

## INTERNET COMPANIES

The emergence of the worldwide Internet (1) on the commercial scene in the decade of the 1990s, spawned a new Internet industry in which a variety of information and communication technologies and services began to be offered by an ever-increasing number of Internet companies.

Internet companies offer one or more of a number of Internet-based services (2), including but not limited to dedicated and dial-up Internet access, Internet World Wide Web (WWW) content development and Internet WWW site hosting, Internet-based real-time services such as voice and video and Internet consulting, and Internet and network security services. In this article we will describe Internet companies in terms of these major service offerings.

### DEDICATED AND DIAL-UP INTERNET ACCESS

The Internet provides a wide range of services including electronic mail (e-mail), file transfer via the file transfer protocol (ftp), and various other multimedia and interactive services using the World-Wide Web (3). However, in order for these services to be available to a particular user, it is first necessary to obtain a connection to the Internet. Internet access companies provide the means for such Internet connections for stand-alone home or business computers or for corporate networks.

Internet Access companies can be divided into two major groups, namely network service providers (NSPs) and Internet service providers (ISPs). The NSPs include such companies as AT&T (4), MCI (5), SPRINT (6) and UUNET (7), and these companies maintain the high-speed backbone of the Internet. ISPs buy Internet connections from the NSPs and are typically connected via single or multiple T1 circuits (digital communication links operating at about 1.5 million bits/s). In addition most NSPs also offer ISP type of services. The dial-up end user would then use a modem to connect to a terminal server at the ISP location using the correctly configured software and would then be connected to the world-

wide Internet (see Fig. 1). Alternatively corporate users may purchase a leased or permanent connection to the ISP, and with the correct routing equipment provide access to all computers in the corporate network via this link. In any event the dial-up or dedicated connections to the Internet via the NSP or ISP companies facilitate access to the awesome information resource of the worldwide Internet consisting of thousands of separate and independent networks and millions of individual computers.

When we examine the NSP companies, we find that many long-distance and local telephone service providers have adapted to the new era of Internet communications and are now providing major local and global Internet grids. Other companies such as Microsoft (8) and IBM (9) have also developed their own global network. UUNET also offers an impressive global high speed network.

While there are only a handful of companies providing backbone NSP services, ISP companies have evolved in many flavors in most local communities where access to the Internet is available. Some ISPs provide local dial-up access nationally or internationally so that a user with a portable computer simply needs to determine the local dial-up access number(s) for a particular area without having to make a long-distance call to the home location. ISP companies offering this facility include AT&T Worldnet, UUNET, MCI, and America Online (AOL) (10). Smaller localized ISPs provide equivalent access but users must call the given access number in a particular area.

Manufacturers of communication equipment have also capitalized on the growing Internet market and there are now several traditional and newer companies whose major business is Internet access. Dial-up users attach an external or internal modem operating at 28,800 to 56,000 bit/s to their computers and then dial-up to their ISPs. It is also now possible to obtain special digital dial-up connections using the Integrated Services Digital Network (ISDN) (2) or newer varieties of Digital Subscriber Lines (DSLs). One variation of the latter services known as Asymmetric Digital Subscriber Lines (ADSL) (2) is capable of delivering up to 9 million bit/s to the subscriber and 1.5 million bit/s from the subscriber, using the existing copper telephone wires, subject to some distance constraints. Cable TV providers are also now offering Internet access using the cable TV infrastructure. Such services provide data transfer rates of several million bits/s depending on the number of users and the particular cable modem configuration.

For dedicated access, there is a wide variety of communication interface equipment and routers that allows multiple computers on a corporate network to access the Internet simultaneously. Routers are equipped with appropriate software and hardware components to implement the Transmission Control Protocol and the Internet Protocol (TCP/IP) on which the Internet is based.

Dial-up users on the other hand need to have software which will implement the TCP/IP protocol stack once the physical dial-up connection is established via analog modems or other means. Many smaller companies have written programs such as Trumpet Winsock and Twin Sock, which run as applications on various operating systems to provide TCP/IP interconnectivity. On the other hand most recent versions of all modern operating systems provide built-in support for TCP/IP. Microsoft for example provides dial-up networking

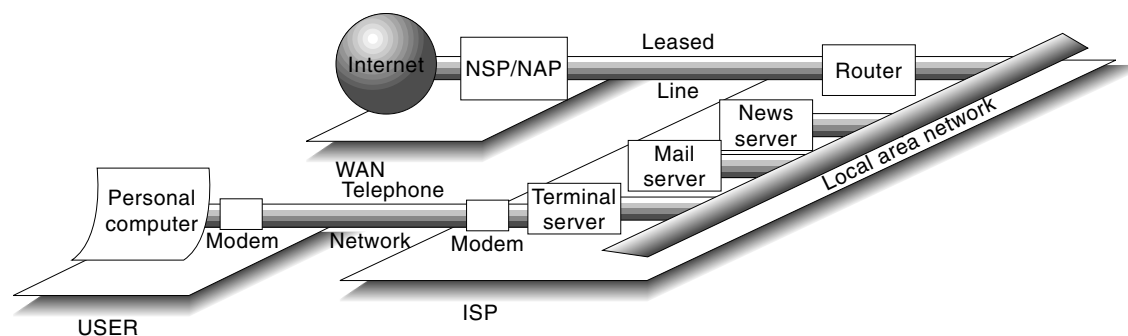


Figure 1. Internet connectivity and services.

support in its Windows operating systems, as do the MAC OS, IBM OS2 and of course the UNIX (11) operating system on which the Internet was originally built.

#### BASIC INTERNET APPLICATIONS—INTERNET SOFTWARE COMPANIES

Several companies now offer integrated software for accessing Internet services such as e-mail, file transfers, and remote terminal access using telnet or rlogin applications. Most of these applications can be obtained from the Internet itself via a shareware marketing scheme, which allows the user to try the fully functional program for a period of time and register the program with the payment of a small fee to the software company. Some companies leave the program registration entirely up to the good will of the user, while others have built-in mechanism for disabling the program if it is not registered after a certain time. Some innovative companies program the software to increment a counter at their Internet location every time the program is used, thus monitoring the usage of evaluation versions of their software.

Some common applications for ftp and telnet are the programs by these names which come bundled with most common operating systems. E-mail programs such as Eudora (12) or Pegasus (13) mail are also quite common though most users now have access to e-mail programs built into the operating system. Microsoft, for example, provides Microsoft Exchange for local and Internet e-mail.

Most Internet applications are based on the client-server model and end-users typically invoke client programs which then access servers such as ftp, e-mail, or telnet servers. On the other hand it is also possible for the experienced end-user to setup server versions of the associated software on their operating systems so that other users can access Internet services from their personal computers. While it is possible for a PC user to install a telnet server to give a system prompt to a remote user, this application is not very common. A more useful application would be to install an ftp server to allow access to some of the files on a personal computer from a remote location. This functionality can also be achieved by using some type of network file system (NFS) as supported by the Internet. It is also possible to install a mail server program on more advanced operating systems using the Post Office Protocol (POP) or the Interactive Mail Access Protocol (IMAP).

#### WORLD WIDE WEB SOFTWARE COMPANIES—SERVERS AND BROWSERS

The most popular Internet applications are based on the World Wide Web. The WWW is the most recent and fastest growing application in the ever evolving Internet. What is today universally known as the World Wide Web (WWW) began in 1990 as a Hypertext project at the European Particle Physics Laboratory in Geneva (CERN) (14). Hypertext is characterized by connections or links within the text to other sources of information. These hypertext links are used to create a complex virtual web of connections or hyperlinks.

Hyperlinked information need not be on the same machine, but it may be distributed across the world in the WWW. Moreover the notion of hypertext can be extended to other nontextual datasets, such as images, audio, and video yielding what has become known as hypermedia.

The architecture of the hypermedia on the WWW consists of stored data in information servers and client processes called browsers which facilitate the navigation of the WWW. A server manages a web of nodes on that machine and negotiates the presentation format with the browser. WWW servers use Hypertext Transfer Protocol (HTTP), which was first implemented in 1991. HTTP is a light and fast protocol specially designed for hypermedia information systems. The protocol was fully defined in an Internet draft in 1992 and implementations were available in early 1993. Several HTTP versions have been released since then.

#### WWW SERVERS

From just a few tens to hundreds of operational WWW servers in mid-1993, the number of HTTP servers had grown exponentially to several thousands in a period of just a few years. A number of HTTP servers have been implemented with varying features, starting from the HTTP server of the National Center for Supercomputing Activities (NCSA) to the currently most popular Apache server. Other WWW servers have also been produced by companies such as the Microsoft Internet Information Server (IIS) and the Netscape Application Server (15).

As individual and corporate Internet users rush to create a presence on the WWW, it is almost always the case that, following the de facto convention, pre-pending WWW to any domain name (www.domain-name) will yield the Internet ad-

dress for a new WWW server and the server will provide access to the required information for this domain.

One reason for the rapid growth of WWW usage can be attributed to the transition of the National Science Foundation Network (NSFNET) from a research to commercial network in late 1994, with more and more corporations perceiving the enormous advertising and global communications potential of the WWW and the Internet in general.

The other factor influencing the phenomenal explosion of WWW servers and usage was the development of easy-to-use graphical browsers, the client processes. Browsers not only implement HTTP but also encompass existing Internet protocols like ftp, SMTP, NNTP, Gopher, and Usenet, and hence they are capable of picking up information from other information sources in addition to HTTP servers. A browser can perform additional functions such as effecting telnet sessions or viewing movies and playing sound using helper programs. Hence a user may transfer files, initiate a remote login, send e-mail, read netnews, search for information, or just "cruise" the Web, all of these activities using the same browser. These recent developments have resulted in a situation in which using the World Wide Web has become synonymous to being "on the Internet."

## WWW BROWSERS

Web browsers have changed the way people view and create information. The first graphical WWW browser called Mosaic was developed at the NCSA at the University of Illinois. As was the case with WWW servers, several free and commercial WWW clients have been implemented, with Netscape Navigator and Microsoft Explorer currently being among the most popular. Other browsers include the text-based Lynx and Emacs W3, Arena, tkWWW, Internet Explorer, HotJava, and WebExplorer.

Resources on the WWW may be accessed using a uniform resource locator (URL). A URL can be considered to be a networked extension of the standard filename concept in that the URL can point to a file in a directory, as does a filename, but in addition the URL can also point to any service on any machine on the network. A URL may be expressed as `service://site/directory/filename`. Some examples are:

```
http://www.list.ufl.edu/new/test.html
ftp://comlab1.list.ufl.edu
ftp://user@comlab1.list.ufl.edu
news://usenet.eel.ufl.edu
gopher://gopher.cis.ufl.edu
```

Most Web documents are written using a simple and extensible language called the Hypertext Markup Language (HTML) and is based on the Standardized General Markup Language (SGML). HTML was standardized by the Internet Engineering Task Force (IETF) in November 1995 and is simple enough to be used by even new users of the language. Simply studying the source for an existing HTML document provides enough information to start writing HTML pages. The WWW Consortium promotes the development and use of the WWW by establishing common standards, producing specifications, and implementing reference software.

If the many global connections in the global Internet may be said to resemble a web, the World Wide Web (WWW), then it would take a spider to effectively navigate this web. This is indeed the case, and several spiderlike software programs are being written to automatically search and index the resources available on the WWW, returning an HTML document with the links already in place for a global virtual electronic library. In addition, there are many search engines for locating desired information on the Internet. The list of global Internet search engines is growing on a daily basis with the leading companies including Excite (16), InfoSeek (17), Lycos (18), WebCrawler (19), and Yahoo (20).

Advanced WWW documents may be developed to enable external computer programs to be executed on the server (using the Common Gateway Interface CGI) or on the client (using Applets or special programming languages such as JAVA or Active X). This latter development represents a major paradigm shift in the way software is written, distributed, and used, and the ever expanding computer communication capabilities will facilitate these innovations even further.

## WWW CONTENT DEVELOPMENT AND WWW HOSTING COMPANIES

The popularity of the World Wide Web has driven the development of another set of Internet companies that provide web site development services and web hosting services.

## WEB SITE DEVELOPMENT COMPANIES

It is fairly straightforward to create a simple HTML document with links to multiple other documents on the same or other computers. Indeed many word processing systems now support an option to save documents in HTML format. However, there is a growing need for the Internet presence of corporate entities and individuals to have a professional look and feel when competitively matched against other Internet web sites.

Many companies now offer WWW design and development services for WWW sites. These services include graphic design of logos, animated graphics and information buttons, as well as the digitization of pictures, audio and video content. WWW developers also write programs using PERL, JAVA, or other languages to provide interactive data exchange between the WWW server and the user.

Web sites can be developed on a variety of platforms and using a number of readily available software tools. Thus there are many small WWW development companies, and the cost for these services varies quite widely.

## WWW HOSTING COMPANIES

Once a WWW site is developed on a local computer, it is necessary to publish the associated WWW document on a WWW server permanently connected to the Internet so that this information is always available to potential users. If the company or individual has access to a permanent connection to the Internet, a WWW server can be installed on one of the computers on this network and the server can be configured to respond to the URL `http://www.yourdomain.com` to provide

access to the newly developed WWW site. Many times, however, it is desired to publish a WWW site without having to maintain a permanent connection to the Internet and the associated computer hardware and software. In this regard there are now WWW hosting companies who will provide virtual WWW hosting or virtual WWW servers for a fee.

Most ISP's for example will allow dial-up users to use a URL of the form `http://www.isp-name.com/~username` to access a user WWW site. In this case the user has a directory—typically `public_html`—under the user's home directory, in which the WWW site files are placed, with the file `index.html` or `index.htm` being the default startup file. This file would then use hyperlinks to call the other files in this directory or appropriate subdirectories or even on another Internet accessible computer. It is also possible to define a URL `www.isp-name.com/yourdomain`, in which case the directory for the WWW site files is specified as the directory `yourdomain` under the root of the WWW server tree.

Internet companies have also been established to provide hosting services for WWW sites such as `username.ispname.com` and for entire domains and WWW sites such as `www.yourdomain.com`. The WWW server would receive the IP address corresponding to the given URLs and would serve documents configured for those IP addresses. In this way the same WWW server can be used to provide virtual WWW service for multiple domains, providing of course that the host computer can respond to multiple IP addresses.

Of course the most desirable URL for a corporate WWW site is `www.yourdomain.com`, since this gives the impression of a formal and permanent entity rather than a shared and perhaps temporary site. WWW hosting companies will register the new domain `yourdomain.com` with a central registration authority such as the InterNIC (21) and will provide a pointer to domain name servers (DNS) for this new domain. All requests destined to hosts such as `www.yourdomain.com` or `mail.yourdomain.com` will be referred to the designated name servers (a primary and secondary server is always specified). The hosting company normally provides the DNS support and simply assigns a single IP address to the address `www.yourdomain.com`. The hosting company also adds entries to the configuration of its WWW server so that the server will respond to requests to the IP address corresponding to `www.yourdomain.com`. A new directory is also defined for the location of the required files for this WWW site with the file `index.html` as the default startup file. The user is able to change the files in this directory using the ftp. Thus the WWW site can be developed by one company and the hosting services can be provided by another. Note also that a registered domain `yourdomain.com` also allows the hosting company to provide not just WWW site hosting but also a Virtual Domain Hosting. This latter service allows the user to receive email as `user@yourdomain.com` using appropriate entries for mail exchange in the DNS for this domain.

While it does take quite an extensive outlay in terms of infrastructure and Internet connectivity to provide Web Hosting and Virtual Domain Hosting services, some hosting companies purchase virtual WWW server space from larger hosting service providers, reselling the access to these robust WWW and DNS servers, without having the task of maintaining hardware, network connectivity, and valuable data. The hosting rates are competitive, and it is quite inexpensive to set up a basic WWW site for a corporate entity or even for an individual.

## COMPANIES SUPPORTING REAL-TIME CONTENT ON THE INTERNET

It is desirable to have the WWW site hosted on a high-speed connection to avoid congestion on slower links as well as to provide bandwidth for multimedia applications such as audio and video. Some WWW hosting companies provide support for streaming real-time multimedia content, and this is very desirable from the perspective of providing input to multiple human senses to get the message across. While it is possible to provide links to sound and image files at any WWW site, in this case the WWW browser will attempt to download the entire file and then to decode the audio or video content using an appropriate helper application. Clearly, if the file is large, then the downloading process could be quite lengthy, especially so for low-speed connections. An alternative is to use streaming technologies now offered by several companies, and this allows the incoming information to be decoded as it is being received, with no need for downloading the entire file first.

RealNetworks (22) has produced a very useful client-server technology (RealMedia) for delivering streaming audio and video via LANs, WANs, and the Internet. The audio and video signals are digitized and encoding using the *RealEncoder* and then sent to a computer running the *RealServer* program. The digitized multimedia information may be stored for later use by clients anywhere on the Internet, or the information may be sent to the RealServer as a “live” stream. In the latter case, when clients request the live stream, they join the transmission at the current “real-time” location of the broadcast, while a connection to archived media always goes to the beginning of the stored information, with the provision for fast forwarding and reverse.

A free version of the *RealServer* can be downloaded from `www.real.com` and is able to support up to 60 simultaneous connections—combinations of input streams or client access. Free versions of the *RealEncoder* and the *RealPlayer* (23) are also available. In live applications the *RealEncoder* accepts a video input via a video capture card and an audio input via a standard multimedia sound card. The analog data are then compressed using the host CPU and sent as a live stream to the *RealServer* as a live stream (`live.rm`). The *RealPlayer* client then connects to the *RealServer* at the location `pnm://server-address/live.rm` to receive the live video stream. Multiple servers can access the same stream simultaneously, thus providing a means for delivering live video and audio content to various location via the Internet. This content can also be made available via the WWW with the *RealPlayer* defined as the helper application for these types of files. In that case the HTML document accessible via the WWW is linked to a file such as `live.ram` with the embedded link `pnm://server-address/live.rm`.

By adjusting the various parameters of the *RealEncoder*, it is possible to obtain a good quality video signal (a frame rate of about 20 frames/s) together with a CD-quality audio signal at an encoding bit rate of about 250 kbit/s. The received quality on the *RealPlayer* under these conditions are also quite good based on subjective observation tests.

Unfortunately, the *RealMedia* system achieves this good quality result by introducing a delay of at least 7 to 10 s so that adjacent video frames can be compared and processed together. While a 10 s delay in a one-way point-to-multipoint video broadcast program may be acceptable, switching be-

tween multiple points of origination, while possibly using multiple origination streams to the *RealServer*, would introduce various multiples of 10 s delays. Thus the *RealMedia* system, while viable for one-way broadcast, would probably be unacceptable for interactive applications. In addition, apart from the audio and video capture cards, the entire process of encoding, broadcasting, and decoding is software based, and this places substantial demands on the host computers.

Despite these drawbacks, the *RealMedia* system is very simple to use, extremely cost-effective to deploy on small or large scale, and very robust in its operation. It is possible to encode a high bit rate stream at about 250 kbit/s which could be sent to the server for access by sites on a high-speed LAN or WAN connection, and a low-data rate stream could also be provided for access via low speed dial-up or Internet connections.

Some other companies which support multimedia video and audio content include ICAST Corporation (24) and Microsoft. Intel Corporation (25) and Vcon Corporation are among the leading companies which provide hardware-based video encoding for transmission over the LANs, WANs and the Internet using the H.323 standard. H.323 products from these companies operate at 64 to 768 kbit/s (hardware and software capable of operating at 1.5 mbit/s is also being tested). Additionally companies offering MPEG (Motion Picture Expert Group) video at a variety of speeds over the Internet are also beginning to emerge.

Another real-time application of great commercial interest is Internet telephony. Several companies now offer software that will work in conjunction with standard sound cards to allow computer users connected to the Internet to dial each other and conduct a conversation in real-time. VocalTec Communications (26) was founded in 1989 and has been a leader in Internet telephony. VocalTec and other companies are now marketing gateways between the Internet and the Public Switched Telephone Network (PSTN) so that PC users with a multimedia computer equipped with speakers and a microphone, can actually make telephone calls (dialed from the keyboard) to a regular phone number. Other companies including Lucent Technologies (27) are beginning to offer complete Internet telephone systems (ITS), in which a caller from a regular telephone makes a local call into an ITS gateway, which then completes a long-distance call over the Internet to another PSTN telephone via another ITS gateway which makes another local call. In this way the long-distance charges are entirely avoided, and thus substantial savings can be achieved. Of course the performance of the Internet telephony in terms of voice quality is predicated on the absence of pathological congestion and network failures along the prescribed Internet path. While ideal conditions cannot be guaranteed, tests suggest that acceptable performance can be obtained on a large number of connections. Entire networks are being deployed to support Internet or IP-based telephony.

Internet-based electronic chat clients and servers are also being developed and marketed by several Internet companies. Several of these are based on the Internet Relay Chat (IRC) Protocol, but others are based on WWW scripting languages and use a common file for storing shared information. Still others require each user to connect to a central Internet server to log their presence and availability so that colleagues who know the user name or handle can contact each other

directly. The purpose of the server is merely to advertise that a particular user is now connected to the Internet and to specify the IP address currently being used by that user. Subsequent connections can then be made with this user by making direct use of the advertised IP address.

## INTERNET SECURITY AND CONSULTING COMPANIES

As more and more companies connect their internal corporate networks to the Internet, the concerns over the issue of security become more significant. The TCP/IP protocol is inherently quite insecure, and many sites have had hackers attack and successfully access sensitive data. Companies that specialize in network and data security have begun to emerge to provide training and consulting services in this area. Many organizations have installed firewalls and proxy servers to limit access to their network and to police all activity across the interface from their network to the rest of the Internet. There is a growing market for Internet consultants to help corporate entities design the best and most secure Internet solution that provides a balance between connectivity driven productivity and network and data security. Secure transactions such as financial funds transfer and credit card payments are now supported using various forms of security protocols and encryption.

## ADVERTISING ON THE INTERNET

While the very presence of a company on the Internet is inherently a form of advertising, it is possible for a company's WWW site to remain hidden from view of the majority of Internet users. Clearly having a domain such as `www.your-well-known-company-name.com` provides an immediate WWW site recognition mechanism. On the other hand, submission of a WWW site to numerous search engines can also enhance the possibility of being found on the Internet as a result of a keyword search. Many WWW site managers have also taken the position that it would be beneficial to pay to have particular WWW sites advertised on WWW pages which are known to be frequently visited. For example, one could place a banner ad with popular search engines so that when keywords you are interested in appear in a search string, your banner ad is displayed with a live link to your WWW site. Clearly an attractive graphical ad with animated images flashing the right keywords will lure visitors to your site in preference to other sites resulting from the given search. Several Internet companies are now specializing in advertising on the Internet, and several popular WWW sites are beginning to sell "real-estate" (screen space) on their WWW sites for banner and columnar advertisements.

## CONCLUSION

It is clear that Internet companies ranging from Internet access providers to multimedia WWW content development, Internet server and client software developers, WWW hosting, Internet security, consulting, and advertising service providers have become well-established corporate entities. These companies all contribute to making the Internet a rich resource of information globally accessible by anyone anywhere and anytime in the new Internet generation.

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