

CS 4/55231
Internet Engineering

Kent State University
Dept. of Computer Science

LECT-1

A Course on Internet and World Wide Web

Today's Topic

Unit background and administrivia

Introduction to
Internetworking



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General Course Information

This course will not teach you how to write HTML or Java code. Nor will make you a Web Master!

In this course you will learn

- the design principles,
 - architecture,
 - protocols and algorithms
- behind the components of the complex system which is known as **Internet**.



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- Javed I. Khan
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Phone: 672-9038
Office Hours: TTR 6:30 -- 7:30 p.m.

- Web Page: <http://www.cs.kent.edu/~javed/class-IN04S/>
- **Books:**
 - Computer Networks & Internet, Comer, D. E., Prentice Hall, ISBN 0-13-083617-6
 - Web Server Technology, Nancy Yeager & McGarth, Morgan Kaufmann, 1996, ISBN 1-55860-376-X
 - Web Protocols & Practices, Krishnamurty & Rexford, Addison Wesley, ISBN-0-201-71088-9



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Class Mechanics

- TO: JAVED@kent.edu
- Always need to send email with subject-field set to "IN2007F" to obtain reply.
- Use Computer/Email as much as possible:
 - Reports preferably in Computer.



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What is Expected Out of You?

- At least 12 hours per week (to pass)
- Learning by doing
- questions and exercises
- reading textbook & materials
- asking questions
- taking part in discussions

• Read/Listen Think Do **Ask**



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Grading

Test Type	Frequency	Weight
Borwser Server Project	2	20%
End Term Exam	1	20%
Mid Term Exam	1	20%
Take Home Assignments	3	20%
Traffic Engineering Lab	1	10%
Unannounced Quiz	2-5	10%



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What is Internet?



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A World Wide Network of Millions of Computers



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Internet = Network of Computer Networks



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The Internet is a global network of networks enabling computers of all kinds to directly and transparently communicate and share services throughout much of the world. Because the Internet is an enormously valuable, enabling capability for so many people and organizations, it also constitutes a shared global resource of information, knowledge, and means of collaboration, and cooperation among countless diverse communities.

*-Internet Society
June 1998*



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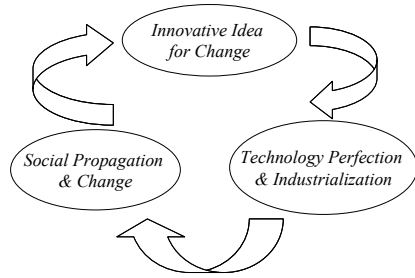
The Internet is more important in what it enables than what it is; more phenomenon than fact. Yes, the Internet is networks, software, computers and other technologies; but more so, it is a catalyst of change, a new mass medium, a culture, a mind warp, new things never before imagined.

-J. Neil Weintraut
Wall Street Technologist



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Cycle of Technological Change



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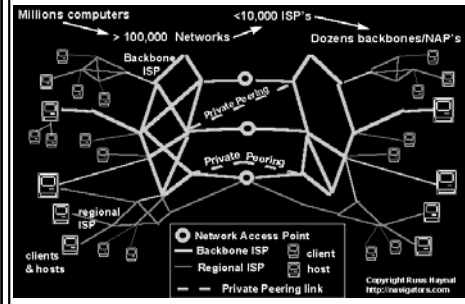
Structure of Internet

[Click Here](#)



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Physical Network



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The Wide Area Network that formed the backbone of the Internet before 1992. Funding came from NSF, IBM, MCI, and MERIT

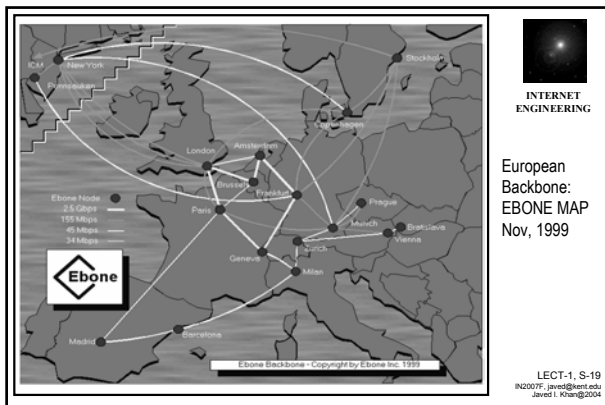


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THE INTERNET

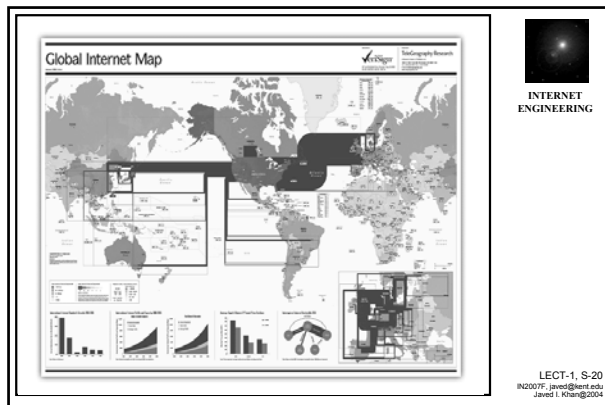


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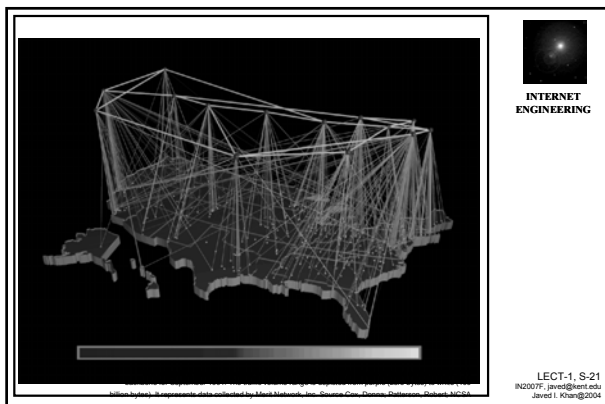


European Backbone: EBONE MAP Nov, 1999

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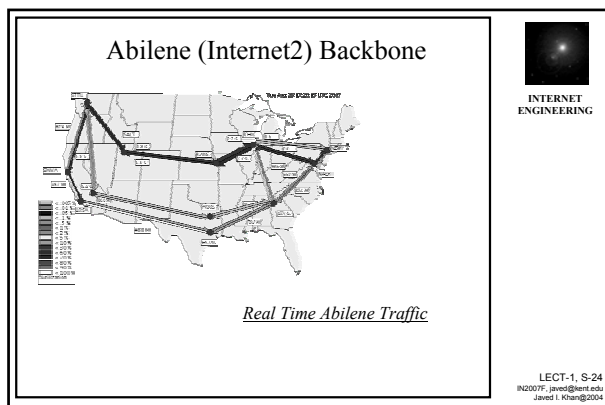
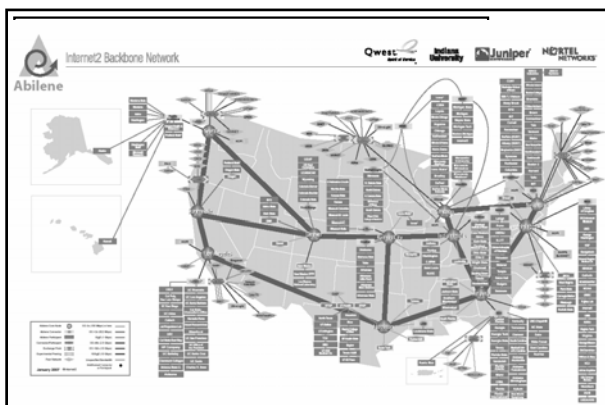
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Next Generation Internet....

- A network always “one step ahead”
 - HPCC in 1993
 - vBNS launched in 1995.



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Next Generation Internet (cont..)

- A network always “one step ahead”
 - HPCC in 1993
 - vBNS launched in 1995.
 - vBNS+ 1997
 - Internet-2 Abilene
 - Grid+ Lambda Rail+ GENI



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Abilene Features

- Low latency (average coast to coast less than 100 ms)
- High throughput (over 490 Mbps of payload)
- Stable (99.95% or greater service availability)
- Uncongested (average utilization less than 50%)
- 622 Mbps 14,000+ route mile backbone network

- Today, the vBNS connects:
 - five supercomputing centers
 - about 100 universities
 - peers about 11 other Networks.



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Demonstration Route Tracing



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Next Class

Map of Cyberspace Who Manages Internet?

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Class Mechanics

- Web Access:
- Groups Project
 - Next class we will form groups of 1-2
 - group work/ individual report.
 - 2 phases + optional creative enhancement
 - In class group demonstration
- Class attendance will be important



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Today's Topic

Internet Real-state

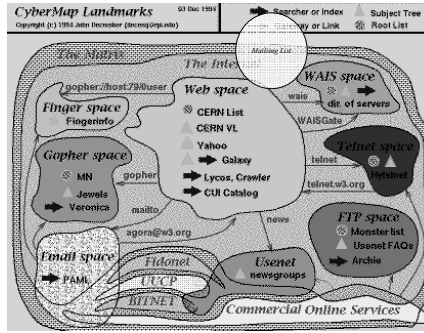
Who manages Internet & Its Organization.

History of Internet.



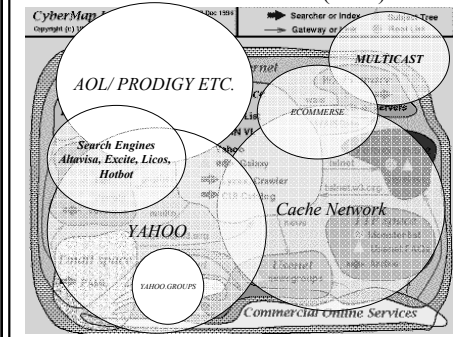
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A Map of Internet Real-State (1998)



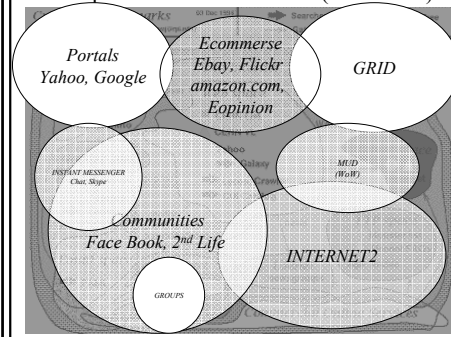
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Internet Real State (2000)



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A Map of Internet Real-State (2005-now)



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Applications & Services

The real story of the Internet excitement is however is the new genre of systems and applications developed on it.

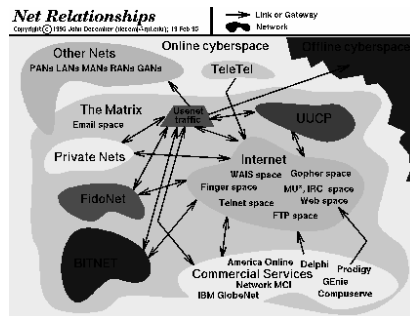
The Internet offer access to data, graphics, sound, software, text, and people through a variety of services and tools for communication and data exchange:

- Hypertext (WWW)
- Remote login (telnet)
- File transfer (ftp)
- Electronic mail (e-mail)
- News (USENET or network news)
- Platform independent computing (Java)
- E-commerce, Digital Library, Online Banking
- Communities, P2P, Online Game



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World Wide Networks



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Who Manages Internet?

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There is no single body which manages the Internet.

It runs through a host of independent or loosely coupled coordinating organizations.

The organizations below play a major role in the organization, management and development of it:

- Internet Society (ISOC)
- Internet Architecture Board (IAB)
- Internet Engineering Task Force (IETF)
- Internet Engineering Steering Group (IESG)
- Internet Corporation for Assigned Names & Numbers ICANN)
- W3C



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Internet Society (ISOC)

A nonprofit, non-governmental professional-membership organization of individuals and organizations interested in the development of Internet. More specifically, this is the legal umbrella for other coordinating bodies (such as IAB, IANA) for global cooperation and coordination for the Internet and its internetworking technologies and applications.



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Internet Architecture Board (IAB)

IAB is a technical advisory group of the Internet Society. Its responsibilities include oversight of IETF, editorship of the RFC document series, administration of Internet assigned numbers, and liaison of the Internet Society in liaison relationships with other organizations concerned with standards.



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Internet Engineering Task Force (IETF)

Body to address and resolve technical and operational problems on the Internet and to develop Internet standards and protocols.

The membership of IETF is international and completely voluntary. Members consist of network designers, operators, vendors, researchers and other interested individuals.



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Internet Assigned Numbers Authority (IANA):

Based at ICANN, IANA is in charge of all "unique parameters" on the Internet, including IP (Internet Protocol) addresses and manages the Root Domain Name Service.



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Global Internet Assigned Numbers Authority

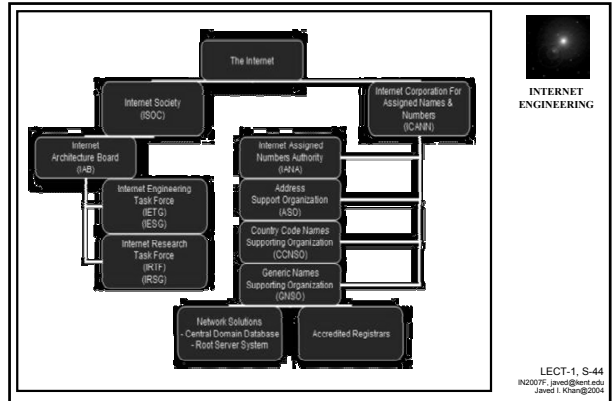
Americas and sub-Saharan Africa:
The American Registry for Internet Numbers (ARIN)

Europe and North Africa:
Reseais IP Europeens (RIPE) (<http://www.ripe.net>)

Asia and Australia:
Asian-Pacific Network Information Center (APNIC)
(<http://www.apnic.net>)

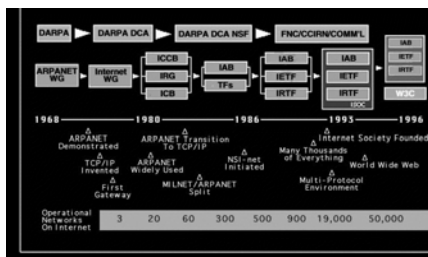


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Evolution of Internet's Management



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Global Village

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World Connectivity in 1991

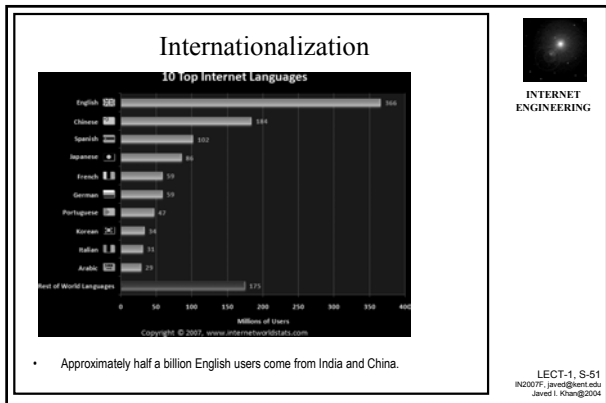
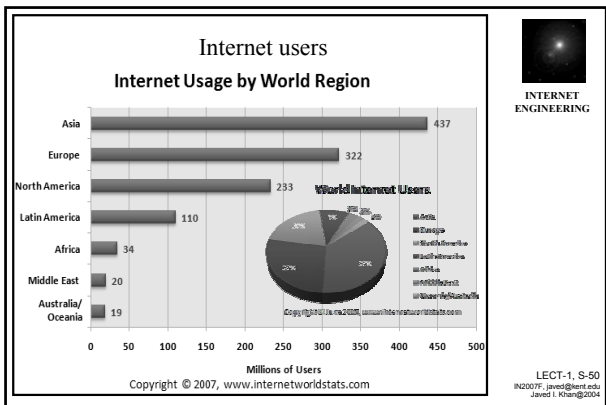
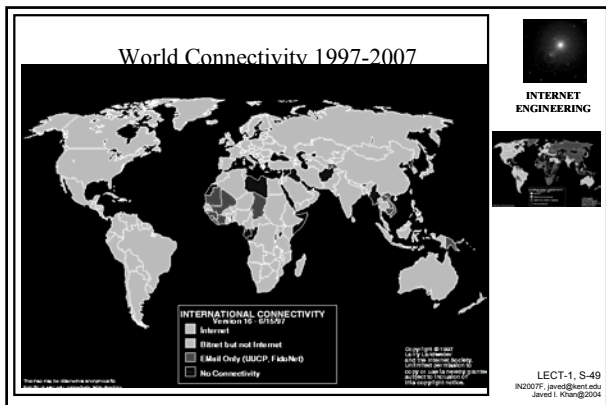


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World Connectivity in 1995

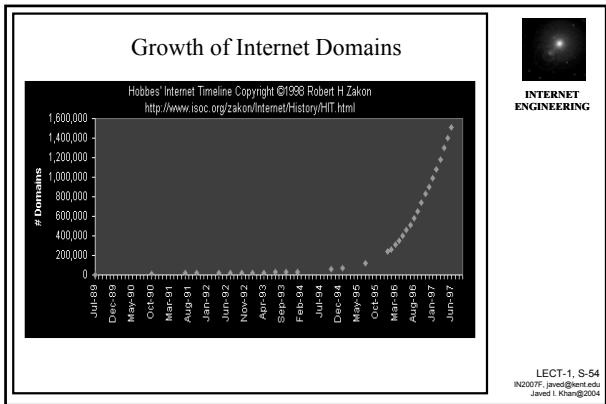
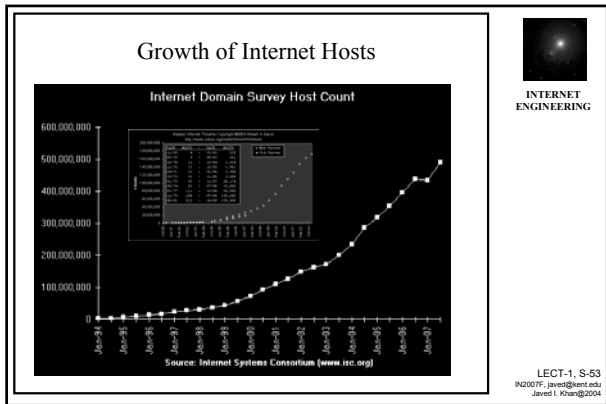


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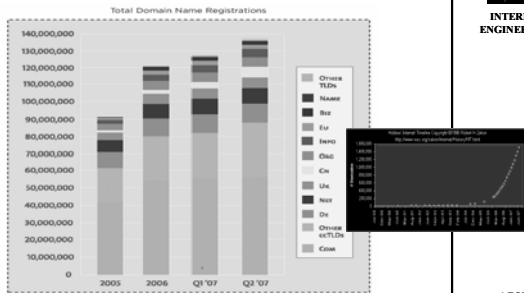


Growth Rates

52

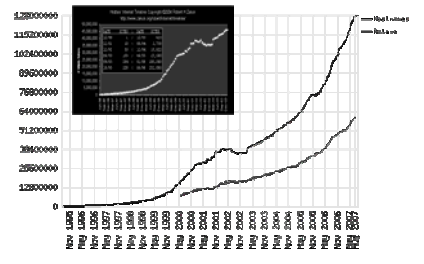


Growth of Internet Domain Names (Recent)

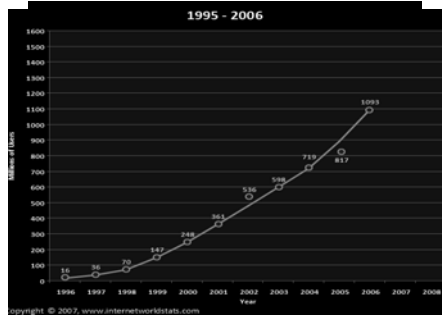


Growth of Web Servers

Total Sites Across All Domains August 1995 - August 2007



How Many Online?



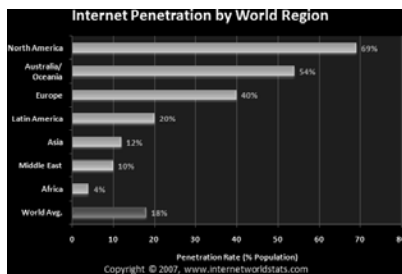
Looking Back.. The History of the Internet

- ARPANET (Advanced Research Projects Agency Network)
- TCP/IP (Transmission Control Protocol/Internet Protocol)
- NSFNET (National Science Foundation Network)
- Desktop computers
- Network upgrades
- Web Technology



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Yet to Grow...



- It is estimated that out of 6.5 billion world population now 1.2 billion has used internet. (Count as of June 30, 2007)



History of Internet

Looking Back.. The History of the Internet

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- TCP/IP (Transmission Control Protocol/Internet Protocol)
- NSFNET (National Science Foundation Network)
- Desktop computers
- Network upgrades
- Web Technology



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1950's

1957 USSR launches Sputnik, first artificial earth satellite. In response, US forms the **Advanced Research Projects Agency (ARPA)** within the Department of Defense (DoD) to establish US lead in science and technology applicable to the military.



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1960's

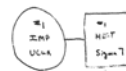
1969 - The Department of Defense Advanced Research Projects Agency creates an experimental network called ARPANET. This network provides a test-bed for emerging network technologies.

ARPANET originally connected four universities

- Node 1: UCLA - (September)
- Node 2: SRI - Stanford Research Institute (October)
- Node 3: UCSB
- Node 4: University of Utah



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THE ARPA NETWORK
SEPT. 1969

FIGURE 6.1 Drawing of September 1969
(Courtesy of Alex McKenzie)

The first node on ARPANET at University California Los Angeles (UCLA) on the 2nd of September 1969. (Source: "Casting the Net", page 55) UCLA was the home of the Los Alamos's Network Measurement Center; Doug Engelbart's Network Information Center resided at SRI. And some of the earliest graphics work was being done at Santa Barbara and Utah.



THE ARPA NETWORK
DEC 1969

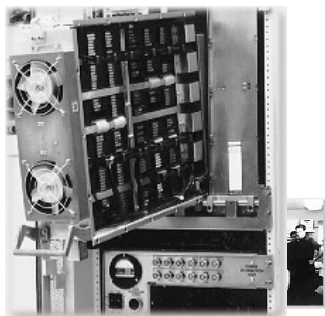
FIGURE 6.2 Drawing of a Node Network
(Courtesy of Alex McKenzie)

By the end of the year there are four nodes on the "ARPA NETWORK", as shown in schematic above. (Source: "Casting the Net", page 56. See also The Computer Museum Timeline.)



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IMP



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1960's (continued..)

Information Message Processors (IMP) [Honeywell 516 mini computer with 12K of memory] developed by Bolt Beranek and Newman, Inc. (BBN) First node-to-node message sent between UCLA and SRI (October, 1969)

First Request for Comment (RFC): "Host Software" by Steve Crocker (April 9, 1969)

Michigan State and Wayne State University establish X.25-based Merit network for students, faculty, alumni.



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1970'S

1971 ALOHAnet developed by Norman Abrahamson, University of Hawaii, heart of Ethernet and connected to the ARPANET in 1972.

1972 The National Center for Supercomputing Applications (NCSA) develops the telnet application for remote login, making it easier to connect to a remote computer.

1973 FTP (file transfer protocol) is introduced, standardizing the transfer of files between networked computers.



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1970'S

1972 Ray Tomlinson (BBN) writes basic email message send and read software (March) Larry Roberts writes first email utility to list, selectively read, file, forward, and respond to messages (July)

1973 Bob Metcalfe's Harvard Ph.D. Thesis outlines idea for Ethernet.

1976 Elizabeth II, Queen of the United Kingdom sends out an e-mail (various Net folks have e-mailed dates ranging from 1971 to 1978)

UUCP (Unix-to-Unix Copy) developed at AT&T Bell Labs and distributed with UNIX one year later.



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1980's

1981 BITNET, the "Because It's Time NETWORK" Started as a cooperative network at the City University of New York, with the first connection to Yale.

CSNET (Computer Science Network) built by a collaboration of computer scientists and University of Delaware, Purdue University, University of Wisconsin, RAND Corporation and BBN through seed money granted by NSF to provide networking services (especially email) to university scientists with no access to ARPANET.



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1980's

- **1983** Name server developed at Univ of Wisconsin, no longer requiring users to know the exact path to other systems.

- Internet Activities Board (IAB) established, replacing ICCB

- Berkeley releases 4.2BSD incorporating TCP/IP.

- EARN (European Academic and Research Network) established. Very similar to the way BITNET works with a gateway funded by IBM. FidoNet developed by Tom Jennings.

- **1984** Domain Name System (DNS) introduced. Number of hosts breaks 1,000

- JUNET (Japan Unix Network) established using UUCP.



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1980's

- **1983** The TCP/IP suite of networking protocols, or rules, becomes the only set of protocols used on the ARPANET. This decision sets a standard for other networks, and generates the use of the term "Internet" as the network of networks which either use the TCP/IP protocols or are able to interact with TCP/IP networks.

- To keep military and non-military network sites separate, the ARPANET splits into two networks: ARPANET and MILNET.



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1980's Continued..

- In **1982** and **1983**, the first desktop computers began to appear. Many are equipped with an operating system called Berkeley UNIX, which includes networking software. This allows for relatively easy connection to the Internet using telnet.

- The personal computer revolution continues through the eighties, making access to computer resources and networked information increasingly available to the general public.



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1980's Continued..

1985-86: The National Science Foundation (NSF) connects the nation's six supercomputing centers together. This network is called the NSFNET, or NSFNET backbone.

To expand access to the Internet, the NSF supported the development of regional networks, which were then connected to the NSFNET backbone. In addition, the NSF supported institutions, such as universities, in their efforts to connect to the regional networks.

Here is a diagram of the NSF backbone, as it appeared in



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1980's

•**1987** - The NSF awards a grant to Merit Network, Inc. to operate and manage future development of the NSFNET backbone. Merit Network, Inc. collaborates with IBM and MCI to research and develop faster networking technologies.

•**1988 2 November** - Internet worm burrows through the Net, affecting ~6,000 of the 60,000 hosts on the Internet.

•**1989** - The backbone network is upgraded to "T1" from 56Kbps which means that it is able to transmit data at speeds of 1.5 million bits of data per second, or about 50 pages of text per second.



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1990's

1990 - The ARPANET is dissolved.

1991 - Gopher is developed at the University of Minnesota. Gopher provides a hierarchical, menu-based method for providing and locating information on the Internet. This tool makes using the Internet much easier.

1992 - Internet Society (ISOC) is chartered
Number of hosts breaks 1,000,000

1993 - The European Laboratory for Particle Physics in Switzerland (CERN) releases the World Wide Web (WWW), developed by Tim Berners-Lee. The WWW uses hypertext transfer protocol (HTTP) and hypertext links, changing the way information can be organized, presented and accessed on the Internet.



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1990's

1993 - The NSFNET backbone network is upgraded to "T3" which means that it is able to transmit data at speeds of 45 million bits of data per second, or about 1400 pages of text per second.

1993-1994 - The graphical web browsers Mosaic and Netscape Navigator are introduced and spread through the Internet community. Due to their intuitive nature and graphical interface, these browsers make the WWW and the Internet more appealing to the general public.

• **1995** - The NSFNET backbone is replaced by a new network architecture, called vBNS (very high speed backbone network system) that utilizes Network Service Providers, regional networks and Network Access Points (NAPs).



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1995

1995 - RealAudio, an audio streaming technology, lets the Net hear in near real-time

1995 Radio HK, the first commercial 24 hr., Internet-only radio station starts broadcasting

1995 NSF establishes the very high speed Backbone Network Service (vBNS) linking super-computing centers: NCAR, NCSA, SDSC, CTC, PSC

Technologies of the Year: WWW, Search engines

Emerging Technologies: Mobile code (JAVA, JAVAscript), Virtual environments (VRML), Collaborative tools



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1996

ISP Meltdown: AOL (19 hours), Netcom (13 hours), AT&T WorldNet (28 hours - email only)

New York's Public Access Networks Corp (PANIX) is shut down after repeated SYN attacks by a cracker using methods outlined in a hacker magazine (2600)

Various US Government sites are hacked into and their content changed, including CIA, Department of Justice, Air Force
MCI upgrades Internet backbone adding ~13,000 ports, bringing the effective speed from 155Mbps to 622Mbps.

Technologies of the Year: Search engines, JAVA, Internet Phone



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1997

2000th RFC: "Internet Official Protocol Standards"

The American Registry for Internet Numbers (ARIN) is established to handle administration and registration of IP numbers to the geographical areas currently handled by Network Solutions (InterNIC), starting March 1998.

Longest hostname registered with InterNIC:
CHALLENGER.MED.SYNAPSE.UAH.

Technologies of the Year: Push, Multicasting
Emerging Technologies: Push, Streaming Media.



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1998

Electronic postal stamps become a reality, with the US Postal Service allowing stamps to be purchased and downloaded for printing from the Web

Network Solutions registers its 2 millionth domain on 4 May.

San Francisco sites without off-city mirrors go offline as the city blacks out on 8 December.

Technologies of the Year: E-Commerce, E-Auctions, Portals
Emerging Technologies: E-Trade, XML.



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1999

Internet access becomes available to the Saudi Arabian (.sa) public in January, Somalia gets its first ISP - Olympic Computer (Sep), .ps is registered to Palestine (11 Oct)

MCI/Worldcom, the vBNS provider for NSF, begins upgrading the US backbone to 2.5GBps .

First Internet Bank of Indiana, the first full-service bank available only on the Net, opens on 22 February

MCI/Worldcom launches vBNS+, a commercialized version of vBNS

RFC 2550 Proposes the solution of Y10K and Beyond

Technologies of the Year: E-Trade, Online Banking, MP3
Emerging Technologies: Net-Cell Phones, Thin Computing, Embedded Computing



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2000-2003

•2000: The US timekeeper (USNO) and a few other time services around the world report the new year as 19100 on 1 January.

•2001: .biz .museum begun to resolve

•2002: .name, .coop, .aero begin to resolve

•2003: TeraGrid Computing



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2003-2007

- Rise & Fall of Napster: P2P emerges as major technology
- Grid Computing
- Social Networks



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References

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– <http://www.livinginternet.com/>



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Next Class

Sockets

A-B-C of building software
that can talk over internet!

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