e.g.*, handwriting recognition.

- Second-generation PDAs achieve success among business and government users when combined with basic secure messaging abilities, *e.g.*, Blackberry (1999).

New Types of Personal Computing (Cont'd)

- First available in 1973, hand-held mobile phones have evolved to both become much smaller and incorporate basic text-based messaging and computing.

New Types of Personal Computing (Cont'd)

- The convergence of hand-held multimedia-enabled computing and communication technology has resulted in tablet computers and smartphones; the former is preferable for screen size and the latter for device size.

Computing in 2018: The State of the Art

- Cheap personal computing devices
- Cheap easy-to-use software applications
- Cheap(ish) highspeed wireless
- Massive online media (text / audio / video)
- Massive online personal data
- Massive processing power
- . . . All widely available 24/7 . . .
- . . . And there's more of it all every day . . .