RL30987

CRS Report for Congress

Spinning the Web:
The Internet's History and Structure

June 1, 2001

Rita Tehan
Information Research Specialist
Information Research Division

Distributed by Penny Hill Press

http://pennyhill.com

Prepared for Members and
Committees of Congress

Congressional
Research

Spinning the Web:
The Internet's History and Structure

Summary

The Internet is an international, cooperative computer "network of networks" that links many types of users, such as governments, schools, libraries, corporations, hospitals, individuals, and others. No single organization owns, manages, or controls the Internet. However, the Internet is not free. The major costs of running the network are shared by its primary users: universities, national laboratories, high-tech corporations, and governments.

The existing Internet in the United States began as a program of the Defense Advanced Research Projects Agency (DARPA) in the Department of Defense (DOD) in the 1960s. Its purpose was to allow defense contractors, universities, and DOD staff working on defense projects to communicate electronically and to share the computing resources of the few powerful, but geographically separate, computers of the time. In 1990, ARPANET ceased operation because NSFnet and various midlevel networks, sponsored by the National Science Foundation, made the Internet viable for commercial traffic. DOD continues to run a military network.

The last few years have seen dramatic expansion in Internet connections by corporations, governments, schools, and individuals. According to the *ITU Telecommunication Indicators Update,* the Internet connects more than 407 million host computers in 214 countries.

While other industrialized countries show solid gains in Web usage, it appears that Internet use is leveling off in the United States, according to the *Face of the Web II: 2000-2001* survey by research firm Ipsos-Reid. While Americans have typically dominated the Web, the share of U.S. users fell from 40% to 36% over the last year.

The most powerful Internet application is the World Wide Web. With the appropriate browser software, a user can view images, listen to audio files, or see motion pictures.

While the Internet offers almost limitless possibilities for the free communication of ideas, research, and information, there are serious business and consumer issues concerning accessibility, cost, privacy, fraud, security, copyright, and standardization. The future of the Internet involves using standards to create a stable computing infrastructure, which will make the computer network more reliable, ubiquitous, and easy to use, like other utilities, such as electricity, water, and telephones.

This report provides background information on the history, infrastructure, growth, and costs of the Internet.

Contents

Spinning the Web:
The Internet's History and Structure

The Internet is an international, cooperative computer "network of networks" that links many types of users, such as governments, schools, libraries, corporations, hospitals, and individuals, among others. An immense amount of information is available on the Internet: speeches by world leaders; full texts of books, magazines, and newspaper articles; radio broadcasts; movies; medical fact sheets; electronic discussion groups; library catalogs; college courses; recipes; games; Supreme Court rulings; legislation; scientific papers; government documents; music lyrics; software; sports schedules; weather reports; résumés; satellite images; and much more.

This report provides background information on the history and infrastructure of the Internet. In addition, it describes the applications available on the Internet (e-mail, telnet, and FTP) and some online tools for using the Internet—Gopher, Archie, Veronica, Jughead, Wide Area Information Servers, the World Wide Web, and Java.

Organization

No single organization owns, manages, or controls the Internet. It is a fusion of cooperative yet independent networks. Member networks may have presidents or CEOs, but there is no single authority for the Internet as a whole. Substantial influence over the Internet's future now resides with the Internet Society, a voluntary membership organization whose purpose is to promote global information exchange through Internet technology.

A number of nonprofit groups keep the Internet working through their efforts at standards development and consensus building. They include:

- Internet Society (umbrella Internet organization)
- Internet Architecture Board (IAB) (oversees technology standards)
- Internet Engineering Task Force (IETF) (improves technology standards)
- Internet Research Task Force (IRTF) (research into the future of the Internet)Internet Corporation for Assigned Names and Numbers (ICANN) (manages the Domain Name System and the Allocation of Internet Protocol numbers)
- VeriSign (formerly Network Solutions) (first domain registrar and still manager of the central database) and accredited registrars[1]

---

[1] *How the Internet Is Managed*, The Living Internet, at: [http://www.livinginternet.com/].

Internet users express their opinions on how the Internet should operate to the IETF, a loosely self-organized group of volunteers who make technical and other contributions to the engineering and evolution of the Internet and its technologies. The IETF meets three times a year to discuss the Internet's operational and technical problems. If a problem deserves special attention, the IETF sets up a working group to discuss it. The working group eventually issues a report or recommendation, which can be either voluntarily accepted by the IETF or sent to the IAB to be declared a standard.

Among the key technical standards the IETF is currently working on is the next generation of the Internet Protocol (IP), the foundation of the Internet. IP Version 6 (IPv6) will offer a variety of new services, such as enhanced security, automation of many administrative tasks, and expanding the capacity of network addresses.

The IETF began work on IPv6 out of concern that the Internet would eventually run out of unique addresses. Originally published in 1981, IPv4 was designed to link a small number of research networks. IPv4 only allows addresses up to 12 digits, or about 4 billion unique addresses. IPv6 will provide the Internet with one billion-squared addresses, which should suffice for many years. On July 14, 1999, the Internet Assigned Numbers Authority (IANA) announced the worldwide deployment of IPv6, the next-generation numeric addressing system for the Internet.[2] Although there is already some demand for IPv6 addresses, full transition to the new system will take 6-10 years.

Sprint and other computer industry companies are experimenting with the '6bone' network – a network put in place by industry groups to run early versions of IPv6. Sprint operates its portion of the 6bone network running IPv6 traffic exclusively as a "tunnel" within its Internet backbone. Sprint currently provides IPv6 connections to about 70 research, academic, government, and corporate entities.[3]

IPv6 implementations are being developed for many different host operating systems and routers. Many firms are shipping products. This includes host implementations by Apple, Digital, Hitachi, HP, IBM, Linux, Microsoft, Nokia, Novell, and Sun, and router implementations by 3Com, Cisco Systems, Digital, Hitachi, IBM, Merit (routing protocols), and Nokia, among others.[4]

Standards affecting the Internet are also developed by other entities, such as the Internet Engineering Steering Group (IESG), the Internet Architecture Board, the Asynchronous Transfer Mode (ATM) Forum, and the World Wide Web Consortium (W3C).

---

[2] See the IPv6 Information page at: [http://www.ipv6.org/]. For the text of the July 14, 1999, letter on the delegation of IPv6 address space, see: [http://www.ipv6.org/iana-ann.html].

[3] Rendleman, John. Vendors Begin Test Driving IPv6. *eWeek*, July 7, 2000, at: [http://www.zdnet.com/filters/printerfriendly/0,6061,2600183-2,00.html].

[4] IPng Implementations, from Sun Microsystems, at: [http://playground.sun.com/pub/ipng/html/ipng-implementations.html], dated Dec. 13, 2000.

History

The existing Internet in the United States began as a program of the Defense Advanced Research Projects Agency (DARPA) in the Department of Defense (DOD). The Pentagon needed a military command and control system that would continue operating in the event of nuclear war. In 1964, a researcher at the Rand Corporation named Paul Baran designed a computer communications network that had no hub, no central switching station, and no governing authority. In this system, each message was cut into tiny strips and stuffed into "electronic envelopes," called packets, each marked with the addresses of the sender and the intended receiver. The packets were then released like confetti into the web of interconnected computers, where they were tossed back and forth over high-speed wires in the general direction of their destination and reassembled when they arrived. Baran's packet-switching network, as it came to be called, became the technological underpinning of the Internet.

The original network, ARPANET, was created in the late 1960s. Its purpose was to allow defense contractors, universities, and DOD staff working on defense projects to communicate electronically and to share the computing resources of the few powerful, but geographically separate, computers of the time. In September 1969, a one-node packet-switched network was created at the University of California at Los Angeles (UCLA). Shortly thereafter, four nodes were installed and operating effectively. The ARPANET grew rapidly. By 1977, it had 111 hosts. Since many universities and research facilities on the ARPANET later connected their local area networks to the ARPANET, it eventually became the core network of the ARPA Internet, an internetwork of many networks using the Transmission Control Protocol/Internet Protocol (TCP/IP) communication language as the underlying architecture. ARPANET was very important in the development of the Internet. In its time, it was the largest, fastest, and most populated part of the Internet.

In 1984, ARPANET was split into two networks: ARPANET and the Defense Data Network (DDN). DDN continues today as one of the Internet's component networks. (MILNET is the unclassified portion of DDN.) In 1990, ARPANET ceased operation because NSFnet and various midlevel networks, sponsored by the National Science Foundation, made the Internet viable for commercial traffic. The Department of Defense continues to run a military network.

In 1985, the National Science Foundation (NSF) funded several national supercomputer centers, with the intention of making them available to the research community in universities across the country. Many state and regional universities had already developed local and regional networks, and some were TCP/IP based. The NSF funded a 56 kilobits per second (Kbps) network linking the five original supercomputer centers and offered to let any regional and university computer centers that could physically reach this network connect to it. This was the "seed" of the Internet network as we know it today, and the original reason to connect to it was for remote access to supercomputer facilities.

A number of universities linked to the NSF network (NSFnet) to gain access to the supercomputers. In addition to research, they found that the network was useful for electronic mail, computer file transfer, and newsgroups. The traffic on the

network rose fairly dramatically. In November 1987, the NSF awarded a contract to Merit Network, Inc., in partnership with IBM, MCI, and the state of Michigan, to upgrade and operate the NSFnet backbone, the first level of connection to the Internet.

The purpose of the NSFnet backbone by this time was to link the growing "regional" networks created by various university systems. The term "the Internet" was already being used in 1983 to describe the concept of interconnecting networks.

In May 1993, the NSF radically altered the architecture of the Internet, because the government wanted to get out of the backbone business. In its place, NSF designated a series of Network Access Points (NAPs) where private commercial backbone operators could "interconnect." In 1994, NSF announced that four NAPs would be built in San Francisco, New York, Chicago, and Washington, D.C. The four NSF-awarded Network Access Points were provided by Ameritech, PacBell, Sprint, and MFS Datanet. An additional interconnection point, known as MAE-West, was provisioned by MFS Datanet on the West Coast.[5]

On April 30, 1995, the NSFnet backbone was essentially shut down, and the NAP architecture became the Internet.[6]

The Internet's Infrastructure

For different computers on the Internet to connect with each other, they use protocols, which are rules or agreements on how to communicate. The language of the Internet is TCP/IP, which stands for Transmission Control Protocol/Internet Protocol. Any computer seeking to communicate on the Internet must "speak" TCP/IP. This standard is an "open" standard, meaning it is not a proprietary product of any single company. The predominant operating system is UNIX, but the Internet standard has been adapted for use on the most commonly used systems, such as UNIX, PC, and Macintosh.

The Internet consists of interconnecting networks among universities, government agencies, the military, corporations, and other entities. These networks are connected to each other with equipment such as routers, bridges, and switches. Routers decide which direction to send network data by sending packets to the

---

[5] Information on Internet history was taken from the following sources:
Hardy, Henry Edward. A Short History of the Net. November 17, 1998, at: [http://www.ocean.ic.net/ftp/doc/snethist.html].
Leiner, Barry M., et al. A Brief History of the Internet and Related Networks. *All About the Internet, Internet Society*, last revised February 20, 1998, at: [http://www.isoc.org/internet-history/brief.html].
Martin, Richard. Present at the Creation: An Oral History of the Dawn of the Internet. *PreText* Magazine, March 1998, at: [http://www.pretext.com/mar98/features/story1.htm].

[6] Information on the National Science Foundation's NSFnet transition is explained in The *NSFNET Backbone Project, 1987– 1995: NSFNET Transition*, Merit Network, Inc., at: [http://www.merit.edu/merit/archive/nsfnet/transition/].

destination network and then "routing" the data to the proper destination computer, where the packets are reassembled. Bridges join together two segments of cabling within a network; while switches are devices that open or close circuits.

In the United States, the Internet has various components: local networks, midlevel networks, and the various national "backbone" networks.[7] Local networks are the local area and wide area networks (LANs and WANs) within an organization. Examples of local area networks range from agency-wide computer systems to PC-based LANs. It is through a local network that most users access the Internet. Midlevel (regional) computer networks provide Internet access to large organizations, such as universities and federal agencies, in a given geographic area. There are about 20 mid-level networks in the U.S. – for example, GTE Internetworking in the Southeast, CERFnet in New York state, and BARRnet in the San Francisco area.[8]

There are four stages of access to the Internet. The Internet backbone, now known as very-high-speed backbone network services (vBNS), is maintained by IBM Corp., WorldCom Inc., and Merit (a nonprofit organization owned by 11 public universities in Michigan).[9] Access to the Internet is provided at NAPs operated by Sprint Corp., WorldCom, and Ameritech Corp. (which was acquired by SBC Communications Inc. in October 1999), among others. At the NAPs, anyone in theory can interconnect with the rest of the Internet.[10] Internet Service Providers (ISPs) purchase access to the Internet from companies running the NAPs; they then provide access to their customers (e.g., consumers, businesses, and smaller ISPs).

The second level of access is through a series of Metropolitan Area Exchanges (MAEs) connections in large metropolitan areas across the country. This is basically a fiber-optic data ring around a city which connects customers to a citywide network. There are MAEs in San Jose, Los Angeles, Dallas, Chicago, and two in Washington, D.C.

In addition, there are two Federal Internet Exchange (FIX) points, at the University of Maryland in College Park and at NASA's Ames Research Center at

---

[7] Much of the discussion of the Internet's infrastructure is explained clearly and thoroughly in *Internet Architecture*, by Jack Rickard, 1999, at:
[http://www.ece.arizona.edu/~medenis/hw1/inetarch.htm].
See also: *Internet: "The Big Picture": What Are the Major Pieces of the Internet, and Who Are the Major Players in Each Segment?* by Russ Haynal, 1998, at:
[http://navigators.com/internet_architecture.html].
See also: CRS Report 97-392, *Internet Technology*.

[8] For a map of the Network Access Points and regional network connections, see *Inter-regional Connectivity Under the New Internet Architecture*, at:
[http://www.cerf.net/cerfnet/Bbone-map.html].

[9] Standard & Poor's Industry Surveys. *Computers: Consumer Services and the Internet*, March 1, 2001, p. 18.

[10] Information on the National Science Foundation's NSFnet backbone project is explained in *The NSF Networking Architecture of the Late 1990's*, Merit Network, Inc., at:
[http://www.merit.edu/michnet/connectivity/i2/NAPs.html].

Moffett Field, CA. These exist to interconnect MILNET, NASA Science Net, and some other federal government networks.

The third level of Internet access is regional network operators, such as CERFnet in San Diego, ioNET in metropolitan areas in the Midwest, ONENET in Oklahoma, and Brightnet in western states. Typically, they operate backbones within a state or among several adjoining states. They usually connect to one or several national backbone operators.

The fourth level of Internet access is the Internet Service Provider (ISP), such as America Online, MCI, Sprint, AT&T WorldNet, EarthLink, and Microsoft Network (MSN). Due to bottlenecks caused by increasing traffic at NAPs, ISPs are negotiating direct interconnection agreements among themselves, called peering.[11] As a result, most Internet traffic growth over the past decade has remained within an ISP's network without ever reaching the higher level of the NAPs.

As of April 2001, the number of ISPs totaled some 9,600, more than six times the 1,500 ISPs that existed in mid-1996.[12] Internet service providers purchase access to the Internet from the companies running the NAPs; they then provide access to their customers (consumers, businesses, and smaller ISPs). Most services offer a month's trial with a few free hours and a flat-rate price per month upon subscription. These services typically provide Internet/Web access, e-mail, chat rooms, games, news, reference sources, online publications, and technical support. According to a January 2001 Telecommunications Reports International (TRI) report entitled, *Online Census*, 68.7 million U.S. consumers subscribe to the Internet via one of the following methods: paid or free dial-up ISP, Internet television (iTV), digital subscriber line (DSL), or cable modem services.[13]

The four levels of Internet connection are somewhat arbitrarily constructed because there is a fair amount of cross-connection. For example, Sprint is a NAP, as well as one of the largest national backbone operators, and it also provides consumer access nationwide.

According to International Data Corp. (IDC), an information technology research and consulting firm, America Online (AOL) (including subscribers to CompuServe, which AOL acquired in September 1997) is the dominant player in the consumer ISP market, with about 40% of the market in terms of subscribers as of

---

[11] A detailed examination of the interconnection arrangements between Internet backbone providers can be found in the Federal Communications Commission (FCC) report, *The Digital Handshake: Connecting Internet Backbones*, at:
[http://www.fcc.gov/Bureaus/OPP/News_Releases/2000/nrop0002.html]
(press release and link to PDF version of report), dated September 26, 2000.

[12] For a directory of Internet Service Providers, see Internet.com's *The List* at:
[http://www.thelist.com/].

[13] eMarketer, *eStatNews*, February 6, 2001, and TRI press release, at:
[http://www.tr.com/newsletters/rec/TROC_PR.HTM].

mid-2000.[14] In fact, AOL has more subscribers than the next top 20 ISPs combined, with Microsoft's MSN (4.1%) in second place, followed by EarthLink (3.5%), and WorldNet (3.4%). Thousands of other primarily regional and local ISPs fight over the remainder of the market.

Next Generation Internet and Internet2

In October 1996, President Clinton proposed the Next Generation Internet (NGI). This project is a plan to build a national network that connects universities and federal research organizations at rates 100 to 1,000 times faster than today's Internet.[15] (For a more detailed discussion of the Next Generation Internet, Internet2, and related initiatives, see CRS Report 97-521, *Next Generation Internet and Related Initiatives*.) Seed money for development of the network has gone to DOD, the Department of Energy, NASA, and the NSF.[16]

NGI is constructing a high performance distributed laboratory consisting of the 100 NGI sites at universities, federal research institutions, and other research partners at speeds more than 100 times that of today's Internet. This laboratory will be large enough to provide a full system, proof-of-concept testbed for hardware, software, protocols, security, and network management required by the commercial NGI. Second, NGI will develop ultrahigh-speed switching and transmission technologies and end-to-end network connectivity at more than one gigabit per second. Such networks will be pioneering networks limited to 10 NGI sites at speeds 1,000 times faster than today's Internet. Some examples of in-use NGI projects are: real-time telemedicine, weather forecasting, distributed Positron Emission Tomography (PET) imaging, and real-time environmental data.[17]

Types of Applications Available on the Internet

The major applications of the Internet are electronic mail and the World Wide Web.

Electronic Mail and E-mail Discussion Lists

Electronic mail (e-mail) is used for two main purposes: person-to-person communication and participation in electronic discussion groups. A listserver is an organized system in which a group of people are sent messages pertaining to a particular topic. The messages can be articles, comments, or whatever is appropriate

---

[14] Standard & Poor's, *Computers*, p. 10.

[15] Information on NGI is available at: [http://www.ccic.gov/ngi/].

[16] CRS Report 97-521, *Next Generation Internet*.

[17] For a description of these projects, see: *Next Generation Internet Initiative, Grants, Awards, Projects, and Researchers*, at: [http://www.ngi.gov/grants_awards/], updated November 2000.

to that topic. There are more than 90,000 electronic mailing lists covering nearly every imaginable topic.[18]

Another popular use is the electronic journal, or e-journal, in which full-text issues of journals are available electronically to e-mail list subscribers. Other electronic magazines are available via file transfer protocol (FTP) or at World Wide Web home pages. For example, the *Journal of Computer-Mediated Communication* is available through its Web site at: [http://www.ascusc.org/jcmc/]. Some online journals are available only to paid subscribers, e.g., the *New England Journal of Medicine* at: [http://www.nejm.org/content/index.asp].

World Wide Web (WWW or "the Web")

The World Wide Web is currently the most powerful Internet search tool because as a hypertext information browser, it seamlessly integrates linked text, graphics, audio, and video. Hypertext allows a user viewing one document to jump to a related item in another document through hypertext links. With the appropriate software (such as Netscape, Internet Explorer, Opera, or Lynx), a user can view images, listen to audio files, or see motion pictures through the World Wide Web.

In 1990, the Web's main architect, Tim Berners-Lee, a programmer at CERN, the European Particle Physics Institute in Geneva, Switzerland, collaborated with colleague Robert Caillau on a design document that explained hypertext as a way to link and access information. It described how documents could be interwoven in a network of links called a web. The 1990 document discussed notions fundamental to the Web as it is known today: the ability of links to cross computer or network boundaries; a common protocol for exchanging documents (Hypertext Transfer Protocol, or HTTP); a common document protocol for information suppliers and consumers (Hypertext Markup Language, or HTML); support for index searches; and the ability to view these documents with text or graphics browsers.[19]

The most noteworthy Internet development in the last few years was the expansion of the World Wide Web. In 1992, the Web was text-based relatively unknown outside of academia, and used mainly by engineers, scientists, and computer hobbyists. In the spring of 1993, a software program called Mosaic was developed by a team of students at the University of Illinois/National Center for Supercomputing Applications. The Mosaic browser allowed users to view both text and graphics. This transition to a visual interface sparked rising interest in the Web. Marc Andreesen, one of the students who created Mosaic, later cofounded Netscape, one of the two dominant Web browsers (the other is Microsoft's Internet Explorer).

---

[18] A good guide to electronic discussion lists is available at Liszt, a mailing list directory at: [http://www.liszt.com].

[19] Wiggins, Richard W. Webolution: The Evolution of the Revolutionary World-Wide Web. *Internet World*, v. 6, April 1995. p. 35-38.

Other Applications

In addition to the World Wide Web, the Internet supports other online tools to help find and retrieve information: Telnet, FTP, Gopher, Archie, Veronica, Jughead, Wide Area Information Servers (WAIS), and search engines:

- Telnet—Telnet lets Internet-connected computers contact and search other computers. Once a connection is established with a remote computer via telephone lines and a modem, users can search that remote system as if their computer were a hard-wired terminal of that computer. An Internet user can connect to a computer on the other side of the world as easily as he or she can connect to one in the next building.

- FTP (File Transfer Protocol)—The FTP command allows an Internet-connected computer to contact another computer; log on anonymously; retrieve text, graphics, audio, or computer program files; and transfer desired files back to itself.

- Gopher—This software program, developed at the University of Minnesota, organizes information into a series of menus. Using Gopher is like browsing a table of contents: a user crawls through a set of "nested" menus to zero in on a specific subject. There are more than 2,000 Gopher servers on the Internet, some dealing with very narrow topics and others more broadly based.

- Archie—Archie helps find files available at FTP hosts. When searching for a particular term, Archie searches the database and displays the name of each FTP host that has that file or directory and the exact path to that directory.

- Veronica and Jughead—Veronica is an indexer that can query every Gopher on the Gopher system to search for a key word or phrase in a menu title and give the address of all menus with those key words. Jughead works like Veronica but usually restricts its search to a single Gopher on a local campus. It provides a menu-item search of the files located on a local Gopher server.

- WAIS (Wide Area Information Servers)—In important respects, WAIS is a more powerful retrieval tool than Gopher, because it actually searches the full text of a document to look for key words. WAIS accepts plain-English queries, which makes it easier to use than Boolean logic. There are more than 250 WAIS libraries on the Internet. However, since the information is maintained by volunteers, usually in academia, subject material tends to favor research and the computer sciences.

- Internet search engines—Search engines such as AltaVista, Excite, Google, Hotbot, InfoSeek, Northern Light, and Yahoo collect and index Internet resources automatically. These software agents roam

Internet sites (mostly World Wide Web, Gopher, and FTP sites), search them, and create databases from them that can be searched to provide requested information to the user.

Growth

The Internet connects more than 407 million people in 214 countries, according to an estimate by the research firm Nua Internet Surveys.[20] While other industrialized countries show solid gains in Web usage, it appears that Internet use is leveling off in the United States, according to the *Face of the Web II: 2000-2001* survey by research firm Ipsos-Reid. Although Americans have typically dominated the Web, the share of U.S. users fell from 40% to 36% over the last year. The report estimates that the global Web user population grew by about 13% in the last year, and that the global Internet population was about 350 million adults at the end of last year (less than one-tenth of the world's total population).[21] For statistics and other information on the Internet's estimated size and growth rate, see CRS Report RL30435, *Internet and E-Commerce Statistics: What They Mean and Where to Find Them on the Web.*

Who Pays for It?

The Internet is not free. Some of the networks are partially funded by certain government agencies, especially the NSF and other science agencies for use by scientists, researchers, and the education community.

The major costs of running the network are shared by its primary users: universities, national laboratories, high-tech corporations, and governments. Each institution, organization, corporation, or individual with access to the Internet purchases that access through an Internet Service Provider offering Internet access in its area.

Universities, agencies, and other institutions with direct connections via a mid-level network usually absorb the cost of Internet connections in their data processing budgets without charging the costs back to the end users. This is why many Internet users describe the Internet as "free." In reality, however, direct connections usually require a one-time, up-front capital investment in hardware and software (usually $10,000-$20,000). The cost of the connection itself depends on its speed— from

---

[20] *How Many Online?* World Total, Nua Internet Surveys, at: [http://www.nua.ie/surveys/how_many_online/world.html]. For global Internet statistics, see: *ITU Telecommunication Indicators Update*, January, February, March 2001, at: [http://www.itu.int/ti/update/Update_1_01_E.pdf]. See also: *International E-mail Accessibility Based on International Standard ISO 3166 Codes*. This guide to country codes, showing which countries have access to the Internet or general e-mail services, was released Feb. 1, 2001, at: [http://www.nsrc.org/codes/].

[21] *The Face of the Web II: 2000-2001*. Press release by Ipsos-Reid, May 14, 2001: [http://www.angusreid.com/media/content/displaypr.cfm?id_to_view=1229].

$20,000-$25,000 for a T1 connection (1.544 Mbps) to $70,000-$80,000 for a 10Mbps ethernet connection.[22] The midlevel network also may assess an annual membership and/or maintenance fee (from several hundred dollars up). These costs are often absorbed by the computer or communications department and/or distributed evenly throughout an organization.

Individual users who lack organizational access to the Internet must get their access from commercial ISPs. Users with a computer and a modem can gain access, usually through a local telephone call, to a terminal server (computer). Costs vary from $10 to several hundred dollars per month on a connect-time basis, but many commercial providers charge a flat-rate monthly fee. In addition, "free nets" have been established in an increasing number of cities for no-cost or low-cost public access to the Internet.[23]

Conclusion

Historically, many major breakthroughs in technology have held out the promise of wondrous benefits for society, and have actually brought about unimagined and sometimes undesirable changes as well.

While the Internet offers almost limitless possibilities for the free communication of ideas, research, and information, it presents serious business and consumer issues about accessibility, cost, privacy, fraud, security, copyright, and standardization.

Forrester Research predicts that the Web's days are numbered, as the Internet moves beyond browsers to new waves of innovation. Forrester calls this the "X Internet": an executable Internet that greatly improves the online experience.[24] This will allow users to get real-time, interactive experiences over the Net through disposable code—programs that are used once and thrown away—downloaded to their PCs and handheld devices. Forrester also foresees an extended Internet emerging through online devices and applications that sense, analyze, and control the real world. Thanks to inexpensive chips and a worldwide Internet backbone, nearly every device that runs on electricity will have an Internet connection, using both wired and wireless networks.

The Internet has a long way to go to achieve a goal of universal access at a reasonable price for all citizens. This is a daunting technical challenge which will

---

[22] Dennis, David H. The New Internet Provider FAQ. Updated March 19, 1999, at: [http://www.amazing.com/isp/hooking-up.html].

[23] Information on free nets is available from:
Organization for Community Networks, P.O. Box 32175, Euclid, OH 44132, and from its Web site at: [http://ocfn.org]; and
Center for Civic Networking, P.O. Box 53152, Washington, D.C. 20009, and from its Web site at: [http://www.civic.net:2401/ccn.html].

[24] Pastore, Michael. The End of the Web as We Know It. *CyberAtlas*, May 17, 2001, at: [http://cyberatlas.internet.com/big_picture/applications/article/0,,1301_767831,00.html].

require that very complex social and political questions be addressed as well. The Internet expands and diversifies daily, and planning and managing these changes is a challenge for the future.

Further Reading

Hundreds of books and thousands of articles provide detailed instructions on using the Internet and analyzing its impact on society. Information on these materials can be obtained at a local public library or bookstore. The Internet itself provides the most current information on new developments in Internet technology. Below is a list of selected sites which may be particularly useful.

Internet Sites of Interest

Guides.

Books, Journals, and Magazines About the Internet: A Library of Congress Internet Resource Page. [http://lcweb.loc.gov/global/internet/inet-pubs.html]

The Help Web: A Guide to Getting Started on the Internet. A beginner's guide to the Internet, including e-mail, FTP, and the World Wide Web. [http://www.imagescape.com/helpweb/welcome.html]

Internet Scout Project. A collection of quality resources, searching techniques, monthly articles, reference guides, Web tools, and Internet publications. [http://scout.cs.wisc.edu/index.html/]

History.

Hobbes' Internet Timeline [http://info.isoc.org/guest/zakon/Internet/History/HIT.html]

The Living Internet [http://www.livinginternet.com/]

NetHistory: An Informal History of BITNET and the Internet. [http://nethistory.dumbentia.com/]

News.

Good Morning Silicon Valley. Daily technology news updates from the *San Jose Mercury News*. [http://www.siliconvalley.com/opinion/gmsv/]

Industry Standard. The news magazine of the Internet economy, updated daily. [http://www.thestandard.com/home]

News.com. News about the Internet from Cnet, updated daily. [http://www.news.com/]

TechWeb. Technology news from CMPNet, updated daily.
[http://www.techweb.com/]

Wired News. Daily news and opinions from *Wired Magazine*.
[http://www.wired.com]

Books

Abbate, Janet. *Inventing the Internet*. Cambridge, MA., MIT Press, 1999. 264p. TK5105.875.I57 A23 1999 Overflow

Baczewski, Philip, et al. *The Internet Unleashed*. 4th ed. Indianapolis, Sams.net Publishing, 1997. 1,269 p. TK5105.875.I57 E46 1997

Hafner, Katie, and Matthew Lyon. *Where Wizards Stay Up Late: The Origins of the Internet*. New York, Simon & Schuster, 1996. TK5105.875 I57 H338 1996

Moschovitis, Christos, Hilary Poole, Tami Schuyler, and Theresa Senft. *History of the Internet: A Chronology, 1843 to the Present*. Santa Barbara, Calif.,ABC-CLIO, Inc., 1999. 312 p. TK5105.875.I57 H58 1999

CRS Products

CRS Issue Brief IB10045, *Broadband Internet Access: Background and Issues*, by Lennard G. Kruger.

CRS Report RL30719, *Broadband Internet Access and the Digital Divide: Federal Assistance Programs*, by Lennard G. Kruger.

CRS Report 98-67, *Internet: An Overview of Key Technology Policy Issues Affecting Its Use and Growth*, by Marcia Smith, et al.

CRS Report RL30435, *Internet and E-Commerce Statistics: What They Mean and Where to Find Them on the Web*, by Rita Tehan.

CRS Report 97-868, *Internet Domain Names: Background and Policy Issues*, by Lennard G. Kruger.

CRS Report 97-521, *Next Generation Internet and Related Initiatives*, by Glenn J. McLoughlin.

CRS Report 97-556, *Point & Click: Internet Search Engines, Subject Guides, and Searching Techniques*, by Rita Tehan.