

First course of Computer Science

Part VIII: Internet - Connect you with the world

Goals

- Know the brief history of Internet
 - The related IO devices
 - Mechanism
 - Architecture of UIMS – User Interface Management System

Internet

- ts

History of the Internet

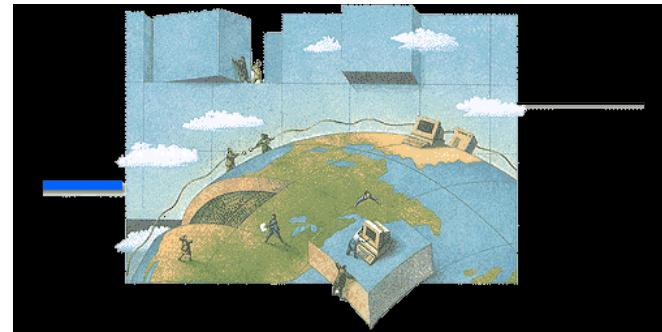
Slides created by Ajay Gopinathan. Content adapted from previous slides by Emir Halepovic as well references found at the end of this presentation

Who are they?



Outline

- The Birth of Internet
- Internet Pioneers
- ARPA & ARPANET
- Switching Network
- Growth of the Internet
- Who governs the Internet
- The development in China
- The Future Prospects



The Birth of ARPA



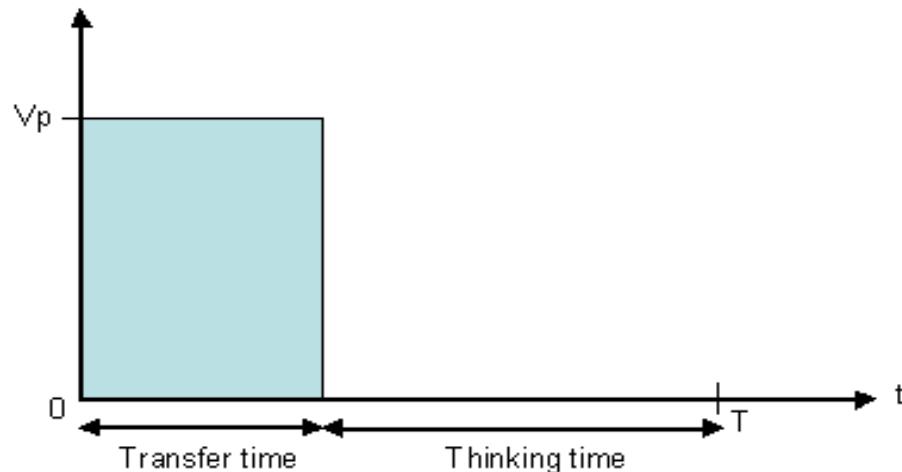
- In 1957, USSR launches the first artificial earth satellite - Sputnik.
- In 1958, US forms the Advanced Research Projects Agency ([ARPA](#))
- ARPA directly reports to the US Department of Defense (DoD) and develops state-of-the-art technology in order to maintain the leading military research position.

The evolution of ARPAnet

- The 1st Packet-Switching (PS) paper was presented in 1961.
- PS-network was presented to the ARPA in 1968. The request for the proposals of ARPA Network (ARPANET) was sent in the same year.
- In 1969, the ARPANET commissioned by DoD for research into networking.
- Only 4 nodes comprise the ARPANET.

Packet Switching

- ❑ Data traffic is bursty – intervals of activity followed by periods of inactivity.
 - E.g. Think of a web browsing session
- ❑ Circuit switched networks would be inefficient



Packet Switching



Photo by Louis Bachrach

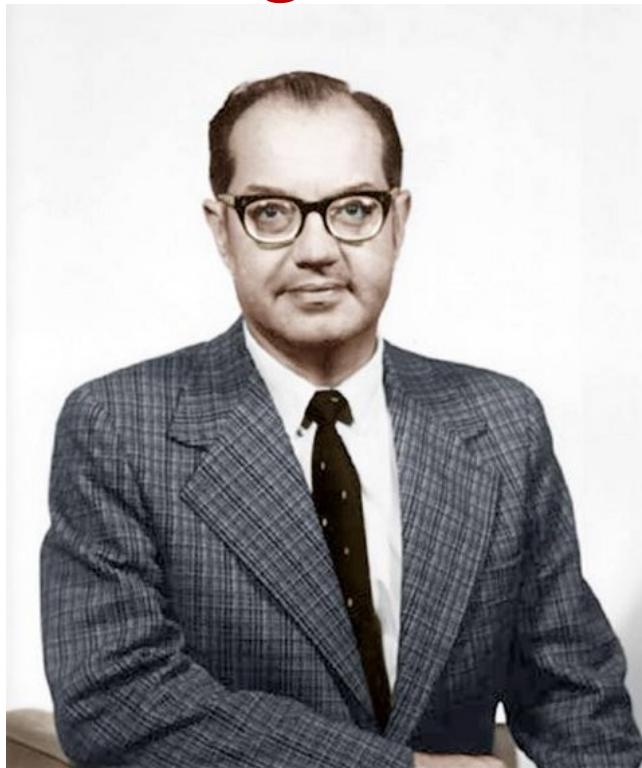
- 1961: Leonard Kleinrock uses **queuing theory**, proposes packet switched networks
 - More bandwidth efficient
 - Robust – not reliant on single route

Packet Switching or Circuit Switching?

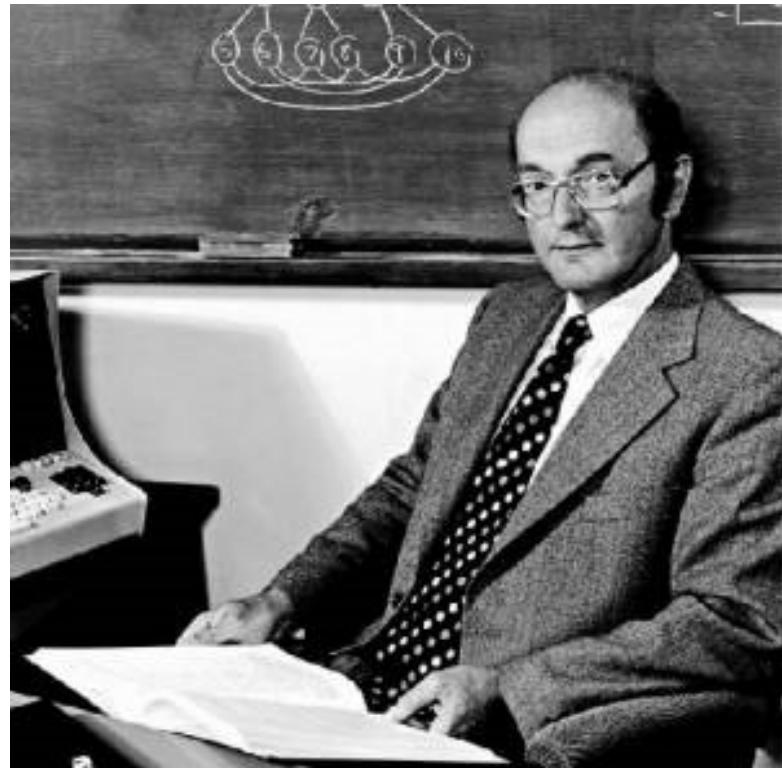
- **Circuit Switching**
 - A network that provides data channels for the sole use by a single user.
- **Packet Switching**
 - Message is broken into pieces of data and is transmitted over the network.
- Demo now!

The fundamental mechanism of the Internet

- Two concepts
 - “Store and Forward” (Baran) & “Packet-switching” (Davies)



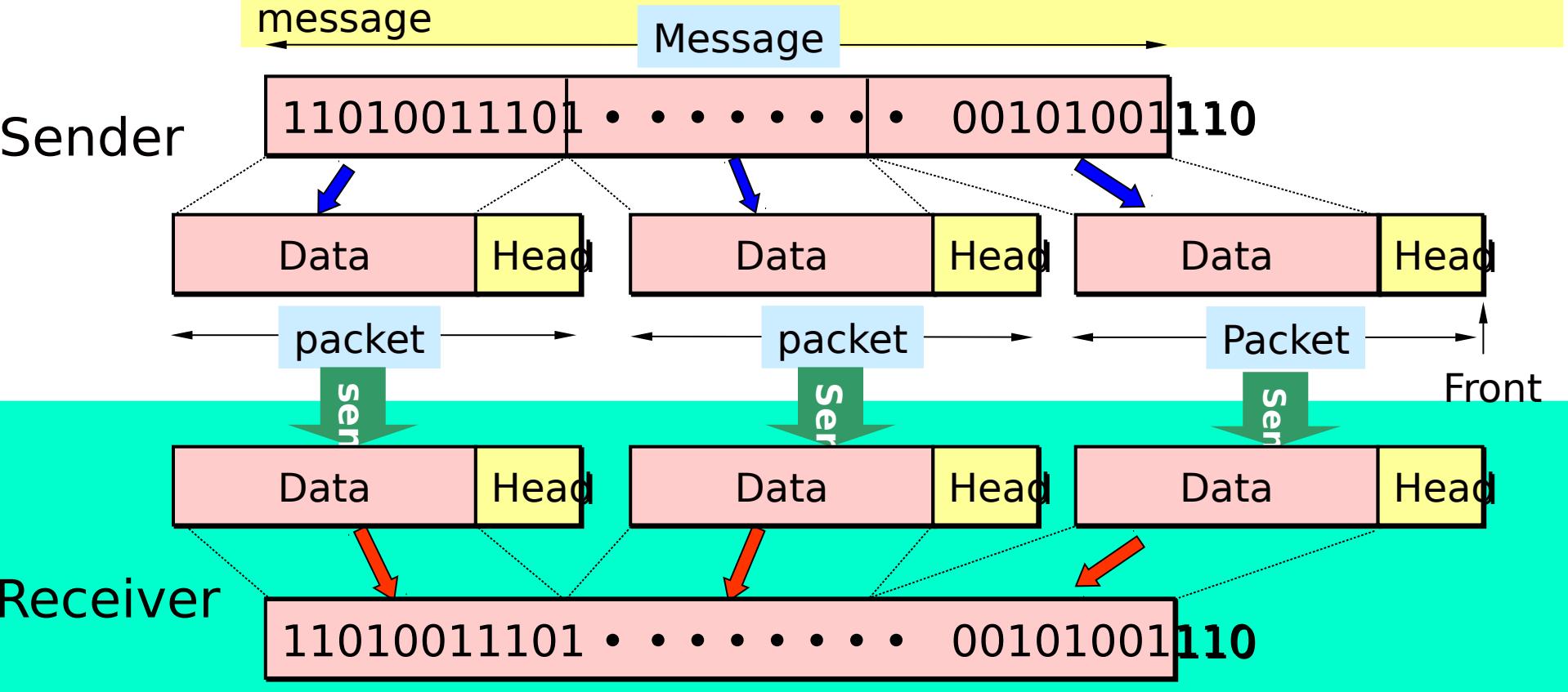
Paul Baran



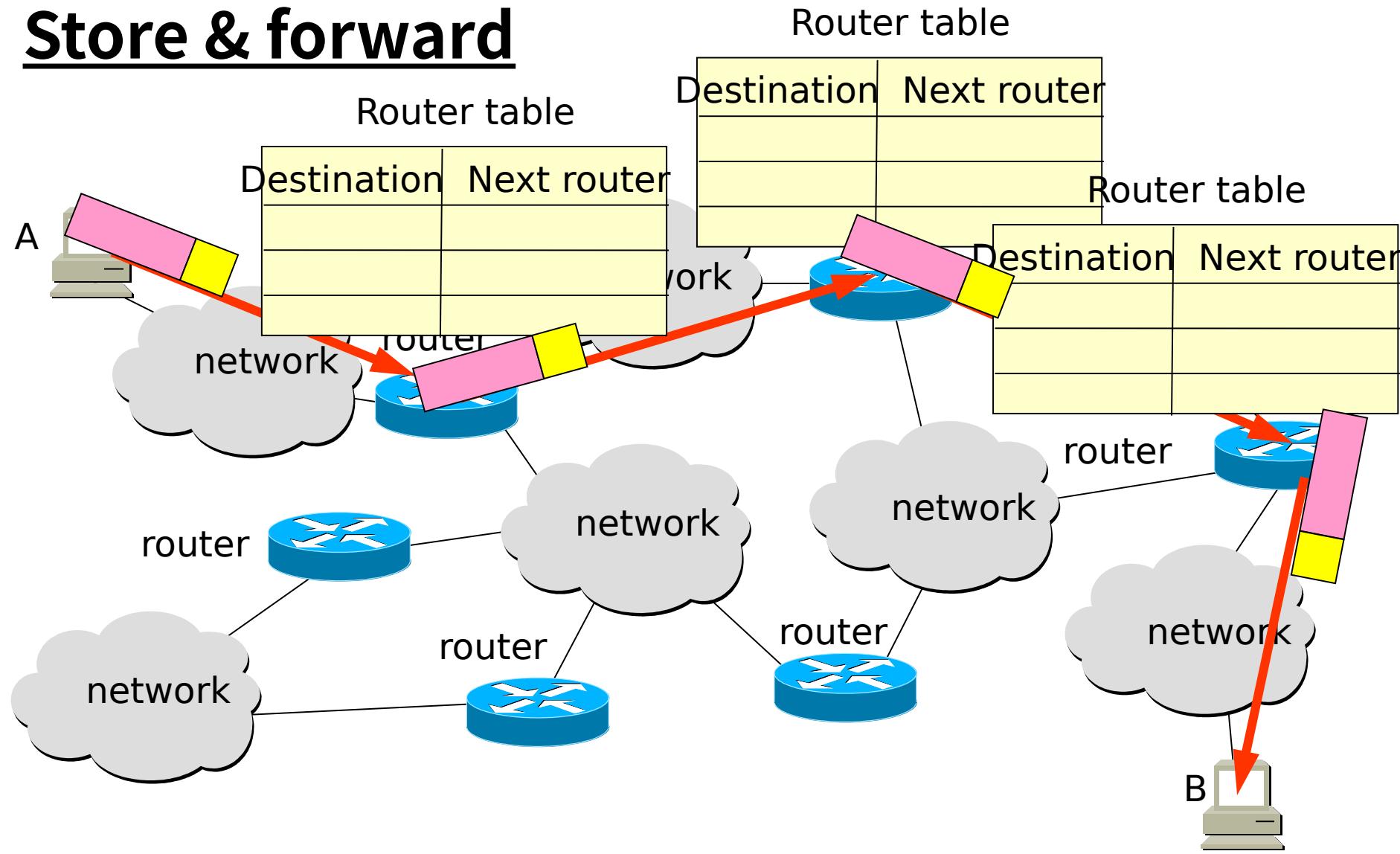
Donald Watts Davies, 1924-2000

• Packet switching [包交換]

- ↳ At sender, split the message into data blocks
- ↳ By adding head info, each data block turns into packet
- ↳ Send the packets to receiver
- ↳ Receiver collects packets, and reverts them into the message

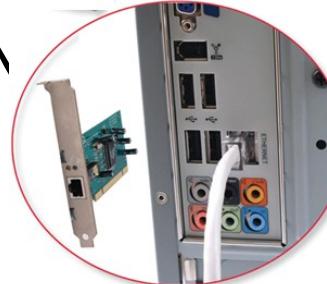
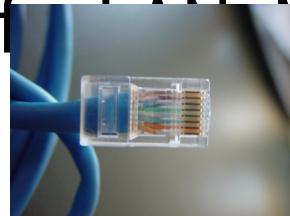


- Transmitting a packet from A to B following **Store & forward**



- By the above knowledge, computers are just the nodes to be connected into the Internet

- To a **router** or **LAN/MAN**

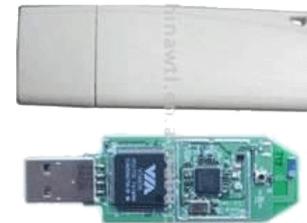


Every device on a network requires network circuitry, such as a network interface card.

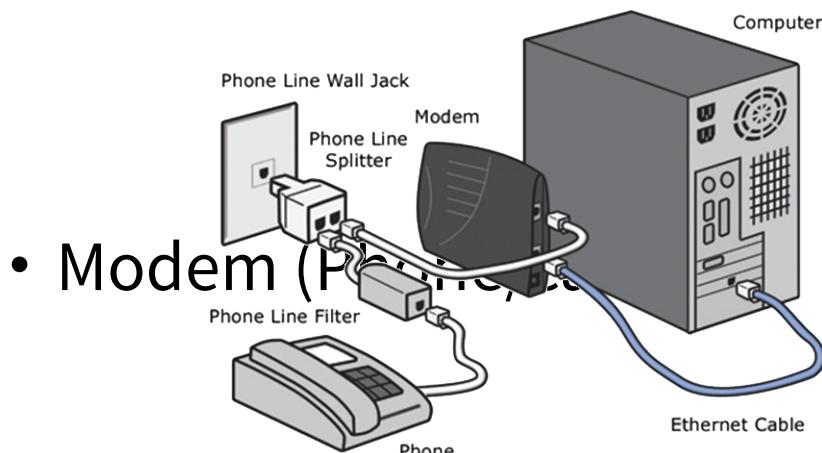
- Twisted pair



Notebook with wireless adapter card



- Wireless

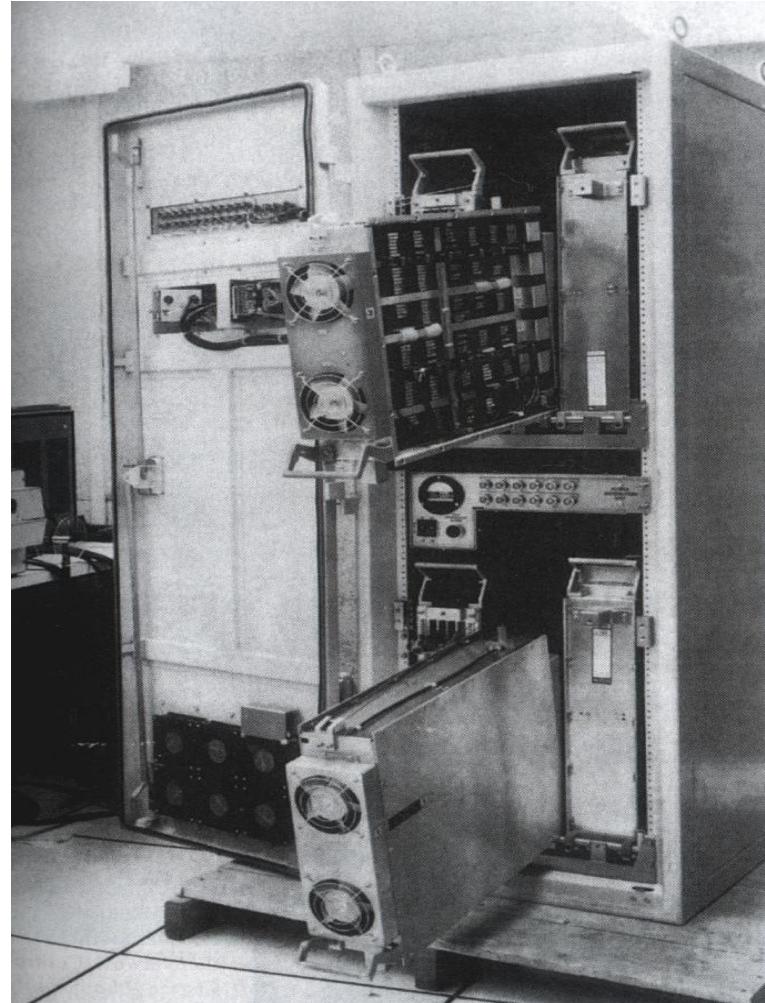


The first ARPANET

- Nodes are connected by AT&T 50kbps lines.
- Node 1: University of California Los Angeles ([UCLA](#)), Host is SDS SIGMA7
- Node 2: Stanford Research Institute ([SRI](#)), Host is SDS940
- Node 3: University of California Santa Barbara ([UCSB](#)), Host is IBM 360/75
- Node 4: University of [Utah](#), Host is DEC PDP-10

ARPANET

- 1967: Lawrence Roberts of ARP A publishes plan for the first computer network system – the ARPANET
- Packet switches were needed. Called Interface Message Processors (IMP), the contract was awarded to BBN
- Oct 1969: IMPs installed in UCL A, Stanford, UCSB and Utah



Interface Message Processor

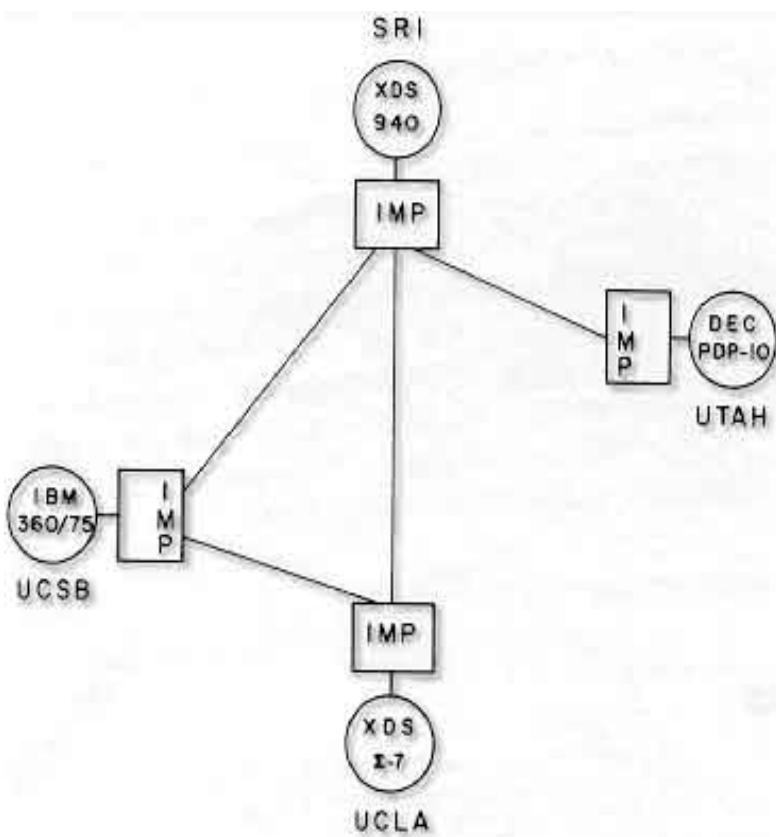
Hosts

- IBM 360/75

DEC PDP-10



ARPANET



- 1969: At UCLA Kleinrock attempts the first ever remote login at Stanford:

"We set up a telephone connection between us and the guys at SRI...," Kleinrock said in an interview : "We typed the L and we asked on the phone, "Do you see the L?"

"Yes, we see the L," came the response.

"We typed the O, and we asked, "Do you see the O."

"Yes, we see the O."

"Then we typed the G, and the system crashed"...

Interface Message Processor (IMP)

- 4 IMPs were connected, ARPANET was born.



Interface Message Processor (IMP)

Geographical Position

Host 1(UCLA)

Host 2 (SRI)

Host 3 (UCSB)

Host 4 (Utah)

SALT LAKE 2002 
OFFICIAL SITE OF THE 2002 OLYMPIC WINTER GAMES

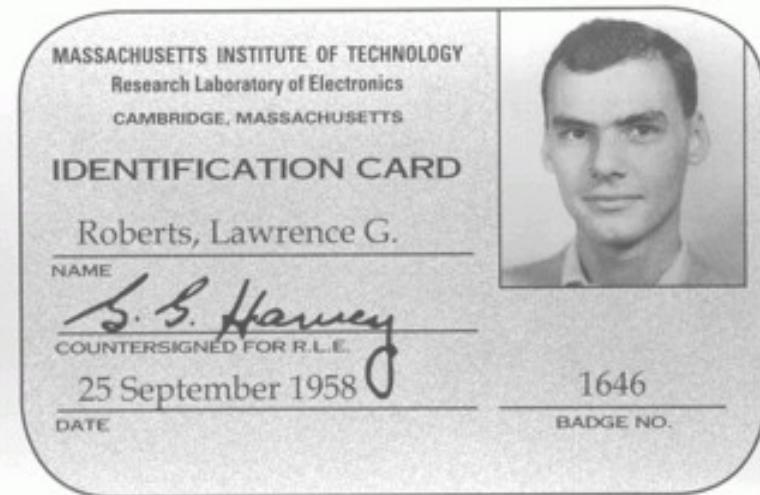


Geographical Position



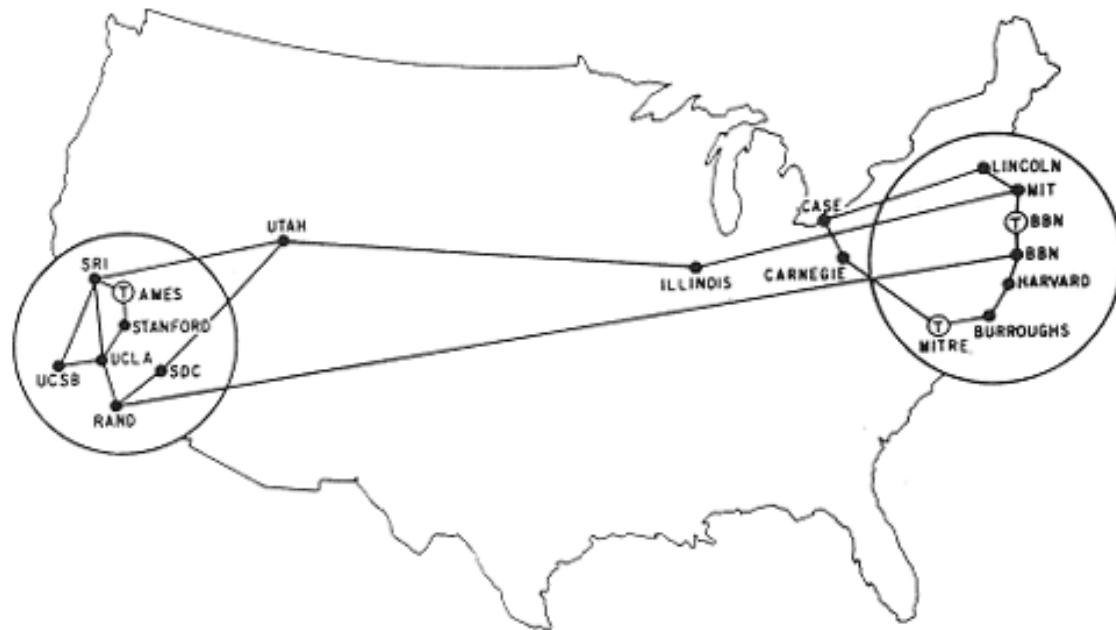
The father of ARPANET

- Larry Roberts is the principal architect of the ARAPNET



The growth of ARPANET

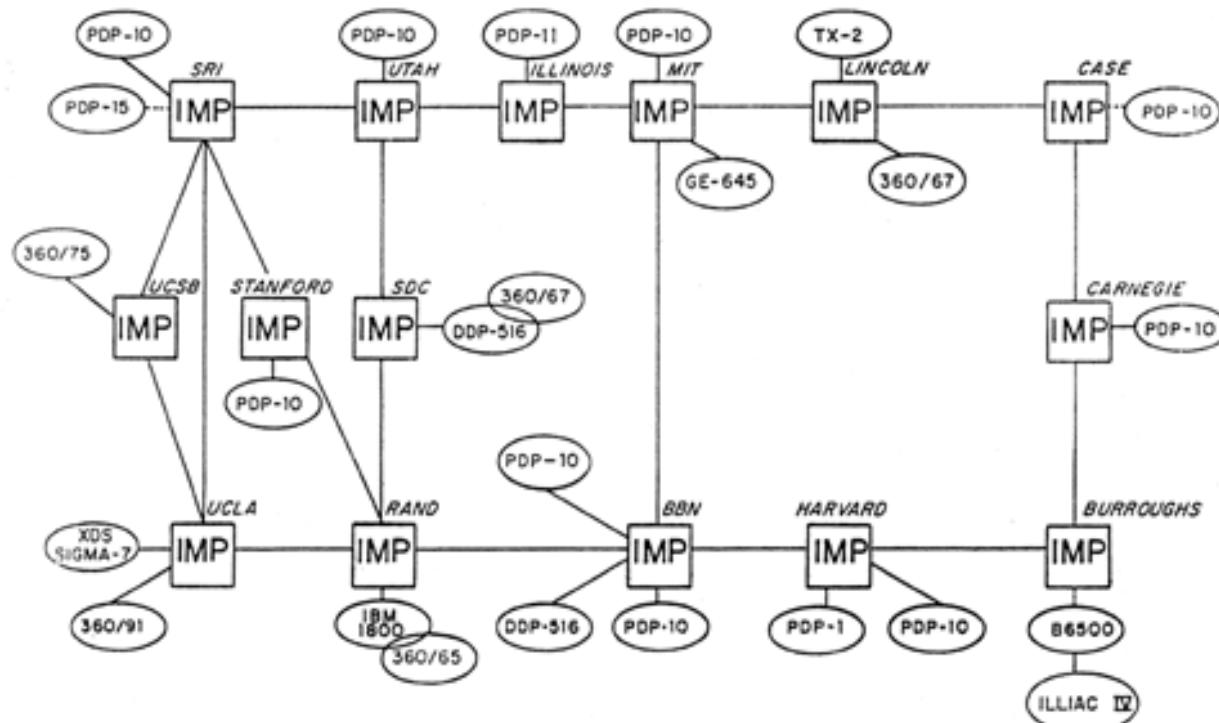
- 1971, 15 nodes (23 hosts): UCLA, SRI, UCSB, Univ of Utah, MIT, Harvard, Stanford, UIUC, CMU, NASA, etc...



MAP 4 September 1971

The growth of ARPANET

- 1971, 15 nodes (23 hosts): UCLA, SRI, UCSB, Univ of Utah, MIT, Harvard, Stanford, UIUC, CMU, NASA, etc...



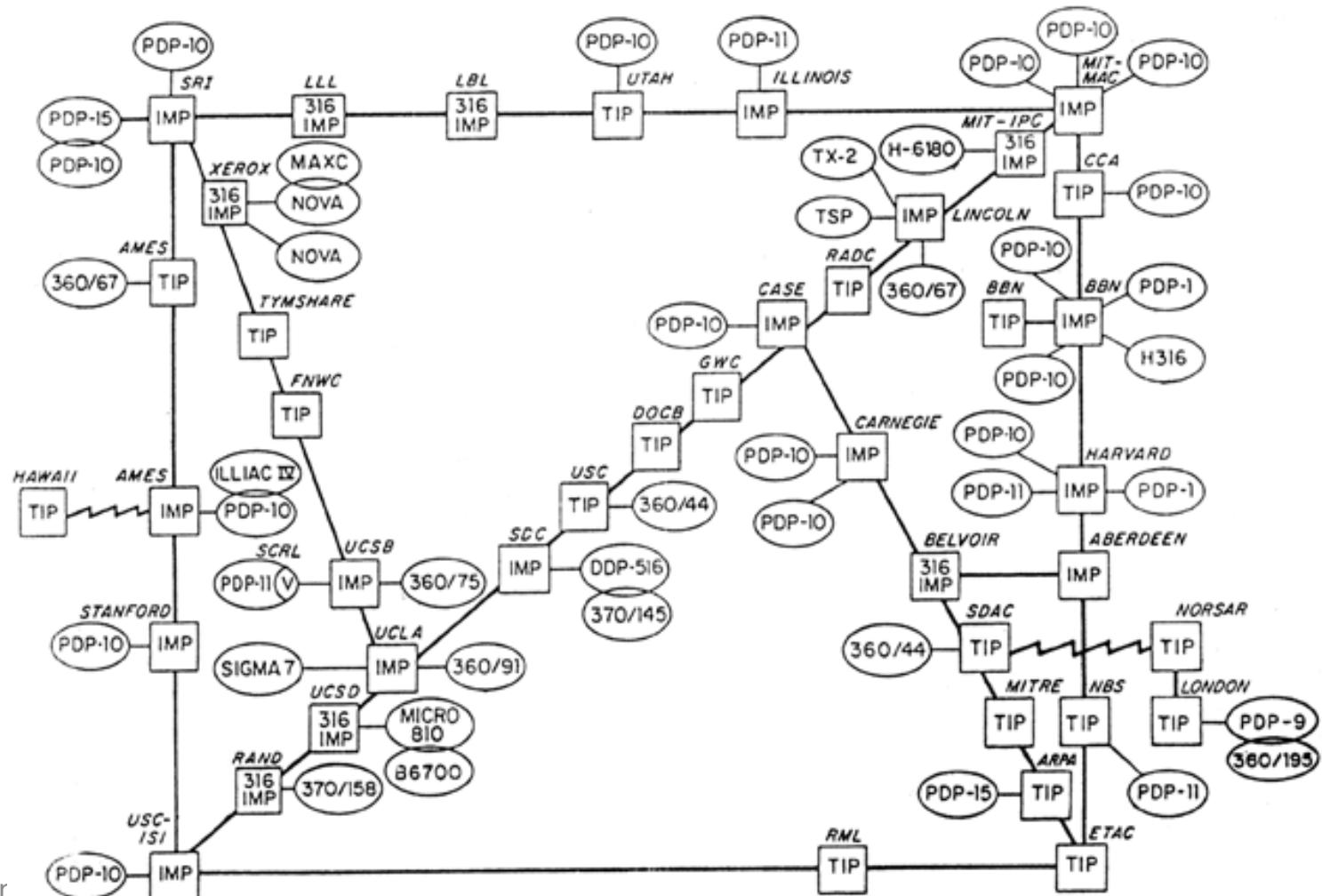
The growth of ARPANET

- Ray Tomlinson invents email program (1971), introduce the use of “@”.
- LOHAnet (first packet radio network) from Univ of Hawaii, join ARPANET in 1972
-
- 1973, study shows email compose 75% of the ARPANET traffic.
- Elizabeth II sent an email in 1976.



The ARPANET - 1973

ARPA NETWORK, LOGICAL MAP, SEPTEMBER 1973



Angola	Grenada	Samoa
Anguilla	Guadeloupe	Seychelles
Bahamas	Guinea	Sierra Leone
Bangladesh	Guyana	Solomon Islands
Bosnia-Herzegovina	Haiti	St. Vincent & Grenadines
Botswana	Kiribati	Sudan
Burkina Faso	Lao Democratic R.	Swaziland
Cambodia	Lesotho	Tajikistan
Cameroon	Malawi	Tanzania
Chad	Mali	Togo
Cook Islands	Marshall Islands	Tonga
Cote d'Ivoire	Nauru	Turkmenistan
Cuba	Netherlands Antilles	Tuvalu
Eritrea	New Caledonia	Vanuatu
Ethiopia	Niger	Vietnam
French Guiana	Nigeria	Yugoslavia
French Polynesia	Niue	
Gambia	Papua New Guinea	



Figure 10.1 Countries in 1977 that could send or receive email but were not connected to the Internet.

Early 70s...

- ❑ ARPANET, with 40 nodes, goes public in 1972
- ❑ NCP, first host-to-host protocol, enables network applications
- ❑ 1972: Ray Tomlinson writes email program for ARPA NET
- ❑ First computer to computer chat takes place between Stanford and BBN
- ❑ 1972: Telnet protocol RFC published
- ❑ 1973: FTP protocol RFC published

Ethernet

- ❑ ARPANET – Each node able to only talk to the other node on the other end of wire
- ❑ First medium access control – ALOHANet by Norman Abramson
- ❑ 1973-75: Bob Metcalfe's dissertation leads to the Ethernet protocol
 - Medium access control protocol for wired networks based on Abramson's ALOHA.
 - Dissertation initially rejected by Harvard for not being analytical enough, but won acceptance when a few more equations were added!

Proprietary Networks

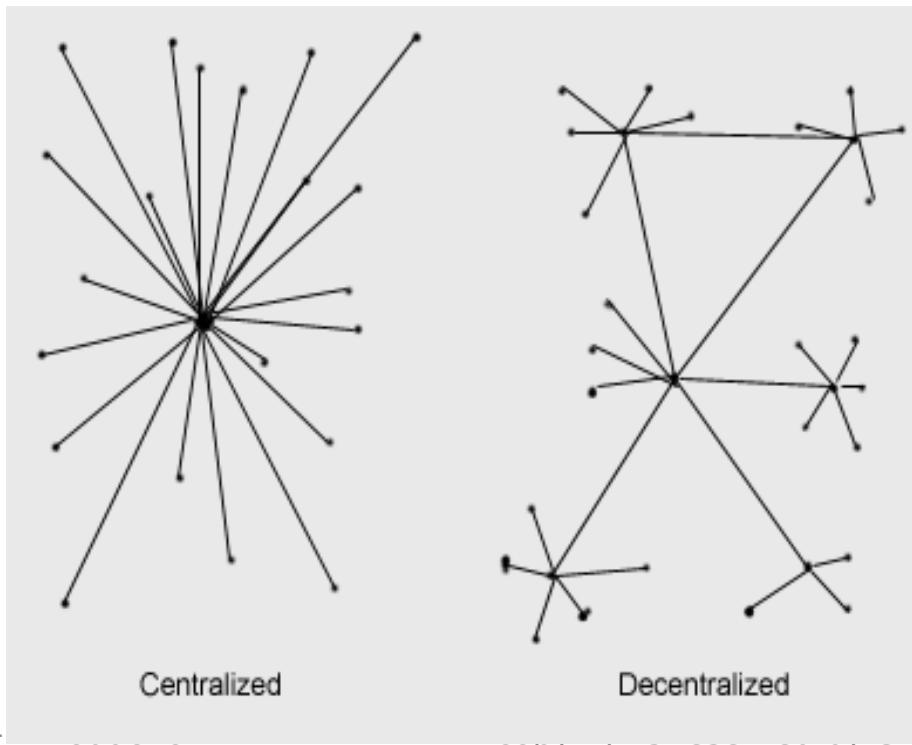
- ❑ ARPANET was a standalone network. Other proprietary, standalone networks were created in the 70s:
 - ALOHANET: Linking Hawaiian universities, using microwave as transmission medium
 - Telenet: by BBN, commercial
 - Cyclades: French packet switching network
- ❑ Number of networks was growing!

Late 1970s, Early 1980s

- Many networks were built
 - In 1981, **BITNET**, the “Because It’s Time NET work” started as cooperative network.
 - **CSNET** (Computer Science NETwork) seeds grant support by National Science Foundation (NSF) and provides connection between universities.
 - **EUnet** (European UNIX Network)
 - **JUNET** (Japan UNIX Network)
 - **JANET** (Joint Academic Network) in UK

Why Decentralized? Why Distributed?

- Centralized model – attack the central point, any counter-attack?



Cheung 2003.

Distributed Network

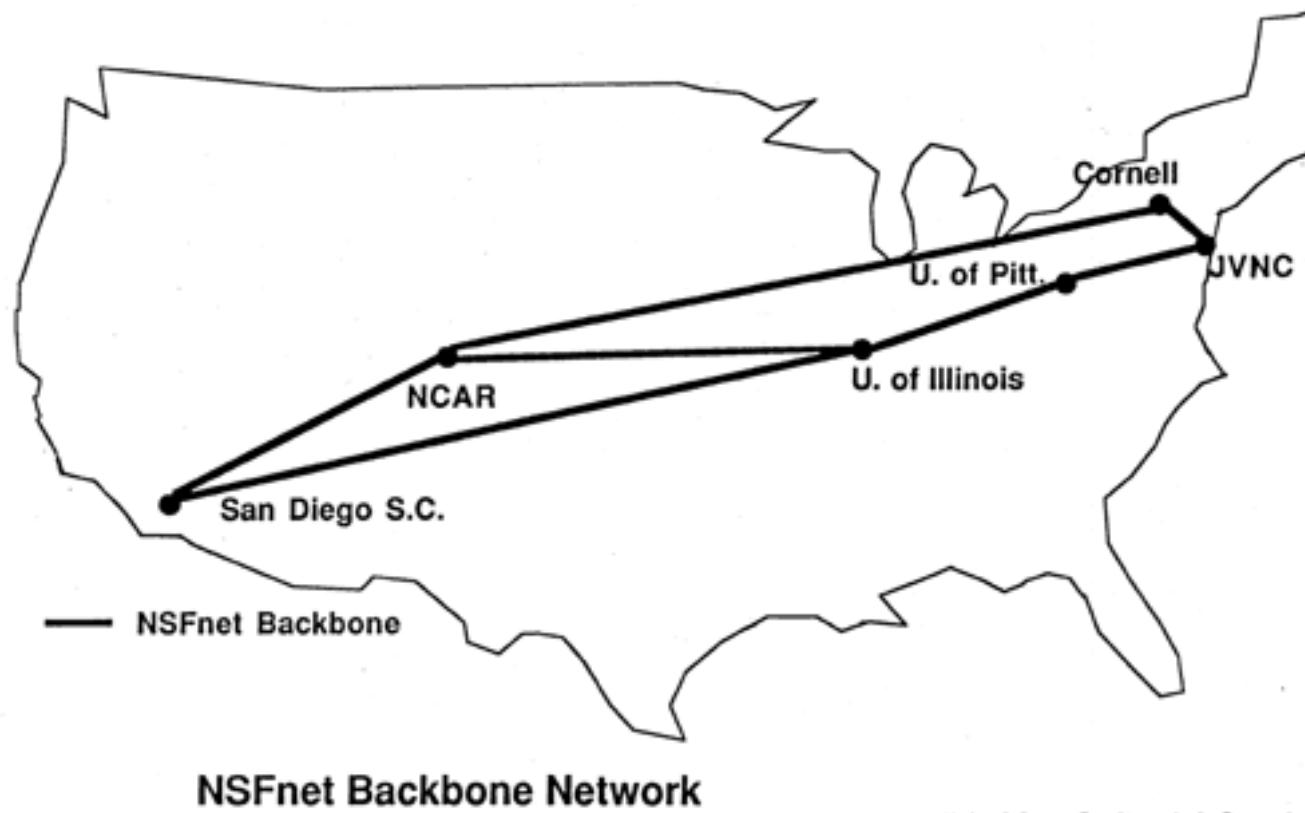
- **Paul Baran** has 2 important ideas to the development of ARPANET
 - Distributed network
 - Packet switching



NSFNET

- In 1986, NSFNET was created (backbone speed of 56Kbps)
- Connected 5 supercomputing centers.
 - JVNC@Princeton
 - PSC@Pittsburgh
 - SDSC@UCSD
 - NCSA@UIUC
 - Theory Center@Cornell

NSFNET - Backbone

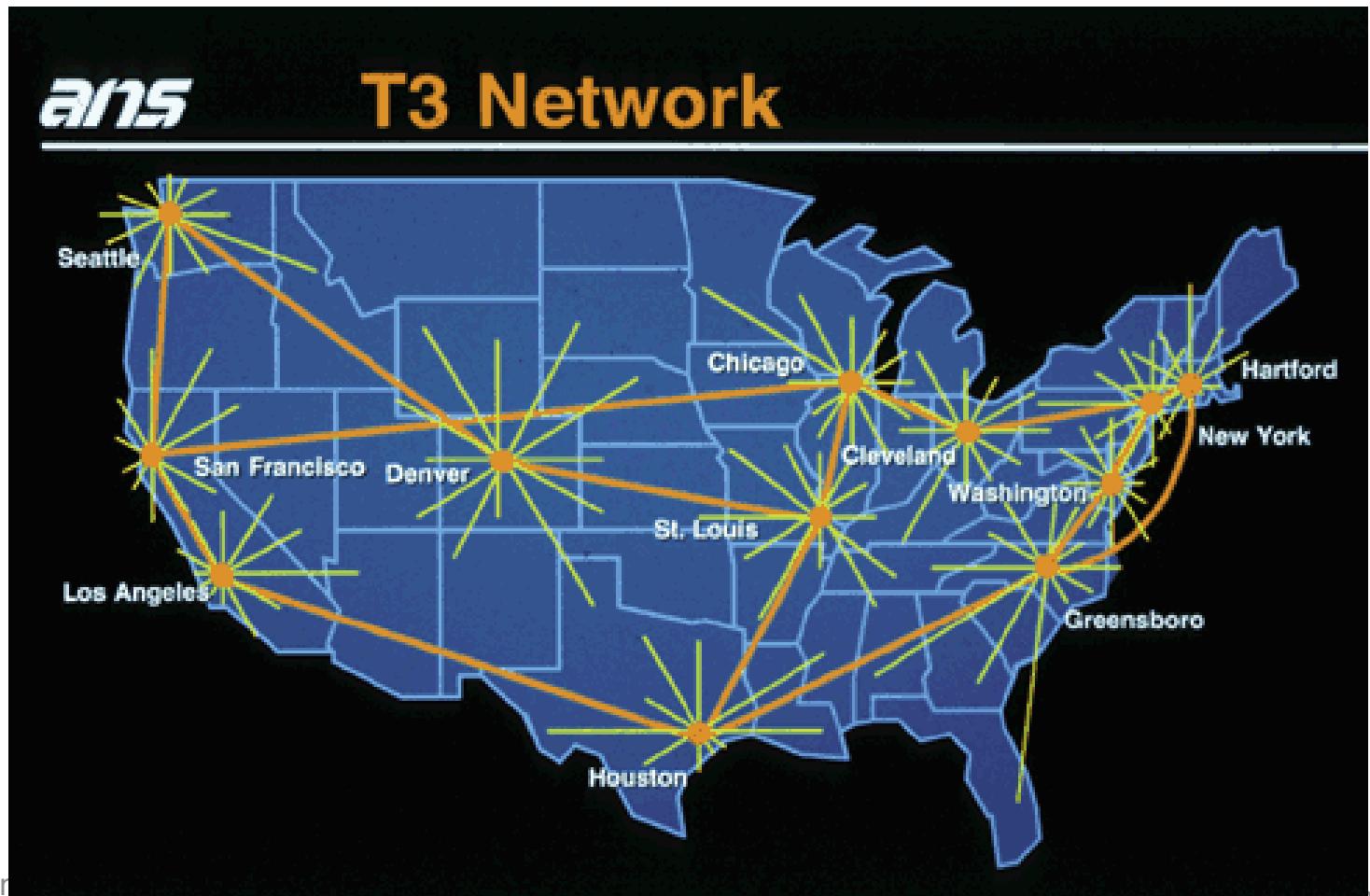


National Center For Atmospheric Research
March 19, 1986

Expansion of hosts

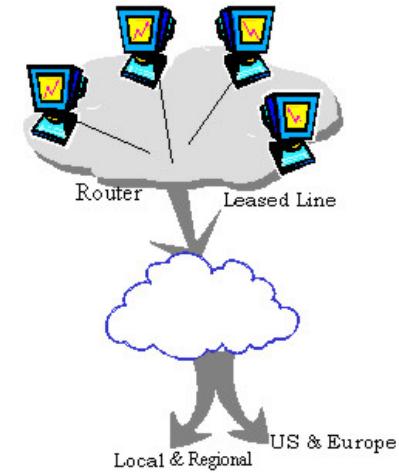
- Number of hosts breaks 10,000 in 1987
- NSFNET backbone upgraded to T1 (1.5M) 1988
- Number of hosts breaks 100,000 in 1989
- NSFNET upgraded to T3 (44.736Mbps) 1991
- Number of hosts breaks 1,000,000 in 1992

T3 Backbone



Trunk Bandwidth

- T1 – Trunk Level 1
- A T3 line is comprised of 28 T1 lines operating at total signaling rates of 45 Mbps.
 - T1 – 1.5Mbps, T2 – 6Mbps, T3 – 45Mbps
- European Standard – E
 - E1 – 2Mbps, E2 – 8Mbps, E3 – 34Mbps, E4 – 140Mbps



Fathers of the Internet



Vinton Cerf and Robert Kahn

- At DARPA, Vinton Cerf and Robert Kahn are working on an architecture to create a "*network of networks*" - *internetting!*

“Internetting” principles

- ❑ Decentralized control
- ❑ Stateless routers
- ❑ Autonomy - networks should be independent, require no modification to participate in the Internet
- ❑ Best Effort Service Model - Packets would be routed through the fastest available route

TCP and UDP

- ❑ Early versions had in sequence delivery (transport layer) combined with forwarding (network layer)
 - It was soon apparent that unreliable, non-flow controlled service was important, e.g. packetized voice
- ❑ This led to separation of TCP and IP and creation of the UDP protocol.

“TCP over IP”

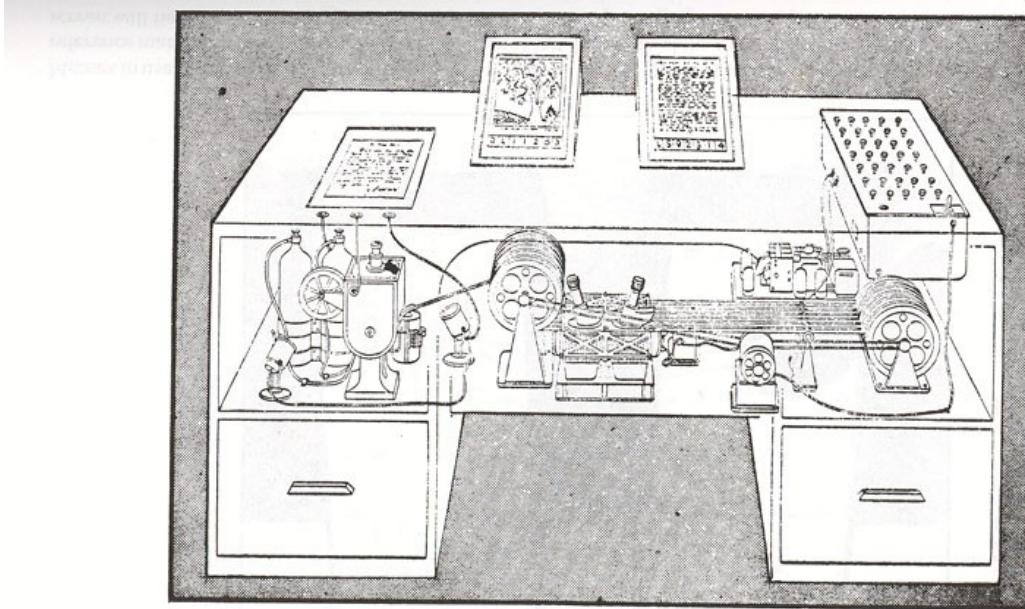
1980s

- ❑ Time of tremendous growth
- ❑ Networks for linking universities together
 - BITNET – email and ftp (Northeast)
 - CSNET – linking universities without access to ARPANE T
- ❑ NSFNET: provide access to NSF supercomputing resources
- ❑ 1983: TCP/IP replaces NCP as universal host protocol on Jan 1.
- ❑ By the end of the 80s, there were 100,000 hosts

1990s...commercialization!

- ❑ NSFNET began to serve as backbone, linking regional networks in US and networks abroad
- ARPANET was decommissioned
- ❑ NSFNET was decommissioned in 1995, most Internet backbone traffic carried by commercial ISPs
- ❑ Increased commercialization, advent of WWW, all lead to explosion of growth

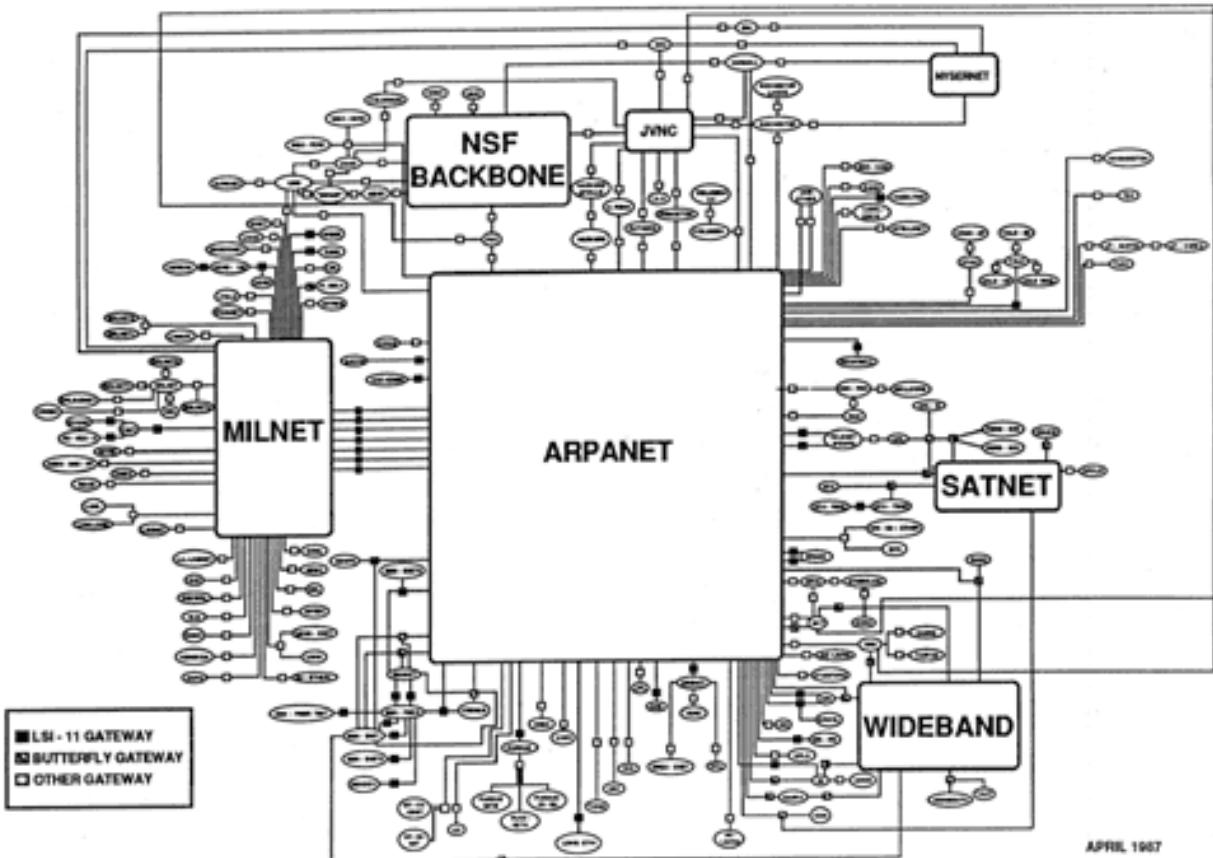
The Memex



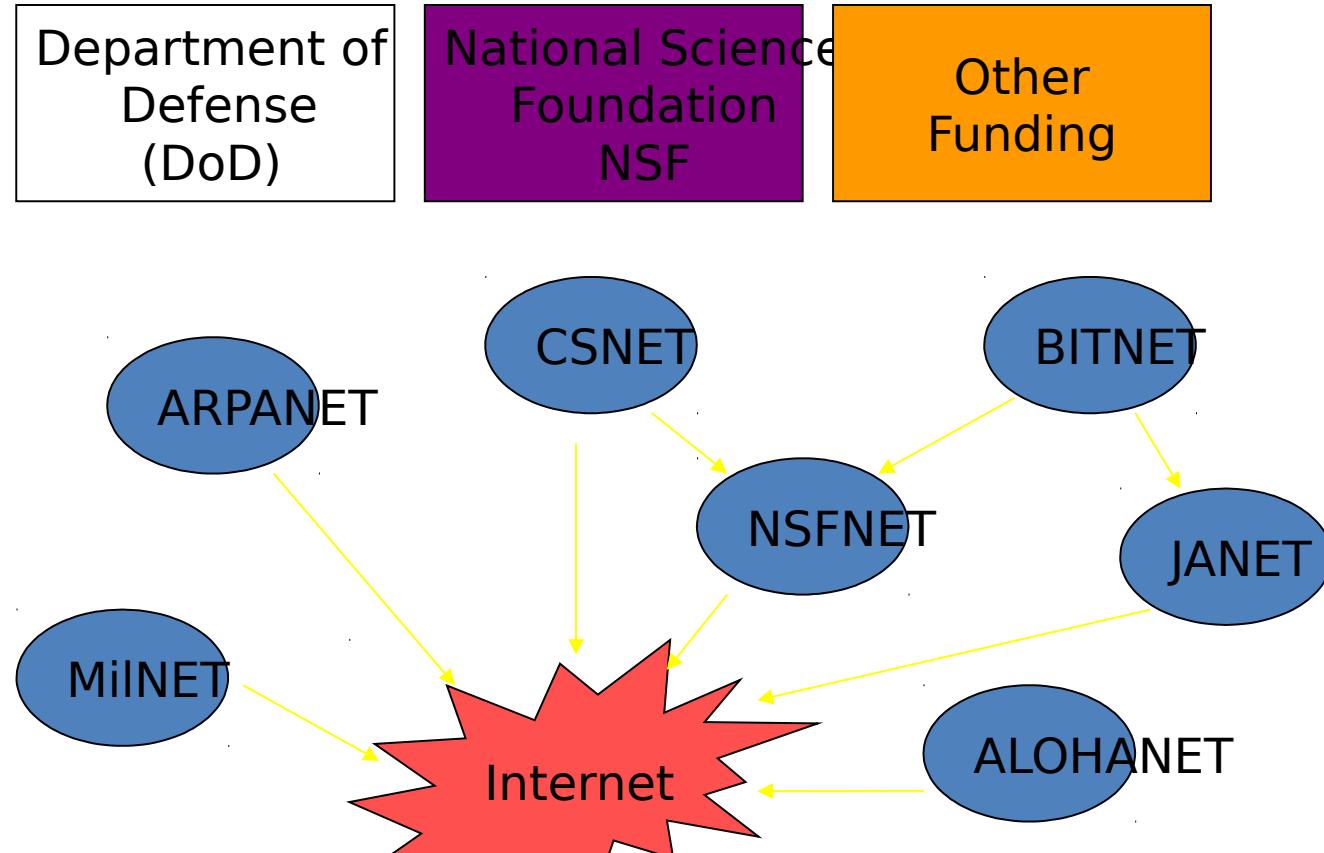
Memex in the form of a desk would instantly bring files and material on any subject to the operator's fingertips. Slanting translucent viewing screens magnify supermicrofilm filed by code numbers. At left is a mechanism which automatically photographs longhand notes, pictures and letters, then files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

- 1945: Vannevar Bush's essay, “As We May Think”, envisaged the **memex**, a device that was linked to books and films in the library
 - Able to follow cross-references from one resource to another - **hypertext!**

The Internet - 1987

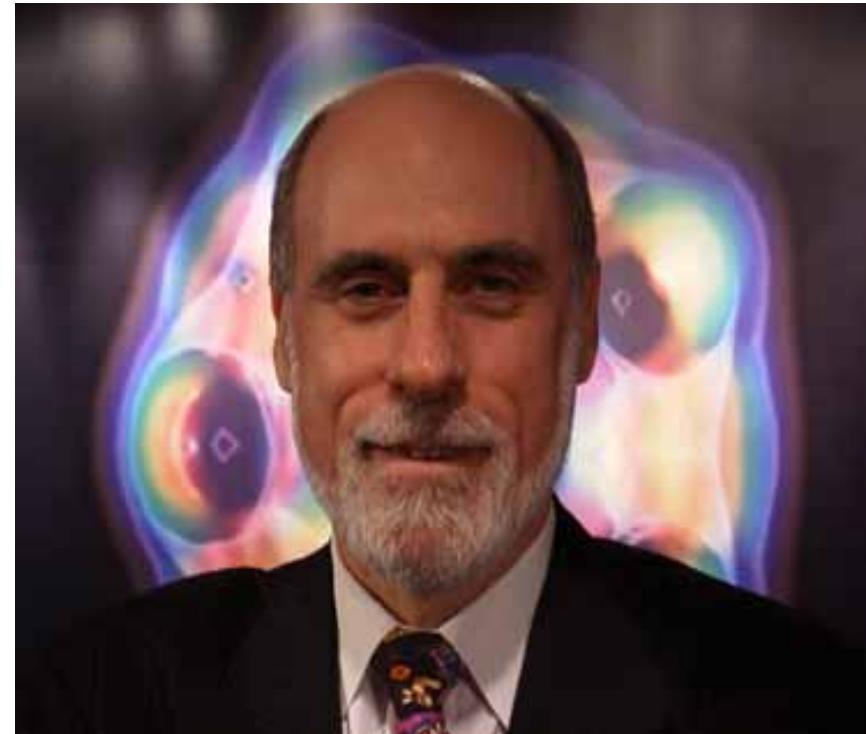


The emergence of the Internet



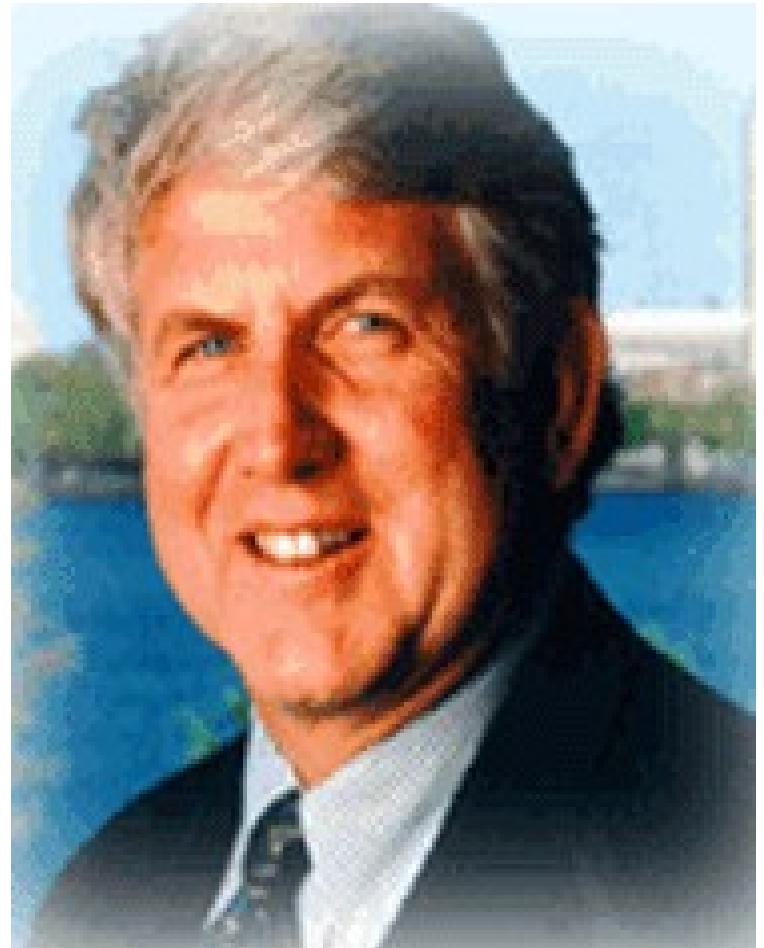
The father of the Internet

- Vint Cerf defines the network protocol and breaks the independent self-contained networks, forms TCP/IP which becomes the standard



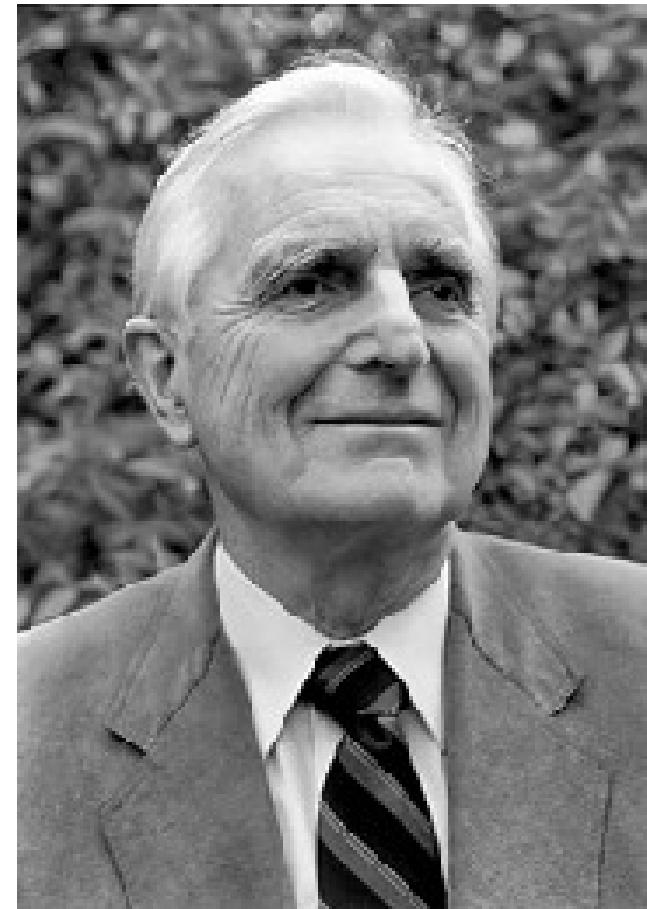
Networking Technology

- Local Area Network (LAN)s are very popular in 1980s, especially in Universities.
- Many workstations were connected by Ethernet which was invented by Bob Metcalfe



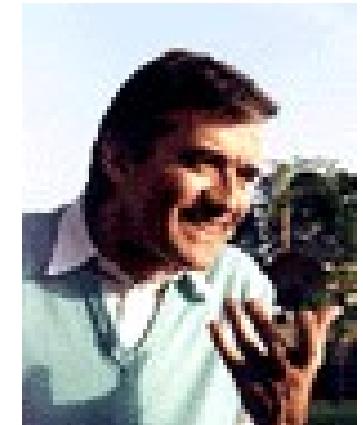
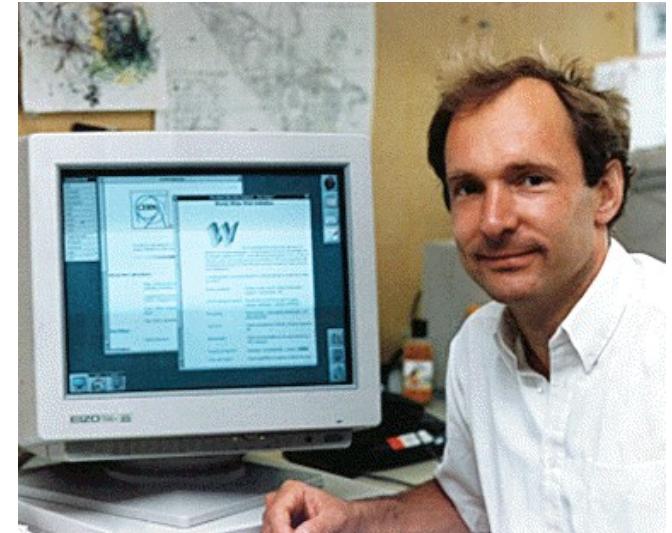
Who creates Mouse?

- Can you surf without the use of mouse?
- We should thank Douglas Englebart for his invention.



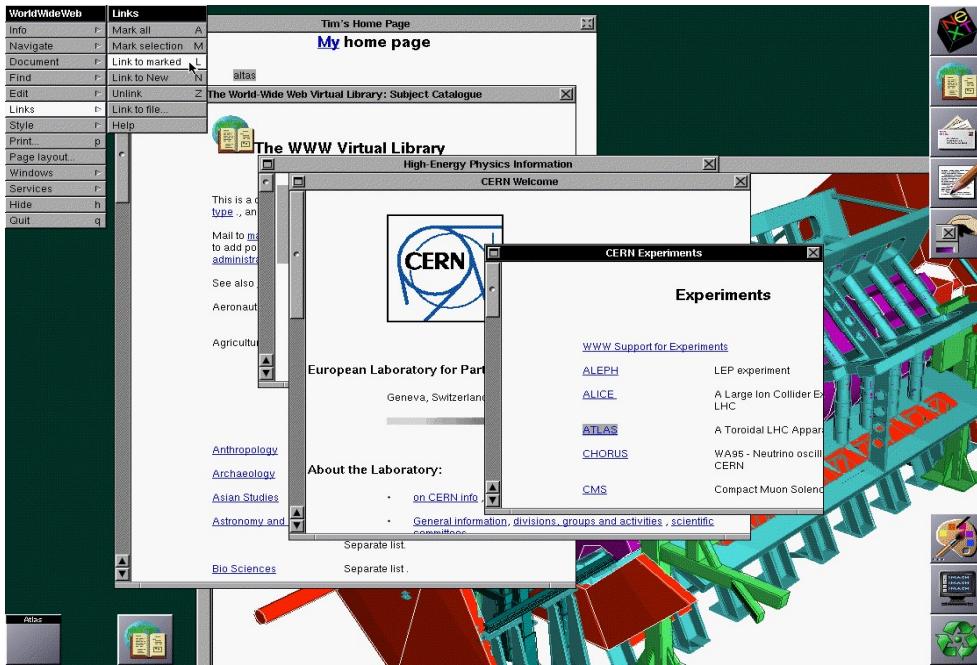
The Invention of WWW

- The World Wide Web (WW) was created by Tim Berners-Lee at European Laboratory for Particle Physics ([CERN](#)) in 1991
- Together with Robert Cailliau wrote the first WWW client and server



The World Wide Web

- Tim Berners-Lee marries hypertext to the Internet, and invents the WWW (1991)
 - HTTP protocol, web browser, web server, web page



The historic NeXT computer used by Tim Berners-Lee in 1990, on display in the Microcosm exhibition at CERN. It was the first web server, hypermedia browser and web editor.

Browser evolution

- Mosaic takes the Internet, 1993
 - A graphical WEB browser, WWW client which was released by Marc Andreessen at NCSA (National Center for Supercomputing Applications) in the University of Illinois in Urbana-Champaign (UIUC)
- Netscape, 1994
 - Marc Andreessen and Jim Clark
 - 1996, 75% uses Netscape
 - It was bought by America Online in 1999 (10 Billion in stock)



Billionaire – Jerry Yang

- David Filo & Jerry Yang started Yahoo when they were doing their Ph D studies at Stanford University in 1994
- Yahoo is one of the famous search engine on the NET.



Internet Worm

- In 1988, Robert Morris, graduate student in Computer Science at Cornell, wrote an experimental, self-replicating, self-propagating program “a worm”
- Distribute itself to over 6,000 of the 60,000 computers that were on the Internet at that time.
- He was sentenced to 3 years of probation, 400 hours of community, a fine of \$10,050.

Recent Threats

HKCERT/CC - Netscape

File Edit View Go Bookmarks Tools Window Help

http://www.hkcet.org/ Search

Mail Home Search Bookmarks

 HKCERT

香港電腦保安事故協調中心
Hong Kong Computer Emergency Response Team Coordination Centre

Verify the identity of this website 中文版

What's New
Computer Virus
Security Alert
News Clipping
FAQ
Events
Articles
Newsletter
Related Link
Subscription
Incident Reporting
Internet Security Handbook
About us

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Disclaimer

What's New

 Computer Virus

- W32.Sobig.F@mm NEW
- W32.Welchia worm NEW
- W32.Blastworm NEW
- W32.Mimail.A@mm
- W32.Sobig.E@mm
- W32.Bugbear.B@mm
- W32.Sobig.C@mm
- W32.Palyh.A
- W32.Fizzer.A
- "Code Red III" Worm
- W32.Deloader.A
- W32.Lovegate.C@mm
- SQL Slammer Worm
- W32.Sobig.A@mm

More

 Virus Hoaxes

- JDBGMR.EXE - Hoax

More

Microsoft MDAC Function Contains Unchecked Buffer Could Enable System Compromise NEW

Microsoft Internet Explorer Multiple Vulnerabilities NEW

Microsoft RPC Interface DoS and Privilege Escalation Vulnerability NEW

Wu-FTPd Buffer Overflow Vulnerability

Microsoft RPC Interface Buffer Overrun Could Allow Code Execution

Oracle E-Business Suite Multiple Vulnerabilities

Novell NetWare Enterprise Web Server /perl/ handler vulnerable to buffer overflow

Microsoft Releases a Cumulative Patch for SQL Server (23 July 2003)

Microsoft DirectX Contains Unchecked Buffer Could Enable System Compromise

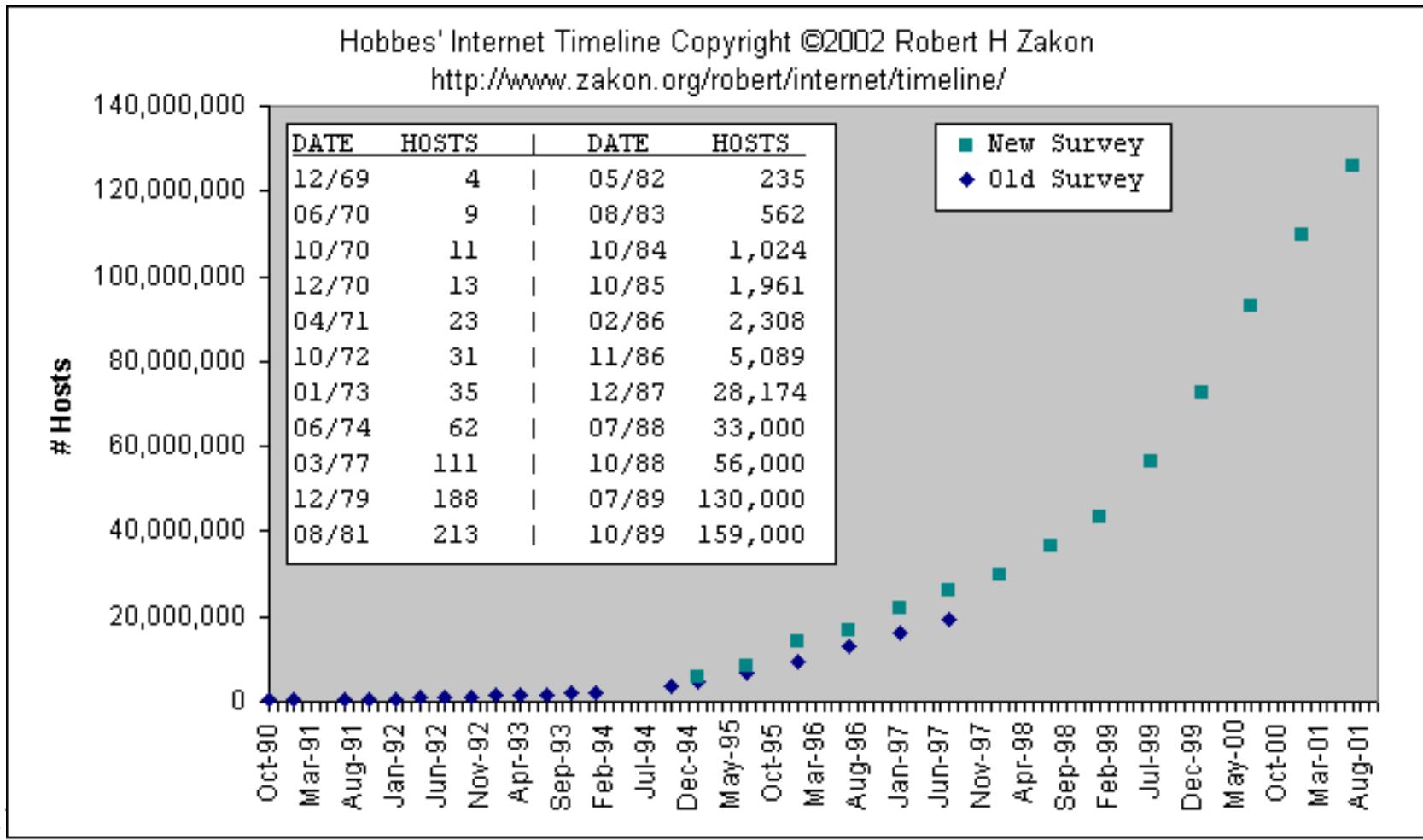
Cisco IOS Interface Blocked by IPv4 Packet

Microsoft ISA Server Error Pages Flaw Could Allow Cross-Site Scripting Attack

Microsoft Windows Shell Contains Unchecked Buffer Could Enable System Compromise

Microsoft Windows Flaw in Message Handling through Utility Manager Could Enable Privilege Escalation

Growth of the Internet Hosts



Some Statistics

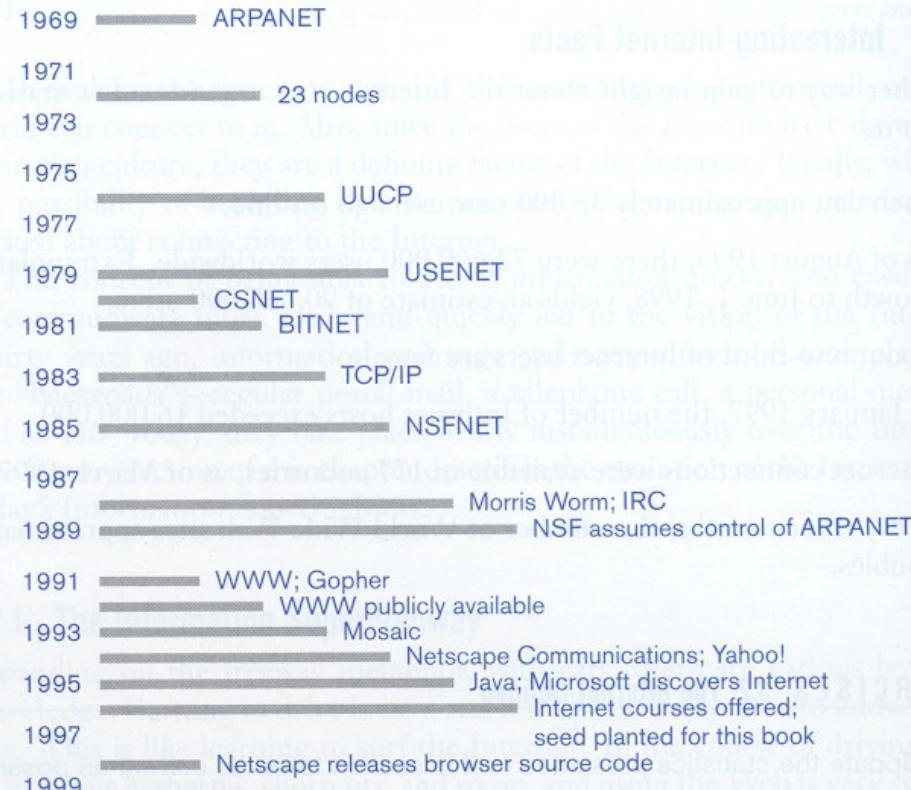
- At January 2000, there are 72,398,092 hosts connecting to the Internet.
- At June 2000, there are 17,119,262 web servers.
- At July 1997, there are 1,301,000 domains.
- At July 1997, there are 171 countries connecting to the Internet.

Interesting Facts

- 25,000 new users daily
- 325 million users (October 2000)
- 50% of users are female
- 73 million hosts (October 2000)
- 200+ countries connected
- World Wide Web sites double every two months

Internet History

FIGURE 3.1 Timeline Illustrating Important Dates in Internet History.



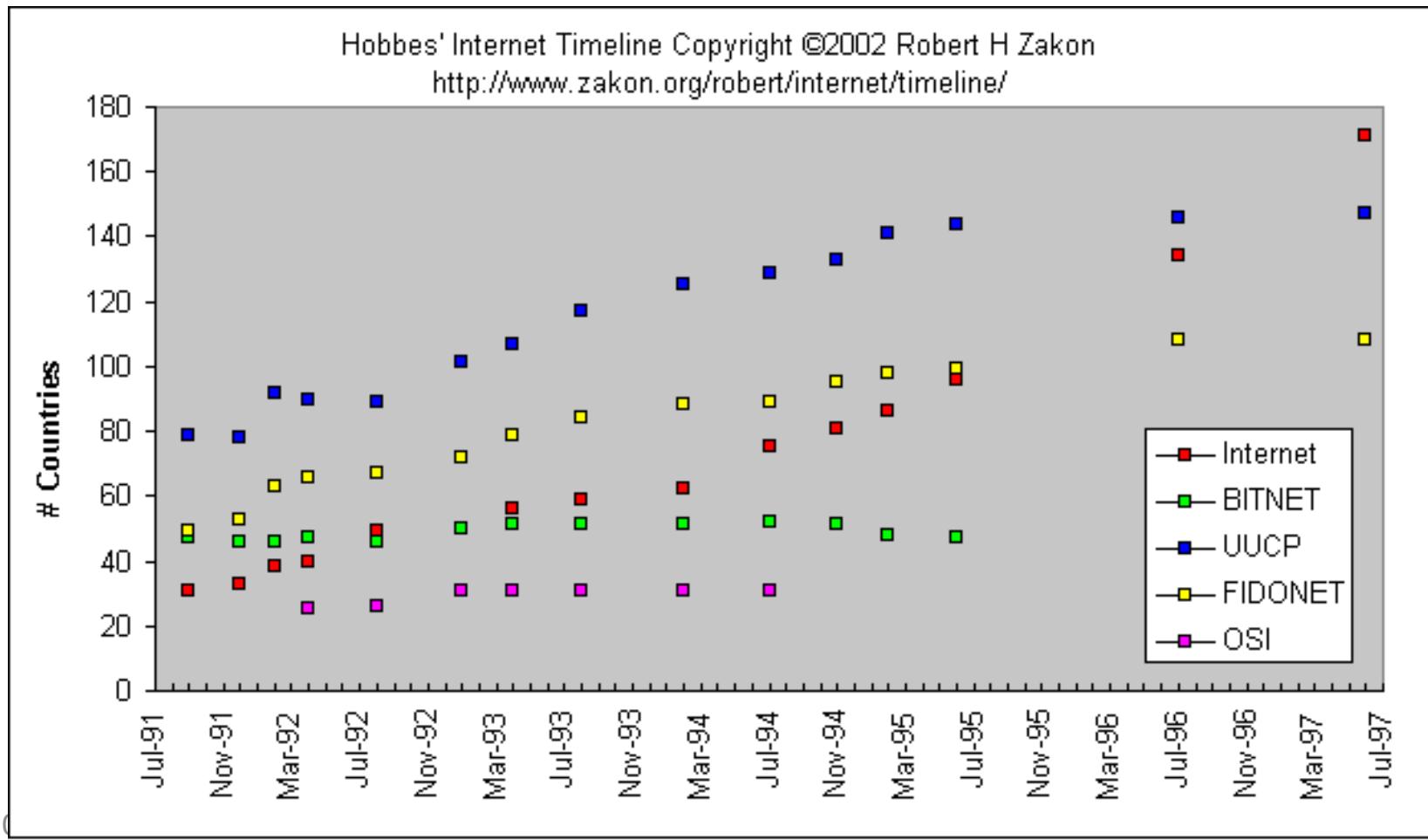
Internet Growth



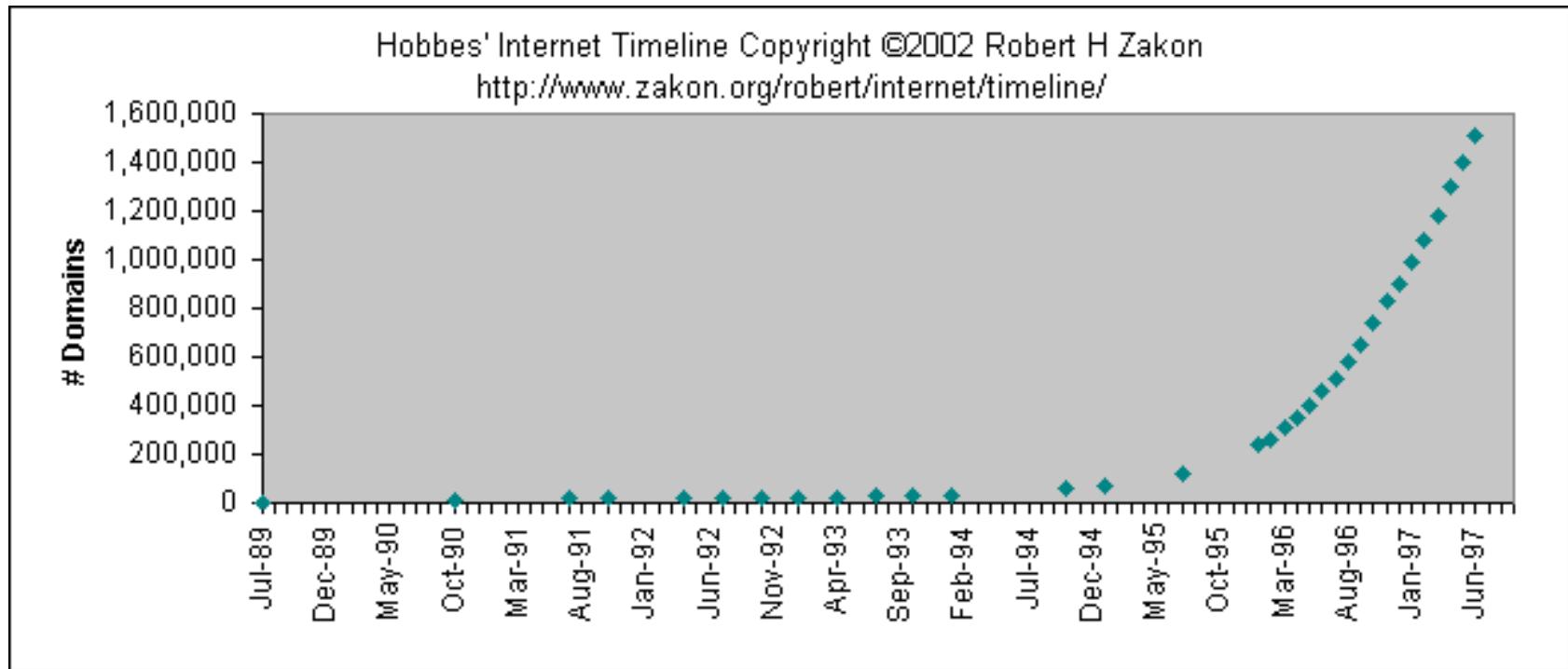
© Scott Adams, Inc./Dist. by UFS, Inc.

The Internet may not be full, but it has grown at a phenomenal rate!

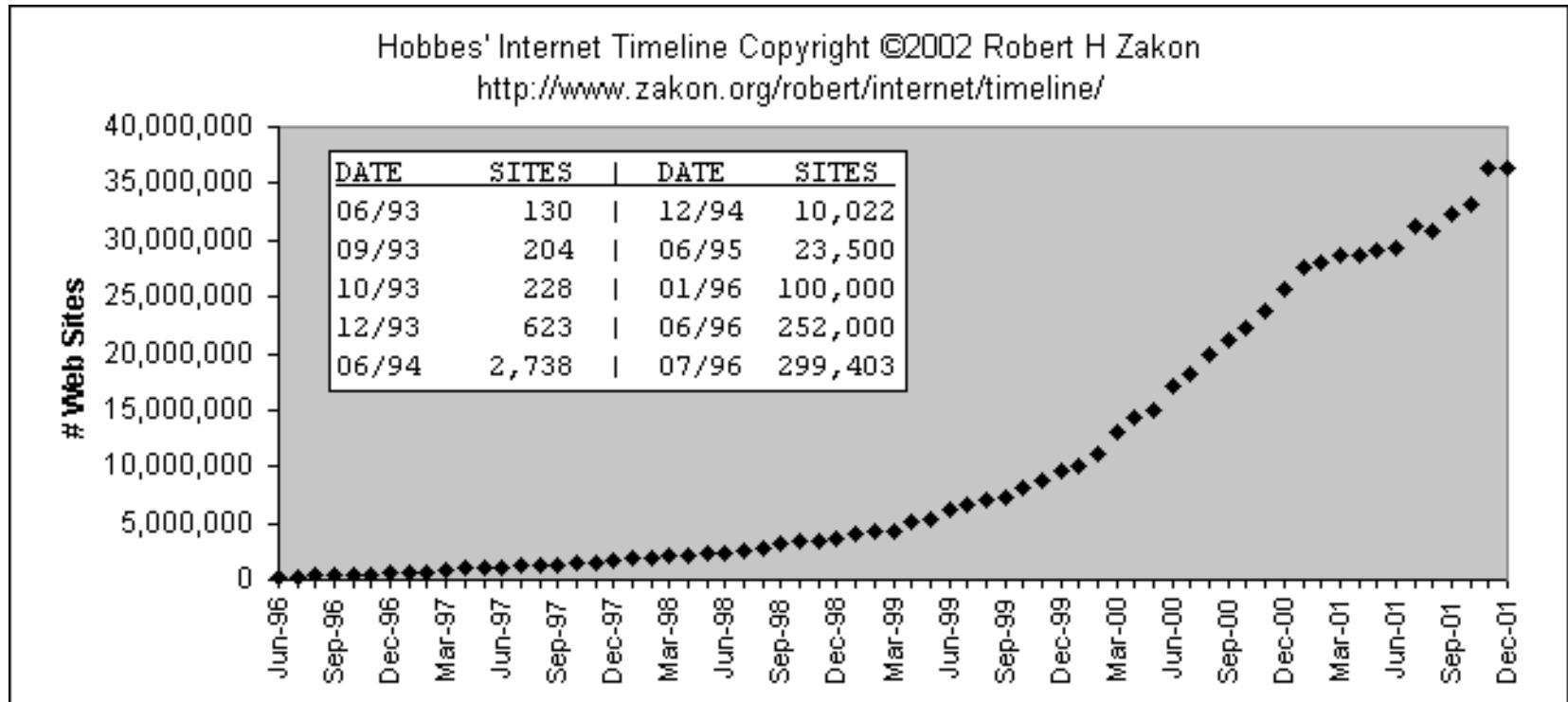
Growth of the Internet Networks



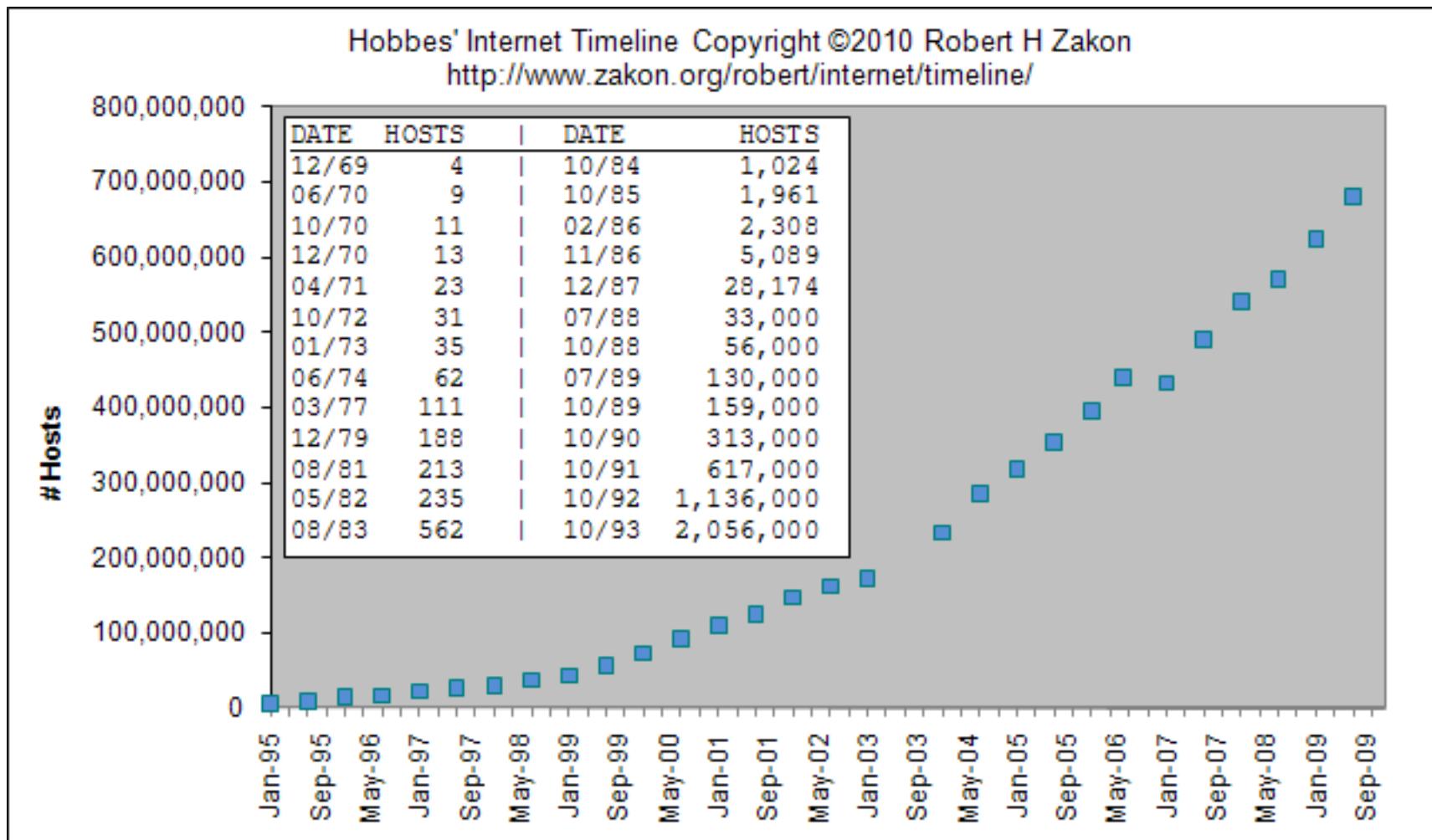
Growth of the Internet Domains



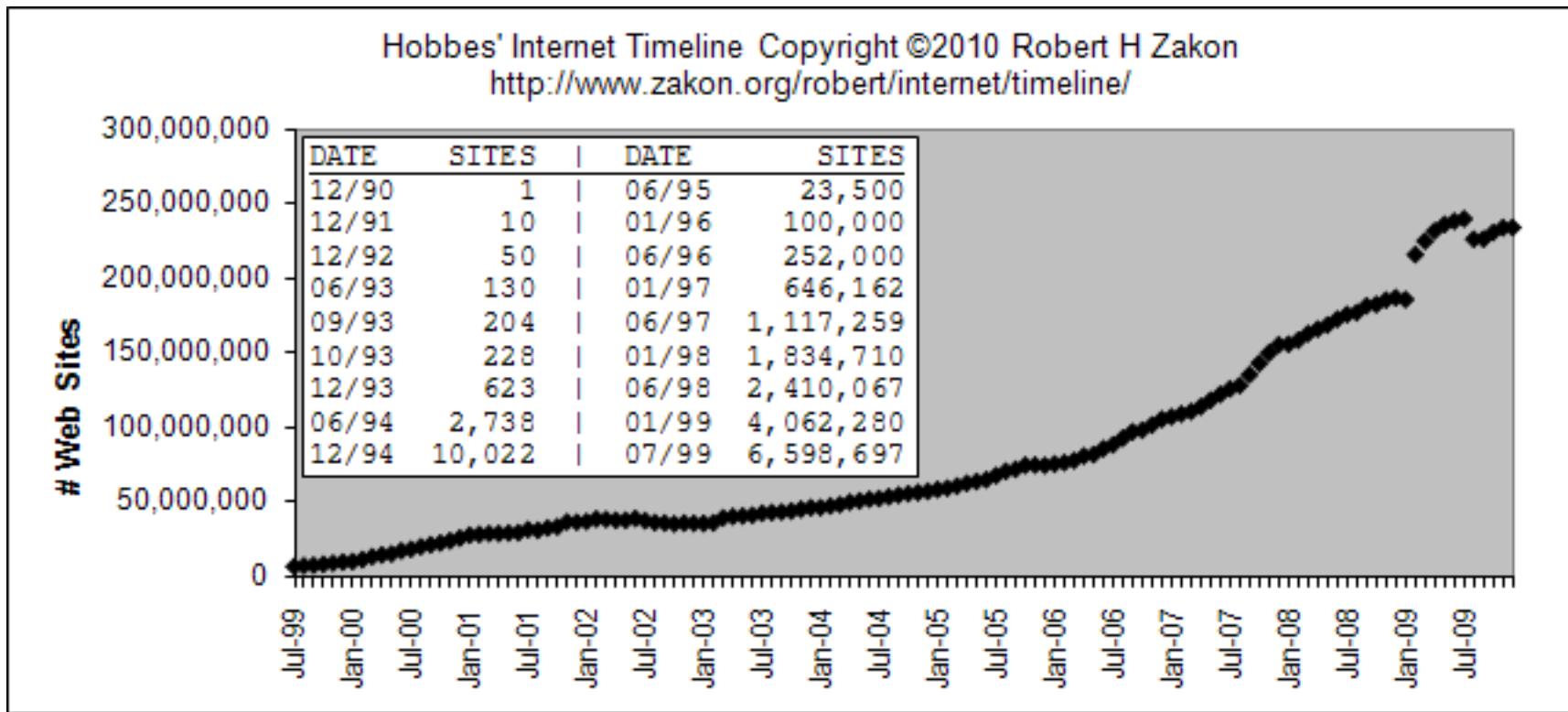
Growth of the Internet Web Sites



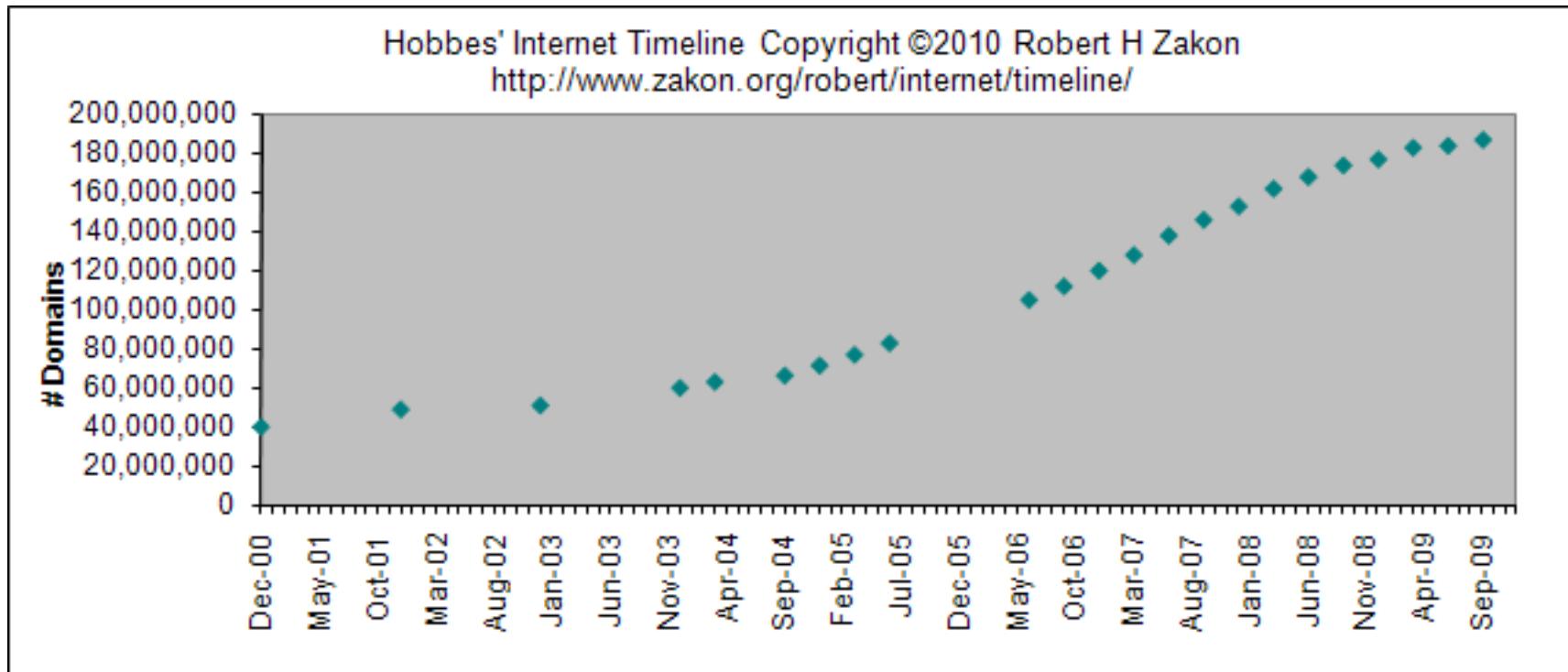
Internet Growth: Hosts



Internet Growth:WWW sites

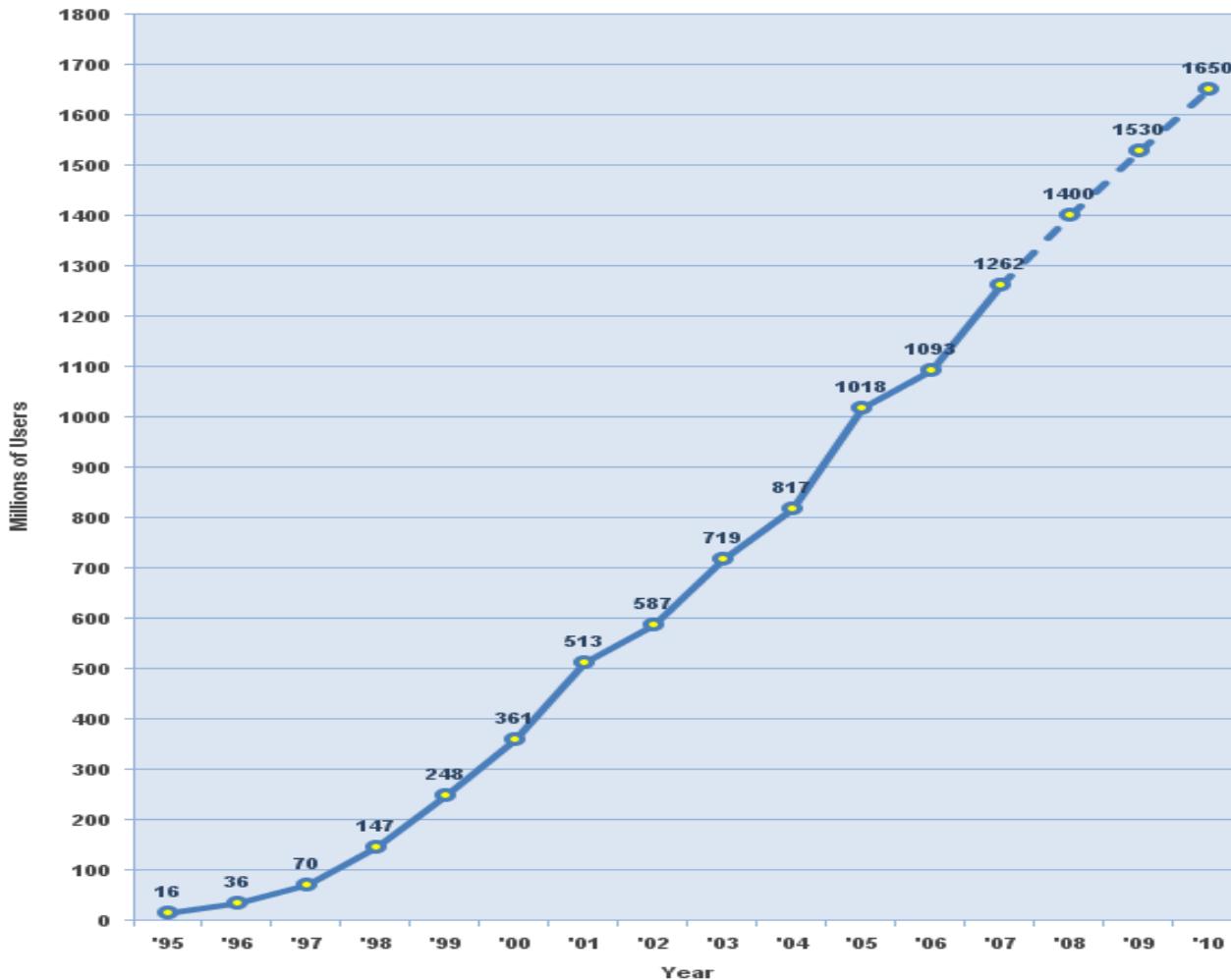


Internet Growth: Domains



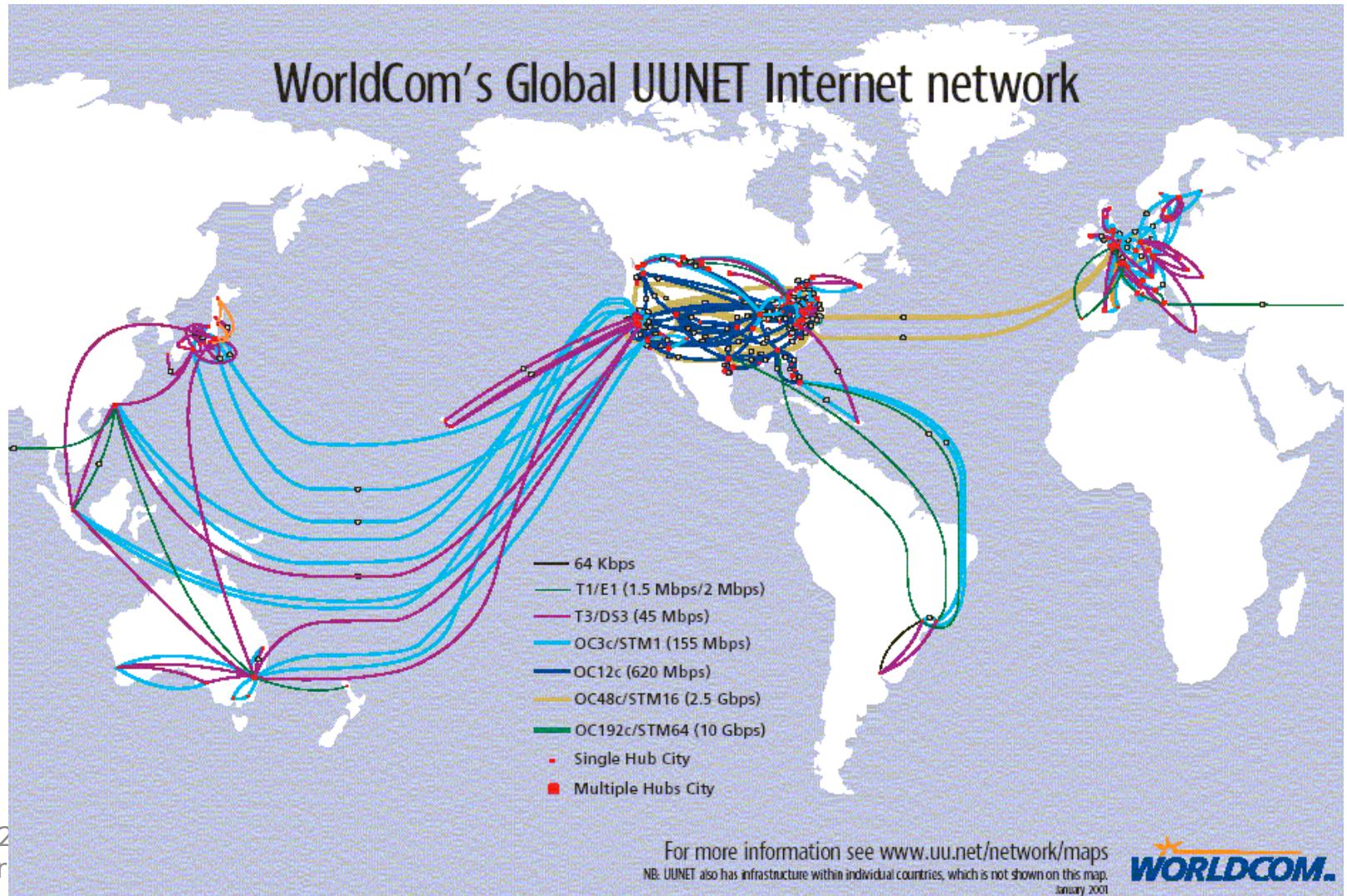
Internet Growth: Users

**Internet Users in the World
Growth 1995 - 2010**

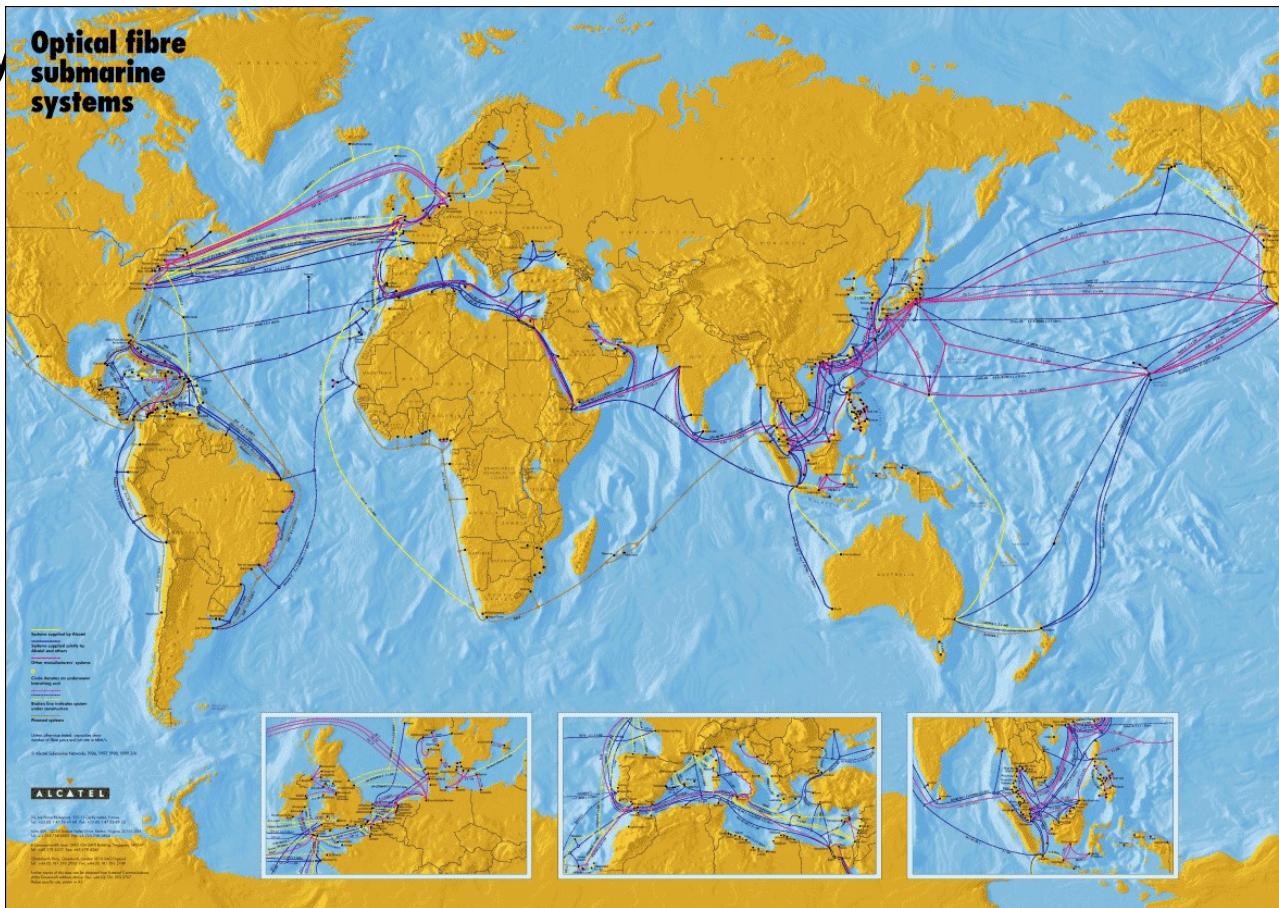


Source: www.internetworldstats.com - January, 2008
Copyright © 2008, Miniwatts Marketing Group

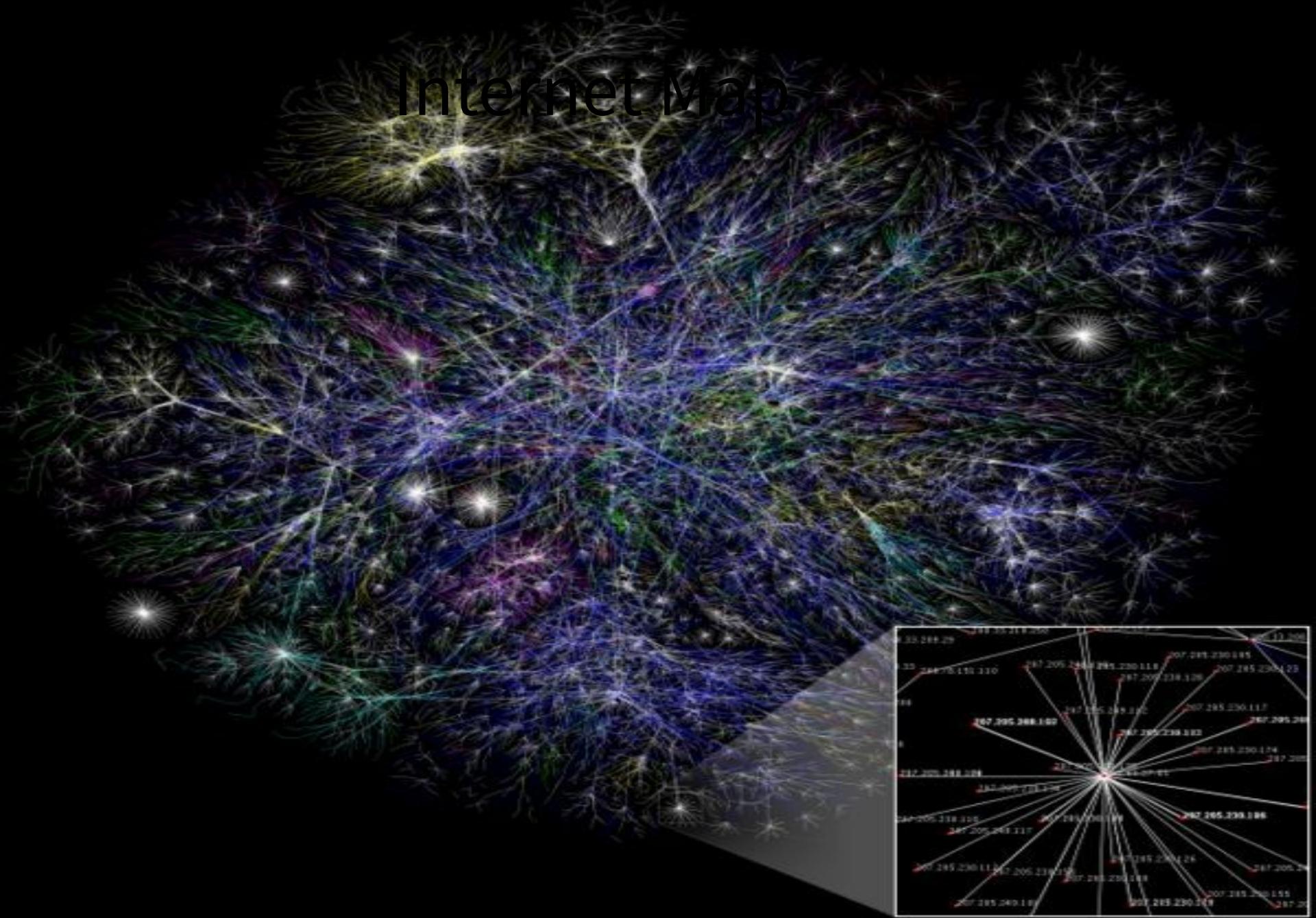
An example global backbone network



- Many media are used to build networks which cover different regions
 - First is the WAN – cover the continents or a country



Internet Map



p://en.wikipedia.org/wiki/Image:Internet_map_1024.jpg

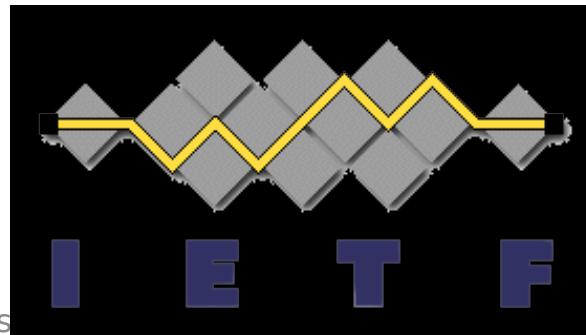
Who governs the Internet?

- NOBODY!!
- Internet Society (ISOC)
 - Professional membership society
- World Wide Web Consortium
 - develops technologies (specifications, guidelines, software, and tools)
- Internet Network Information Center (InterNIC)
 - Domain registration



Who governs the Internet?

- Internet Corporation for Assigned Names and Numbers (ICANN)
 - responsibility for the IP address space allocation, protocol parameter assignment, domain name system management, and root server system management
- Internet Engineering Task Force (IETF)
 - a large open international community of network designers, operators, vendors, and researchers



Who governs the Internet?

INTERNET ADVISORY GROUPS AND ORGANIZATIONS

Organization	Abbreviation	Composition	Function
World Wide Web Consortium	W3C	Commercial and educational institutions	Oversees research and sets standards for many areas of the Web
Internet Society	ISOC	Individuals, corporations, nonprofit organizations, foundations, and government agencies	Concerned with use, maintenance, and development of Internet; oversees other boards and task forces; publishes Internet Society News; coordinates annual Internet conference called INET
Internet Architecture Board	IAB	Body of the ISOC	Defines the architecture of the Internet – including backbone and all attached networks; resolves standards' disputes
Internet Engineering Steering Group	IESG	Body of the ISOC	Responsible for Internet standards process; approves final Internet standards specifications
Internet Engineering Task Force	IETF	Body of the IESG	Studies technical problems and recommends solutions to the IAB and IESG
Internet Assigned Numbers Authority	IANA	Body of the IAB	Assigns and controls numeric designations on the Internet, such as IP addresses and protocols
Internet Network Information Center	InterNIC	National Science Foundation, AT&T, General Atomics, and Network Solutions, Inc.	Registers domain names and IP addresses; distributes information about the Internet
Internet Engineering and Planning Group	IEPG	Internet service providers	Coordinates technical efforts on the Internet; promotes usage of the Internet
Internet Research Task Force	IRTF	Volunteers	Makes recommendations about the Internet to the IAB

- Who manages IP address?

Internet Assigned Numbers Authority (IANA)



- APNIC (Asia Pacific Network Information Center)



• Asia Pacific

RIN (American Registry for Internet Numbers)

APNIC North America, South America, the Caribbean and sub-Saharan Africa.



RIPE NCC (Réseaux IP Européens)

- Europe, Middle East, parts of Africa



The Internet Development in China

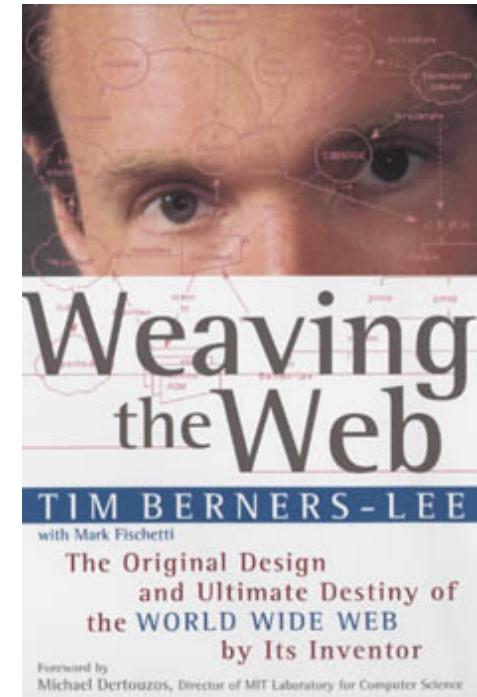
- Sept, 1987 – a professor in Beijing sends out the first email in China
- Oct, 1990 – China registers the country's domain name “cn” at InterNIC
- Sept, 1994 – China Telecom signs an agreement to open two 64K lines in Beijing and Shanghai
- Jan, 1996 – China Public Computer Internet (CHINANET) opens
- Jun, 1999 – 1.46 million computers connected to the Internet and 4 million Internet subscribers, 29,045 .cn domain names and 9,906 web sites
- Nov, 2002 – 145,427 .cn domain names, ...

An Internet Odyssey

- Please suggest what will happen in 2010 to the Internet?
 - De-Mobilization of Free Expression?
 - People listening today, more people will be listening tomorrow
 - Not a substitute for communicating with people

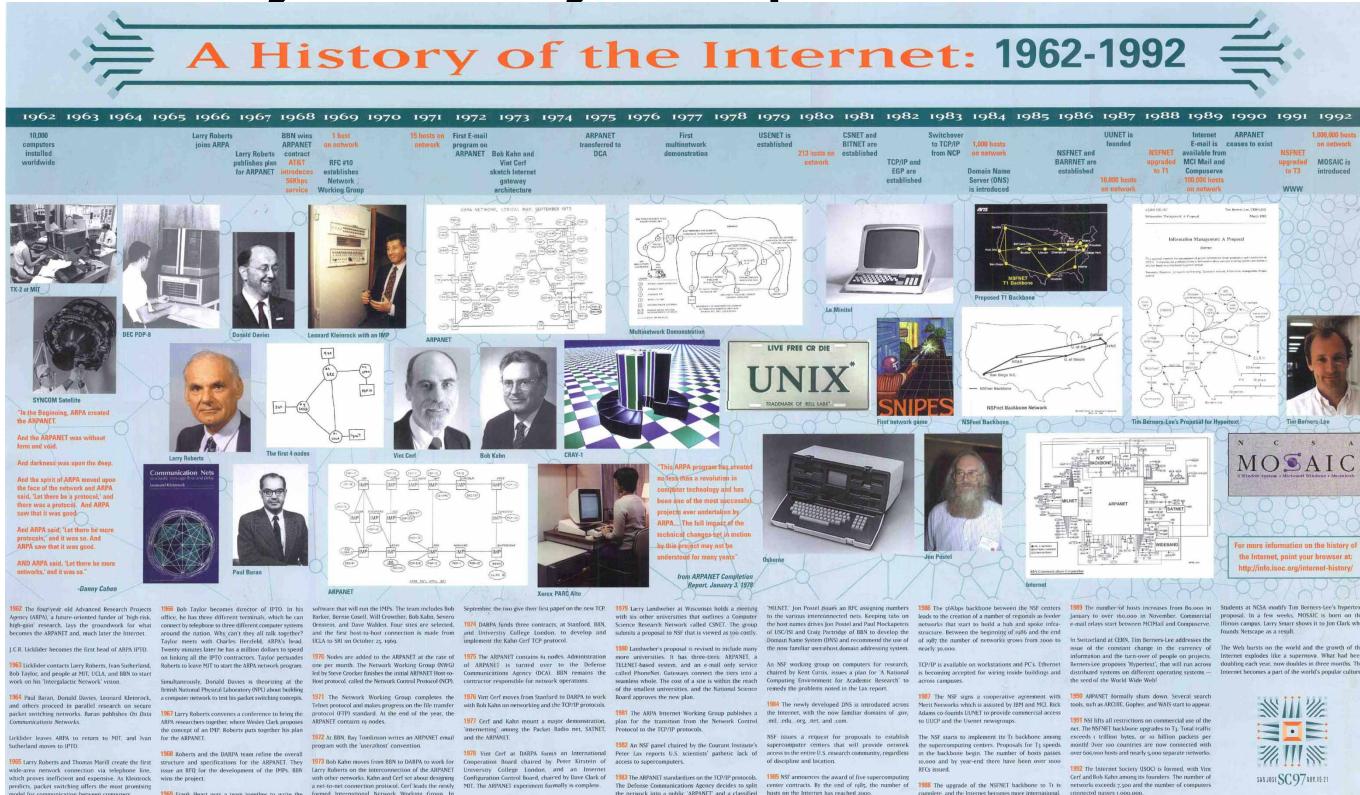
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- [Internet Pioneers](#)
- [Zen and the art of the Internet](#)
- [Life on the Internet](#)
- [China NIC](#)
- Berners-Lee, Tim. (1999). [Weaving the Web](#). San Francisco: HarperCollins.
- Class Exercise:
 - Question: What is Internet2?



The End

- Thank you for your patience!



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