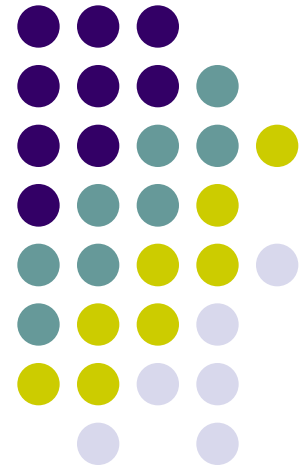


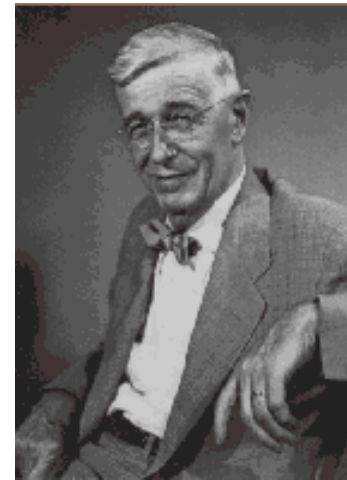
CSE 301

History of Computing

The Internet

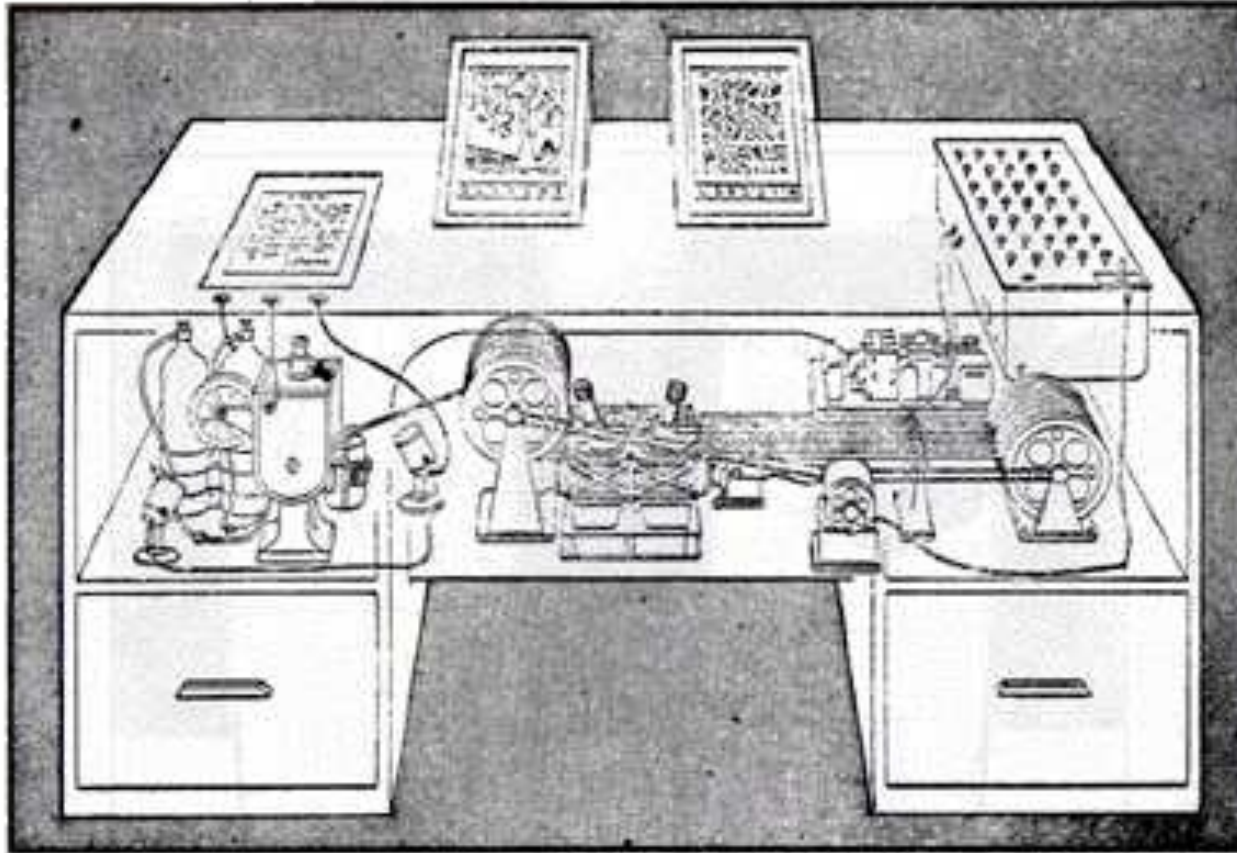
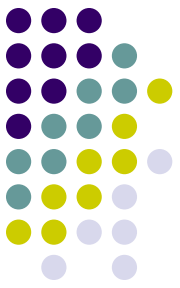


A Vision of Connecting the World – the Memex



- Proposed by Vannevar Bush
 - "As We May Think" in Atlantic Monthly in 1945
 - later in Life Magazine
 - "a device in which an individual stores all his books, records, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility"
 - an idea that would become [hypertext](#)
- Bush's work was influential on all Internet pioneers
 - particularly Douglas Engelbart

The Memex



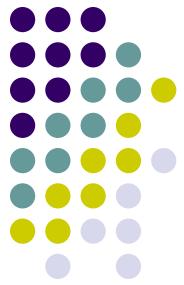
Memex in the form of a desk would instantly bring files and material on any subject to the operator's fingertips. Slanting translucent viewing screens magnify supermicrofilm filed by code numbers. At left is a mechanism which automatically photographs longhand notes, pictures and letters, then files them in the desk for future reference (*LIFE* 19(11), p. 123).

The Impetus to Act



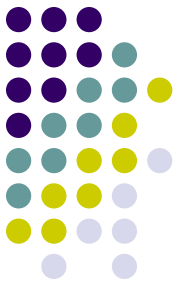
- 1957 - U.S.S.R. launches Sputnik I into space
- 1958 - U.S. Department of Defense responds by creating ARPA
 - Advanced Research Projects Agency
 - “mission is to maintain the technological superiority of the U.S. military”
 - “sponsoring revolutionary, high-payoff research that bridges the gap between fundamental discoveries and their military use.”
 - Name changed to DARPA (Defense) in 1972
 - Name changed back to ARPA in 1993
 - Name changed back to DARPA in 1996

Bell 103 by AT&T (the first modem)



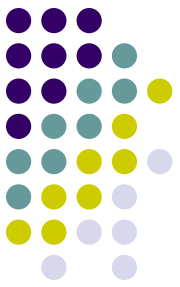
- What's a modem?
 - used for computers to communicate across phone lines
 - uses same frequencies as voice transmission
 - requires dedicated phone line connections
- Modems started to be developed in 1950s for military purposes
- First commercial device available in 1962

If there are modems doesn't that mean there is an Internet?



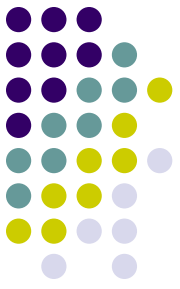
- No
- The Internet uses packet switching, not dedicated lines
- The Internet has a common language of communication (protocols)

ARPANET



- The Advanced Research Projects Agency Network (ARPANET) was the world's first operational *packet switching network*.
- Project launched in 1968.
- Required development of IMPs (Interface Message Processors) by Bolt, Beranek and Newman (BBN)
 - IMPs would connect to each other over leased digital lines
 - IMPs would act as the interface to each individual host machine
 - Used packet switching concepts published by Leonard Kleinrock, most famous for his subsequent books on queuing theory

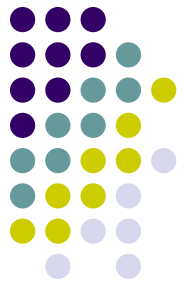
Who's the father of the *Internet*?



- Paul Baran?
- Donald Davies?
- Len Kleinrock?
- J.C.R. Licklider?
- Bob Taylor?
- Larry Roberts?
- Vinton Cerf?
- Robert Kahn?
- Answer: to designate one “father” is silly. Anyway, it depends on who you ask

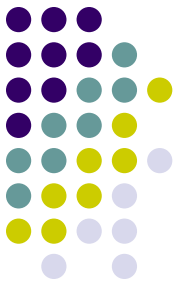
Early work

Baran (L) and
Davies (R)



- Paul Baran began working at the RAND corporation on secure communications technologies in 1959
 - goal to enable a military communications network to withstand a nuclear attack.
 - use of a decentralized network with multiple paths between any two points (distributed computing)
 - devised dividing complete user messages into message blocks before sending them into the network
- Donald Davies of Britain's National Physics Lab had begun working on related concepts in 1965
 - Introduced the term "packet"

Len Kleinrock



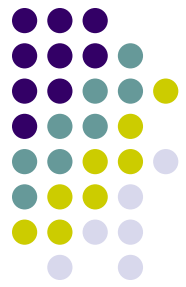
- Queueing theorist & engineer
- Really formalized packet switching research while at MIT
- Later joined ARPANET effort while at UCLA
- Oversaw installation of ARPANET's first IMP at UCLA

J.C.R. Licklider (“Lick”)



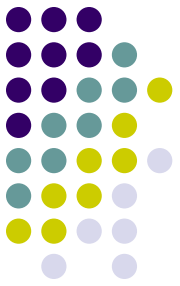
- Wrote *Man-Computer Symbiosis* in 1960
 - outlined the need for simpler interaction between computers and users
- Formulated the earliest ideas of a global computer network at MIT in 1962
- 1962-1964, Licklider was head of the ARPA Information Processing Techniques Office (IPTO)
 - set up ARPA research contracts with leading research institutions (Stanford, MIT, UCLA, etc ...)
 - proposed an “Intergalactic Computer Network“ to link the institutions
 - promoted standards among the various computing facilities

Bob Taylor



- Director of ARPA's IPTO (after Licklider & Ivan Sutherland)
- When he took over, the Intergalactic Computer Network was not actually connected
- He had a direct connection to ARPA computers around the country
 - Different researchers used different computers that could not talk to one another
- Taylor continued Licklider's vision, proposing to link them together in a uniform network (funded \$1 million)
 - the U. S. government's best return on an investment in its history?
 - maybe the Louisiana Purchase or the purchase of Alaska
- Taylor would later supervise Xerox PARC
- Won National Medal of Technology in 1999

Larry Roberts

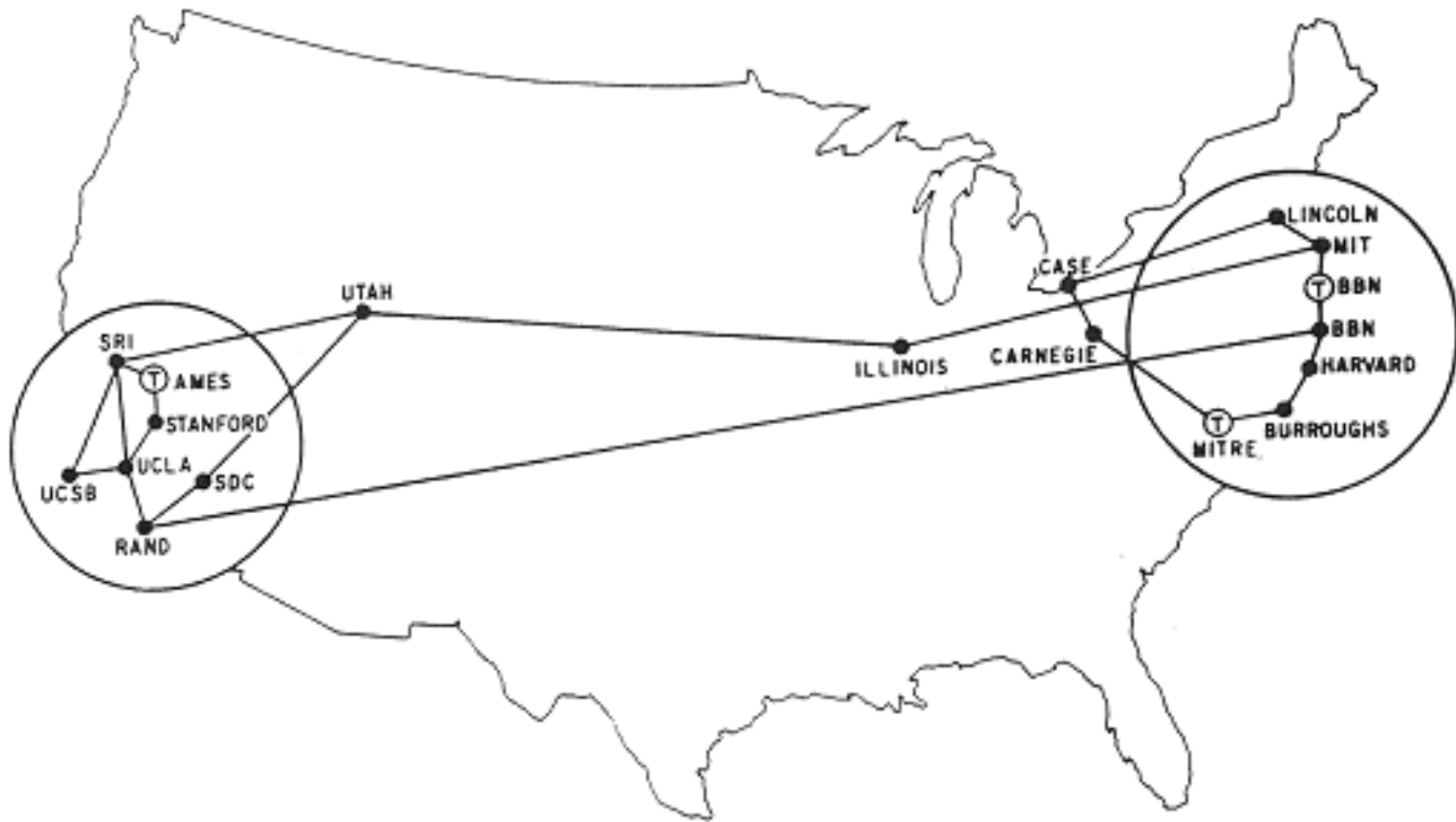


- Sometimes called “the father of ARPANET”
- Built first transcontinental network from MIT to Santa Monica (not packet switched)
- Strong-armed by Taylor to link ARPA computers
 - Roberts was ARPANET’s principal architect
- Decided to use packet switching & IMPs (idea from Wes Clark the researcher, not the former presidential candidate)
- Decided to start with 4 sites: UCLA, Stanford, UC Santa Barbara, & Utah

ARPANET

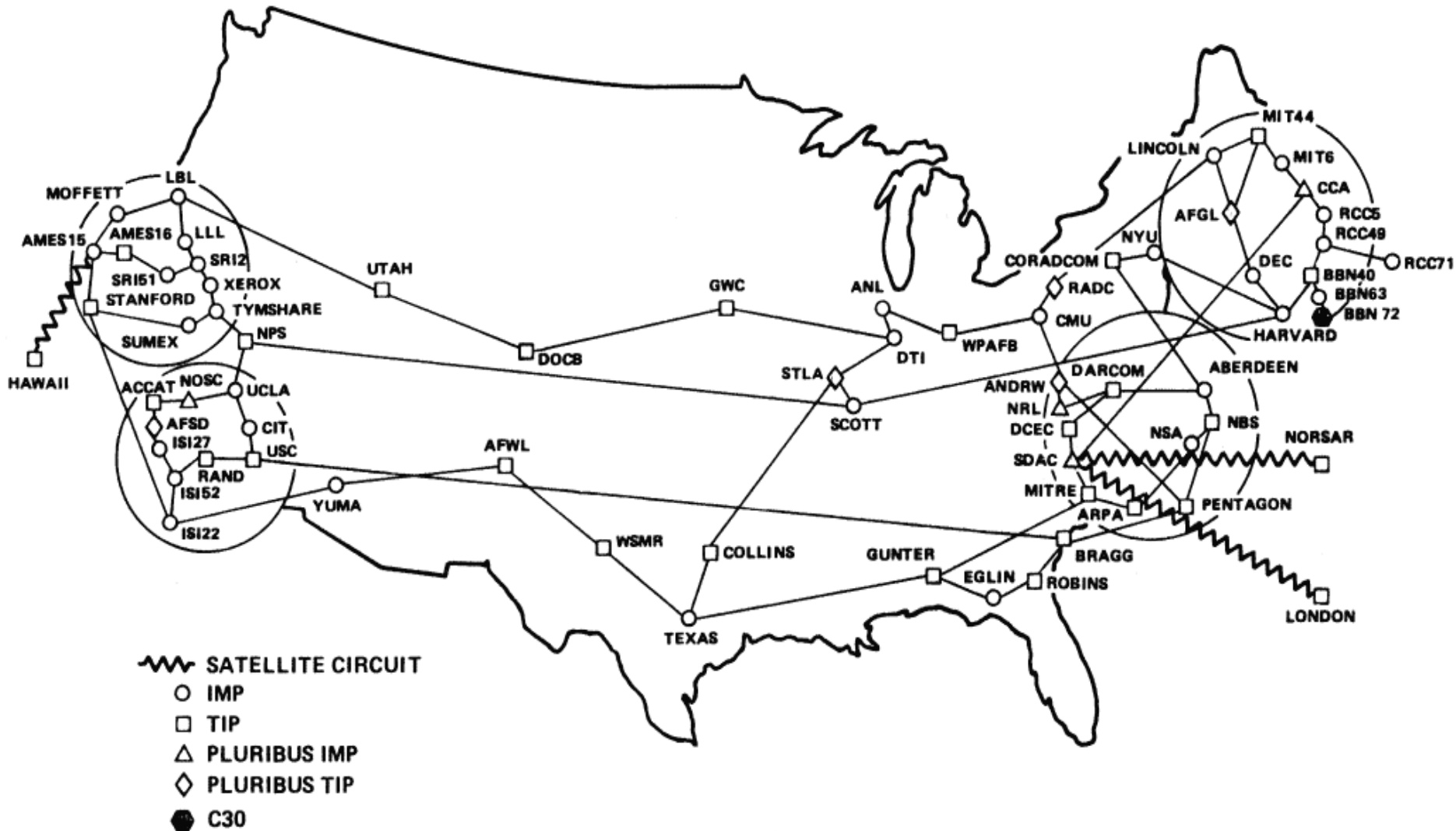


- Initial ARPANET deployed in late 1969 with four hosts:
 - University of California at Los Angeles (UCLA)
 - Stanford Research Institute (SRI)
 - University of California at Santa Barbara (UCSB)
 - University of Utah



MAP 4 September 1971

ARPANET GEOGRAPHIC MAP, OCTOBER 1980



(NOTE: THIS MAP DOES NOT SHOW ARPA'S EXPERIMENTAL SATELLITE CONNECTIONS)
 NAMES SHOWN ARE IMP NAMES, NOT (NECESSARILY) HOST NAMES

ARPANET Goes Public



- In October 1972 Robert Kahn organized a large, very successful demonstration of the ARPANET at the International Computer Communication Conference (ICCC).
 - This was the first public demonstration of this new network technology to the public.
- Electronic mail was introduced in 1972 by Ray Tomlinson of BBN.
 - E-mail took off as the largest network application for over a decade.

Aloha Net



- First wireless network
- Created at University of Hawaii in 1970!
- Send packets over radio waves
- Developed under leadership of Norman Abramson
- Also built with DARPA funding
- Sent data at approximately 80 characters per second
- Only one node could talk at a time
- Inspired future development of Ethernet protocol at Xerox PARC by Bob Metcalfe (3Com founder)

TCP/IP



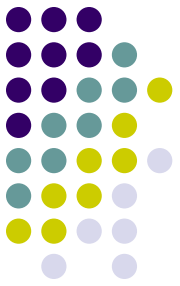
- Instead of the network being responsible for reliability, as in the ARPANET, the hosts became responsible.
 - TCP – Transmission Control Protocol
 - included error-correction techniques
 - IP – Internet Protocol
 - assumed that the end host would deal with transmission errors
 - With the role of the network reduced to the bare minimum, it became possible to join almost any networks together, no matter what their characteristics.
 - One popular saying has it that TCP/IP will run over "two tin cans and a string".
- In 1983, TCP/IP protocols became the principal protocol of the ARPANET

Vinton Cerf



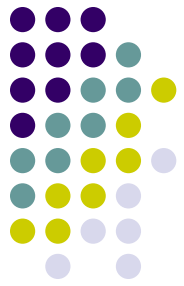
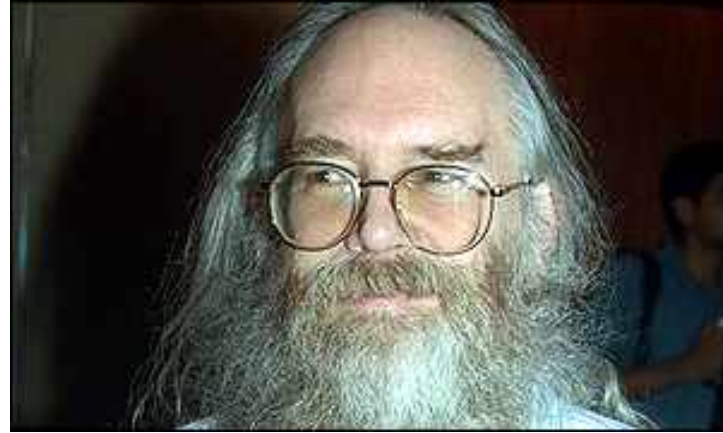
- Known as the “father of the Internet”
 - co-designed the TCP/IP protocol with Robert Kahn
 - led effort for its adoption in 1980s
 - in the mid 1980s, he led the engineering of MCI Mail, the first commercial email service to be connected to the Internet.
- Served as founding president of ISOC (Internet Society) from 1992-1995.
- In 1997, he was presented the U.S. National Medal of Technology, along with Kahn

Robert Kahn



- Known as the “father of the Internet”
 - co-designed the TCP/IP protocol with Vinton Cerf
- In 1997, he was presented the U.S. National Medal of Technology, along with Cerf
- They also won ACM’s Turing Award in 2004

There's only one “God of the Internet”



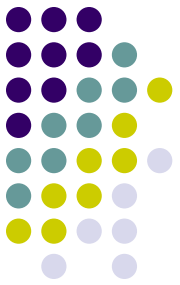
- Jon Postel
- Part of ARPANET while at UCLA
- Designed domain name system
- Top administrator for IANA
 - overall authority for IP Addresses & Domain Names

1980s

The Modern Internet emerges



- Connections expanded to more educational institutions and companies
- National Science Foundation (NSF), became heavily involved in the Internet
 - intended to connect supercomputing centers
- ARPANET was gradually shut down (its last node was turned off in 1989)
- NSF took over responsibility from DOD for providing long-haul connectivity in the US



References

- DARPA Home Page
 - <http://www.darpa.mil>
- Internet Pioneers
 - <http://www.ibiblio.org/pioneers/index.html>