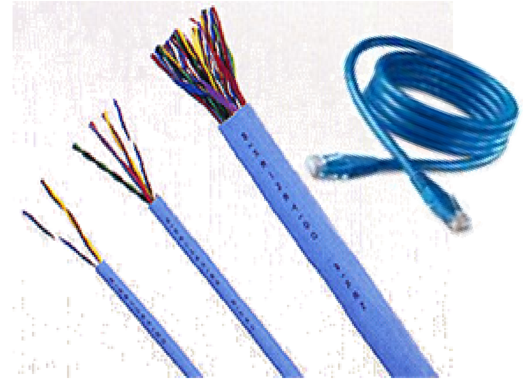
TELEPHONE WIRE AND CABLE

Much of today's Internet traffic travels across the Nation's telephone network infrastructure. This means that for millions of Internet users (particularly home users), access often depends on the same 2-pair copper wiring that still carries many routine telephone calls.

In fact, a dial-up Internet session will likely travel back-and-forth over a wide-variety of transmission media. These could include the older copper wiring still found in many households; high-speed, low-maintenance fiber optic cabling, which connects many U.S. cities; and the 100 megabit per second Category 5 cables that connect many Internet servers.

The terms wire and cable are often used interchangeably today. Historically, a cable was something that contained twelve or more pairs of wires.

CATEGORY 5—CATEGORY 3 CABLE



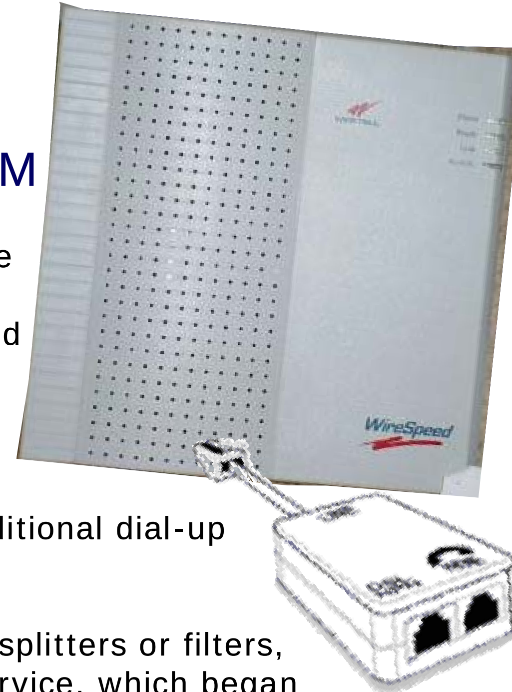
Cat5 and Cat3 are two kinds of wiring typically used inside homes and offices to enable some kind of broadband, high-speed connection to the Internet—whether via cable, satellite, wireless, or DSL.

The difference between these two types of unshielded, twisted-pair (UTP) cables is the number of twists per inch on the wires inside the cable and the throughput speed that will flow over those wires.

Category 5 (Cat5) cabling has three or more twists per inch on each of its four pairs of wires and supports 100 megabit per second throughput over 100 meters. It is recommended for high-speed data networks and broadband access.

Category 3 (Cat3) cabling has fewer twists per inch on each of its four pairs of wires. It supports 10 megabit per second throughput over 100 meters. It is now recommended primarily for phone wiring in new home construction; although, in the 1990s, it was widely used as network cabling.

DIGITAL SUBSCRIBER LINE MODEM



There are several varieties of Digital Subscriber Line (DSL) broadband access — ADSL, HDSL, and SDSL to name just a few. While some of these high-speed access technologies are better suited for home use and others excel in business uses, all of them couple compression techniques and digital modems in such a way that plain telephone lines can achieve download speeds 20 to 100 times faster than a traditional dial-up Internet connection.

DSL can often be implemented, through the use of splitters or filters, without the need for new wiring or cabling. DSL service, which began in the U.S. in 1998, is not available everywhere because DSL generally does not perform well over telephone lines that are more than three miles long.

CABLE MODEM

Canadians were the first North Americans to have broadband cable Internet access in 1996. Cable Internet access utilizes much of the same cabling that was already in place for existing cable television systems.

Those who use a cable modem for Internet access share the cable system's bandwidth with other subscribers in their neighborhood. This means that the speed of each person's cable Internet access can be affected by how many heavy users are on the local cable network at the same time. Cable Internet connection speeds can vary from slower than DSL to three times faster than DSL.

WIRELESS PC CARD MODEM

Wireless Internet access is the newest approach to getting onto the Internet. Although the radio technology that underpins this method of Internet access has been around since WWII, standard, low-cost wireless Internet access has only been available for just a few years.

The advantage of wireless Internet access is that you can link to the Internet as long as your signal and battery hold out. For instance, if you have a wirelessly-enabled, battery-operated laptop, PDA, or PocketPC with you, the FCC's wireless "hot spot" will allow you to connect to the Internet right now.

Explosive growth in the number of wireless access points and the extended distances of new wireless modem standards (802.16, also known as WiMax) make wireless Internet access a technology that appears to have much room for growth in the coming years.

BROADBAND SATELLITE DISH ANTENNA AND MODEM

When satellite broadband access first began in the United States, users had to maintain their dial-up service provider for uploads since the satellite dishes could be used just for downloads from the Internet. Today, broadband satellite users with updated dish antennas can receive both uploads and downloads.

As with receiving television programming via satellite, users must have a clear line of sight to the southern sky to successfully receive Internet signals.

Currently, broadband satellite reception comes via the Ku-Band satellite spectrum, and provides both download and upload speeds roughly equivalent to cable broadband. Higher-frequency and faster services using the Ka-Band are in testing.

ACOUSTIC COUPLER MODEM

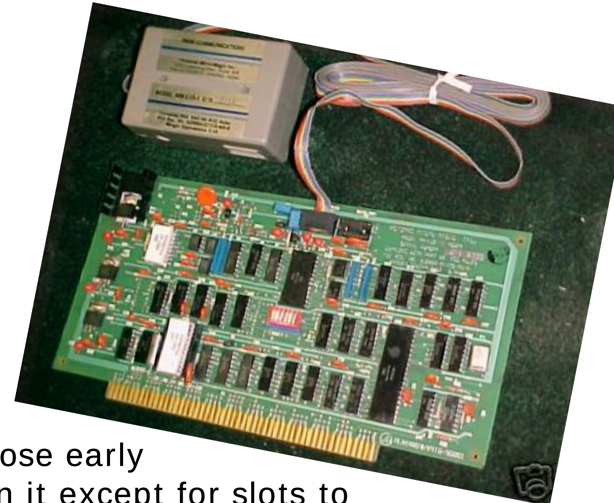
Prior to the 1980's advent of individual personal computers with dial-up modems capable of making direct electrical connections over conventional telephone lines, modems were joined to acoustic couplers that enabled telephone handsets to be used to transmit data.

To make this communication handoff work, the telephone handset was tightly strapped to the acoustic coupler. Then, the number to access the remote computer was dialed on the telephone set.

Because acoustic coupler modems sent data through a regular phone's handset, they were limited to a top speed of 1200 bits per second. Plus, since the phone's handset heard all sounds, there was the possibility for lots of interference if the coupler and phone handset weren't tightly coupled.

Switches on top of this model are for: 1) Originate/Answer; 2) Full/Half Duplex; and 3) Power.

INTERNAL S100 MODEM



This modem and adapter come from the 1970s to mid-1980s era when many hobbyists were building their own Altair, Heath Zenith, or IMSAI computers based upon designs found in magazines like *Popular Electronics*. The motherboard (now usually called a mainboard) of those early S100 computers did not have much soldered on it except for slots to insert daughterboards like this.

This daughterboard is a rare Potomac Micro-Magic direct coupled modem and communications adapter made in 1980. Its manual says it can support baud rates from 61 to 600 baud. But, unless its owner had a crystal clear phone connection, it probably actually worked at between 100 and 300 bits per minute.

EXTERNAL 2400-BAUD MODEM

Dennis Hayes is credited with inventing the personal computer modem in 1977. Modems for mainframe computers existed prior to that time, as had communication technologies like acoustic couplers, but making an affordable modem for use by the personal computer hobbyist (that's what PC users were considered until the late 1980s) is often considered to be one of the significant steps that led to the Internet we know today.

The first PC modems were boards for S100 computers. These were followed by modems for Apple II computers.

Hayes' major breakthrough was solving the problem of how to allow a computer to control the modem with software. His solution was the Hayes Standard AT command set. This modem—the Hayes 2400 Smart-Modem—was the model used to commercially introduce this standard command set in 1981.

COMMODORE 64 COMPUTER

First sold in 1982 for $595, this remains one of the best selling computers of all times (about 22 million units sold). After a rough first year, improvements were made to the computer's manufacturing processes and the price was dropped to $200 in 1983.

One reason for the low price was the lack of a monitor. Although the computer allowed for color graphics, whether or not the image was in color depended on the owner's television set, since that was what was used for the monitor. The black box shown in the picture allowed you to switch between television and computer.

One option for this early computer, with its 64 kilobytes of memory and integrated sound, was a 300-baud modem.

OSBORNE PERSONAL COMPUTER

Designed by Lee Felsenstein, and named in honor of microcomputer pioneer Adam Osborne, this 1981 computer is considered the first truly portable computer. Although it had to be plugged in, it was considered portable because it was small enough to fit under a plane's seat. However, since the computer weighed 24 pounds, some users called it a "luggable," rather than portable, computer.

The computer has a 5" screen that can display only 52 characters across (less than a line of text on this card). It originally sold for $1,795.00 and included two floppy disk drives. Optionally, a modem could be added under the floppy drive on the left (as illustrated above). With the modem came COMM-PAC software, which gave the user 300 baud "access to more than 200 electronic bulletin boards across the country."

AUDREY—AN EARLY INTERNET APPLIANCE

In 1997, research from Jupiter Communications predicted that by the year 2000 sixteen percent of Internet access would come from non-personal computer technologies.

Internet appliances, such as Web TV©, the iOpener©, and this Audrey© began appearing in 1999.

The Audrey©, sold in 2000-2001, cost $499, had a 7.75 inch touch screen, 32 megabytes of memory, a 200 MHz central processing unit, and a built-in 56K modem. It allowed its owner to check email, synchronize personal and business calendars, make to-do lists, and keep track of the family budget.

Visions of connecting and remotely accessing all household appliances via the Internet — from air conditioners, to refrigerators, to outdoor sprinklers — remain strong today.

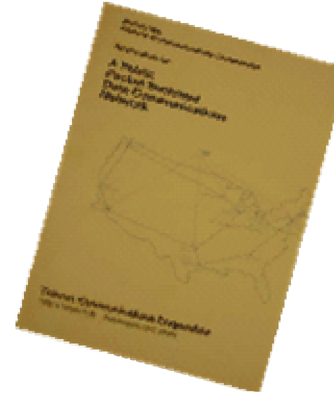
MODERN LAPTOP

There is not consensus on when the first laptop computer was introduced. But, most histories mention the 1979 Grid Compass, used by NASA astronauts on space flights, as one of the first laptop computers. The 1983 Gavilan is also often noted as the first fully functional laptop.

Regardless of who created the first laptop, today's laptop is typically a machine pre-equipped for communication. Standard parts of a modern laptop are a modem and RJ-11 telephone jack, a RJ-45 connector for wired networking, and internal wireless connections for Bluetooth, infrared, or WiFi.

Modern laptops are one of the clearest indicators of the inextricable intertwining of computing and communication in today's world.

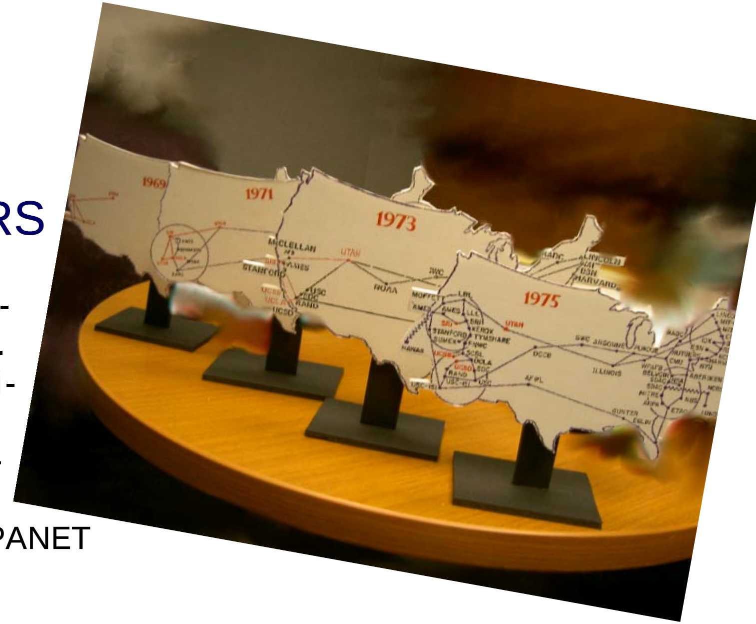
FCC: EARLY INVOLVEMENT WITH THE INTERNET



The FCC became involved with the interdependence of computer and communication services and facilities in 1966 when it began a series of Computer Inquiries. These proceedings established a distinction between regulated telecommunications services and non-regulated information services.

The philosophy of encouraging competition that underpins this distinction is credited with encouraging Bolt Beranek and Newman, the primary contractor for the ARPANET, to form Telenet Communications Corporation in late 1972.

In October 1973, Telenet filed this request with the FCC to become a carrier and to construct a public packet switched network. The request was approved in 1974, and Telenet began commercial operation as a public packet data service in August 1975. Their first customer was the Scientific Time Sharing Corporation, then located in Bethesda MD. A few years later Telenet received FCC approval to interconnect with British Telecom's packet switched service, making Telenet the first new international carrier—of any kind—to be licensed by the FCC since the agency was created in 1934. Telenet's network legacy lives on today in Sprint's SprintLink Internet service.



ARPANET'S EARLY YEARS

The ARPANET, predecessor to the Internet, grew quickly in its formative years. Starting with four nodes in 1969, at universities in California and Utah, it had 61 nodes in 1975. Government laboratories, military facilities, and think tanks joined the universities as the ARPANET grew.

In 1986 a new network, the NSFnet, started to link supercomputers on higher-speed circuits since the ARPANET was already considered too slow. Over time the NSFnet grew as other universities joined that network. In 1990, when ARPANET shut down, the civilian ARPANET traffic shifted onto the NSFnet. In 1991 the NSF then opened the NSFnet to commercial traffic.

ONLINE SERVICES

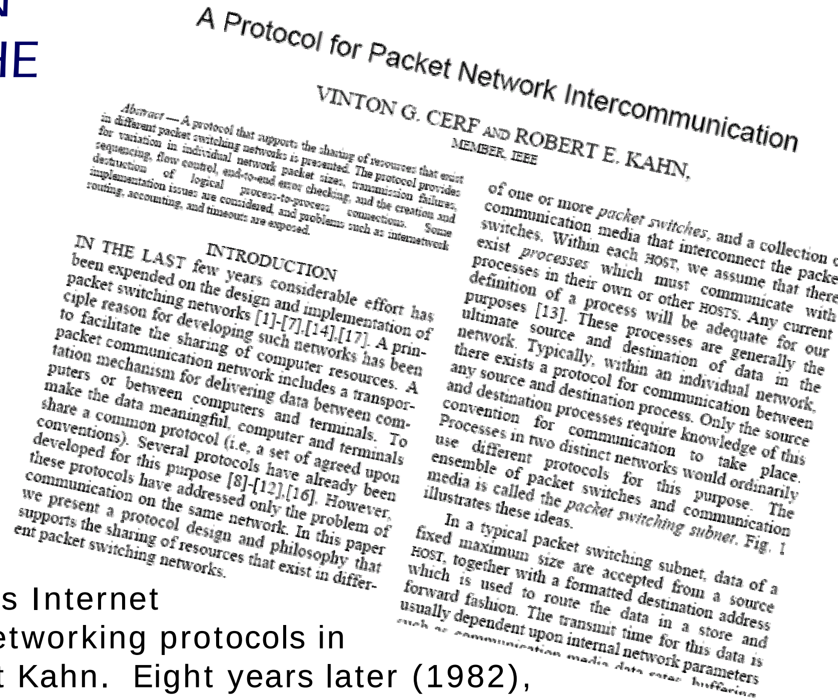
CompuServe, considered by some to be the first online service, opened its doors in 1969 to provide computer time-sharing services.

In 1979, CompuServe offered electronic mail and technical support to personal computer users. In 1980 it began offering real-time chat. In 1995, it provided web access to its users.

By coupling these innovative services with the most extensive network of dial-up numbers in the United States, CompuServe came to be the largest (about 3 million subscribers) and one of the best known online service providers in the early 1990s. But, when competitor AOL started offering flat-rate, unlimited-use pricing in 1996, CompuServe—with its per hour connect rates—was seriously disadvantaged. This eventually led to AOL acquiring CompuServe in 1997.

MAKING THE TRANSITION FROM THE ARPANET TO THE INTERNET

While the ARPANET provided an important learning ground for the Internet, the Internet we know today had to be created and developed on its own terms. Simply put, the difference between the ARPANET and the Internet is the difference between creating one national network versus linking multiple, world-wide networks.



A Protocol for Packet Network Intercommunication

VINTON G. CERF AND ROBERT E. KAHN, MEMBER, IEEE

Abstract—A protocol that supports the sharing of resources that exist in different packet switching networks is presented. The protocol provides for variation in individual network packet sizes, transmission failures, sequencing, flow control, end-to-end error checking, and the creation and destruction of logical process-to-process connections. Some implementation issues are considered, and problems such as internetwork routing, accounting, and timeouts are exposed.

INTRODUCTION

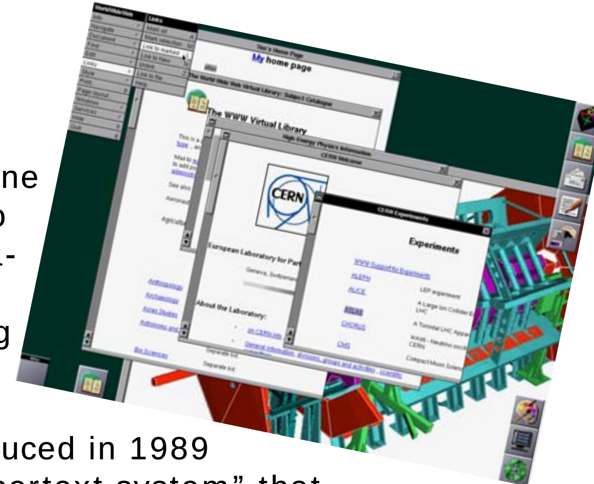
IN THE LAST few years considerable effort has been expended on the design and implementation of packet switching networks [1]-[7],[14],[17]. A principle reason for developing such networks has been to facilitate the sharing of computer resources. A packet communication network includes a transportation mechanism for delivering data between computers or between computers and terminals. To make the data meaningful, computer and terminals share a common protocol (i.e, a set of agreed upon conventions). Several protocols have already been developed for this purpose [8]-[12],[16]. However, these protocols have addressed only the problem of communication on the same network. In this paper we present a protocol design and philosophy that supports the sharing of resources that exist in different packet switching networks.

of one or more *packet switches*, and a collection of communication media that interconnect the packet switches. Within each HOST, we assume that there exist *processes* which must communicate with processes in their own or other HOSTS. Any current definition of a process will be adequate for our purposes [13]. These processes are generally the ultimate source and destination of data in the network. Typically, within an individual network, there exists a protocol for communication between any source and destination process. Only the source and destination processes require knowledge of this convention for communication to take place. Processes in two distinct networks would ordinarily use different protocols for this purpose. The ensemble of packet switches and communication media is called the *packet switching subnet*. Fig. 1 illustrates these ideas.

In a typical packet switching subnet, data of a fixed maximum size are accepted from a source HOST, together with a formatted destination address which is used to route the data in a store and forward fashion. The transmit time for this data is usually dependent upon internal network parameters

One of the seminal engineering contributions to the development of today's Internet was the introduction of the TCP/IP inter-networking protocols in this 1974 article by Vinton Cerf and Robert Kahn. Eight years later (1982), the ARPANET transitioned from its original NCP protocol to the use of the TCP/IP inter-networking protocols. In 1991, the NSF formally decommissioned the ARPANET, lifted all restrictions on commercial use of their network backbone, and today's Internet was begun.

FIRST INTERNET WEB PAGES



Accessing information on the World Wide Web is one of the most popular uses of the Internet today—so much so that many people equate this one application with the Internet itself. But that has not always been the case. In March 1993, the emerging "Web" accounted for only 0.1% of Internet traffic.

The idea for the graphically-based Web was introduced in 1989 by Tim Berners-Lee. Berners-Lee proposed a "hypertext system" that would easily allow for the sharing of information between researchers in the High Energy Physics community. In 1993, the NCSA Mosaic browser was introduced and by September 1993, Web use constituted 1.0% of Internet traffic.

In 1994, Netscape Communications was established and Web traffic skyrocketed. In 1995, Web traffic became the largest volume Internet protocol.

This image shows a screenshot of Berners-Lee's first web pages from 1990.

INTERNET TELEPHONY

Voice Over IP technology (VoIP) makes it possible to conduct a local or long-distance phone conversation over the packet-switching networks that make up the Internet, including connecting calls to the traditional telephone network.

There are many different kinds of Internet telephony. Some require computers or specialized equipment, while others can be used with a traditional telephone. For all kinds, however, voice signals are converted into packets that travel over the Internet or a private IP network to their final destination where the packets are reassembled and the message delivered.