The Internet's History and Development

From Wartime Tool to the Fish-Cam

by Scott Ruthfield

It was 1964, the height of the Cold War, and Americans spent their free time building bomb shelters and stockpiling canned food in preparation for the impending nuclear attack. The government, however, had a more pervasive problem. If war did come, how would the military be able to communicate? A centralized system might easily be destroyed in wartime, and so traditional technologies wouldn't work. This fear impressed a need on the government to do something different -- to develop a whole new scheme for post-nuclear communication.

Today, a descendant of that Cold War mechanism is used to track seismological phenomena, transmit pressing news bulletins, and send email to mom. Does this signal a complete shift in priorities? In part, yes; more appropriately though, it is an example of a technology with more uses than anybody ever imagined.

The Internet we use today is one of the few positive legacies of Cold War paranoia, providing efficient and inexpensive communications between people around the world. As the Iraqis proved during the Gulf War, commercially available Internet technologies were indeed resistant to enemy fire. But as ``Information Superhighway'' becomes the most over-used phrase of the 1990s, mass numbers of people are signing up and trying to become part of the Internet community. By understanding the motives, methods, and technologies behind the Internet's development, we can get a sense of the power and importance of this project gone happily amok.

Research Beginnings

The roots of today's Internet come from the Advanced Research Projects Agency (ARPA). Instead of performing its own research, ARPA (a branch of the Department of Defense), which became DARPA in 1972, regularly funded research projects related to technological development or military problems. In the 1960s, ARPA became interested in developing a way for computers to communicate with each other and began to fund programs at universities and corporations, including MIT and RAND. A network would both advance American technological development and provide a secure command and control over information during wartime. To this end, in the mid-1960s, ARPA began to support research into building an effective network.

On January 2, 1969, designers began working on an experiment to determine whether computers at

different universities could communicate with each other without a central system. The corporation Bolt, Baranek and Newman had been awarded the contract to develop the Interface Message Processor (IMP), the basis of the new communications system. IMPs were small machines which were part of each host and were dedicated to forming the network between computers [1]. IMPs would use a technology called packet-switching, which split large sections of data into small parts called packets, each labeled with its destination address. Packets could be sent in any order and through different routes which all led to the same destination [2]. Upon arrival at the destination computer, the packets could be reassembled. (While the term has died out, IMPs form the backbone of packet-switching networks today.)

IMP's and Packet-Switching

In September of 1969, BBN shipped its first IMP to UCLA, which had spent the previous few months furiously trying to develop a hardware and software interface. With crossed fingers, they plugged in the processor and ran the program; it worked perfectly. Soon after, Stanford, UCLA, UC-Santa Barbara, and the University of Utah performed the first packet-switching experiment, and a network was looking like more of a reality [3].

The advantage of the packet-switching system was very clear. Under a traditional central system, all information had to be chanelled through one source, processed, and sent off somewhere else. Packet-switching, though, allowed for another method; information could first be sent to one place, and if that site was not working or processing too slowly, could be routed, on-the-fly, somewhere else. This concept, called dynamic re-routing, would allow all hosts to be ``equal." With every computer having the same routing abilities, an enemy would have to destroy nearly all computers on the network to be sure that communication lines were dead.

While these developments were looking quite positive, the designers soon ran into trouble. The original systems only supported client-server applications like telnet and FTP, and couldn't handle host-host relationships [1]. This limit would impair the functionality of the network. A new protocol to take care of this went into development soon afterwards; called Network Control Protocol (NCP), it became the primary concept behind networking. Armed with these tools, researchers were ready to unveil their creation: ARPAnet.

Bonjour, ARPANet!

ARPAnet made its first public appearance flashily, as the star of Washington D.C.'s International Conference on Computers and Communications (now International Conference on Computer Communication) in 1972. Arranging for an ARPAnet IMP to be on-site, head researchers demonstrated the abilities of the network. Terminals set up at over 40 locations were able to locate the IMP and other processors. More than 1000 people witnessed a new technological revolution, as remote access to files became possible [1]. What had once only been research was now being taken seriously by vendors and

manufacturers. After the unveiling, technologies to help develop the network began to sprout. By 1973, a satellite link to Hawaii was running; by the end of the year, more distant hosts were connected over telephone lines.

While the technology was growing quickly, the number of terminals hooked up to ARPAnet was still moving slowly. Between 1969 and early 1977, ARPAnet only added 107 hosts. (In contrast, more than one million hosts were added to the Internet between January and August 1994) [4]. Even so, engineers at DARPA and RAND recognized that this new communications network was going to grow into something far larger than they had ever imagined, and needed to develop a design suitable for a large network.

TCP/IP Development

Knowing that NCP was not ready for a mass influx of hosts, researchers at DARPA began working on a new protocol which would be able to handle larger numbers of users, and Transmission Control Protocol/ Internet Protocol (TCP/IP) was born in the mid-1970s. This more sophisticated technology was accepted by the U.S. government in 1978, and TCP/IP became the preferred networking tool. Many people view January 1, 1983, when all of ARPAnet was switched over from NCP to TCP, as the ``official'' beginning of the Internet [3].

During 1983, to provide operational separation, the military broke off from ARPAnet and formed MILnet. The Department of Defense continued to run and fund both networks. Further, more networks were popping up; educational and commercial organizations that didn't fall into ARPA's original charter wanted to use the same packet-switching technologies.

In the early 1980s, two large networks sprang up: CSnet (Computer Science Network), for members of the computer science academic and industrial community, and BITNET (Because It's Time Network), for the general academic community. Other small networks, like ones for space scientists and high-energy physicists grew for specific needs [5]. (The latter also helped develop the foundation of the World Wide Web in 1989.) While these networks existed separately from ARPAnet, there was a need for interconnection between all of them. In 1983, CSnet and ARPAnet negotiated an agreement which allowed members of the two networks to exchange electronic mail. Further agreements followed, and the networks began building gateways between one another.

NSFNet: More Power, More Speed

For several years, the myriad networks were effective; organizations were able to complete their work and communicate without trouble. However, by mid-1985, more resource-intensive programs became widespread, and even the most advanced networks could not keep up with the demand. At the same time, the National Science Foundation's Office for Advanced Scientific Computing became interested in high-speed computing. A combination of technological advancements and the availability of funds led

the NSF to encourage the use of supercomputers in networking, and begin funding the construction of its own network (NSFnet).

The planners envisioned a three-tiered system. Instead of user organizations (like universities and manufacturers) connecting directly to the backbone of five top supercomputers, they developed a mid-level tier, where regional networks would connect the two levels together[2]. Starting in 1987, the NSF funded research organizations at IBM, MCI, and the Merit Computer Network. Originally, the NSF wanted to incorporate its network into ARPAnet, but a number of political and technical difficulties caused it to build its own network.

The original supercomputer centers turned out to be unsuccessful; few of them worked, and still fewer were cost-efficient enough to maintain. The NSF kept up its network, though, adding more than a dozen backbones and more large regional networks. By 1989, ARPAnet had been co-opted; it folded, having provided the impetus for technologies that far exceeded its capabilities.

Today's Internet Maintenance

From 1989 until 1995, there were few changes in the structure, but a mass explosion of interest. The number of hosts more than doubled in two years, and national magazines ran a number of cover stories about ``cyberspace.'' On April 30, 1995, the government and the organizations that built this system from scratch, released it; NSFnet was turned off, and Internet traffic was handed over to commercial networks. While the NSF is still funding research and setting guidelines for network providers, new infrastructure will be built and maintained by offsprings of telephone companies (like MCI and Sprint) and other organizations.

Global Networking and Future Ideas

While the United States still leads the world in Internet-based technologies, other nations have developed similar networks, which connect through gateways. The Coordinating Committee for Intercontinental Research Networks (CCIRN) has led the way in bringing the world into internetworking [5].

New ideas continue to pop up. For example, when he was a Tennessee Senator, Vice President Albert Gore proposed the National Research and Education Network, which (building off of NSFnet) would provide top computing facilities to research communities and schools. This program went into development in 1991 and continues today. While many people are frightened by the prospect of the government having a larger role in Internet policy (even as it divests itself from hardware), others are pleased that the ``information-poor'' may be given a chance to become part of this expanding world [2], [3].

Scientists developing networking technology in the 1960's knew that what they were building would be far bigger than themselves; nobody, however, could have predicted the explosion in Internet access and interest in the past several years. The original designers didn't even think email would be something people would want! Commercial networks, students, and even Internet cafes are scrambling to sign up and be part of a technological revolution. It is important for us to remember that the real revolution took place two decades ago -- today's technology just rides on the wave of yesteryear.

References

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For Further Reading:

Most mass-produced books about the Internet include a section on history and development. These are, of course, of varying quality (and information). Virtually any text will give you a basic understanding of the history, but several books stand out. The *Internet System Handbook* has an excellent technical description of product development and a lot of first-hand information. Both *The Internet Guide for New Users* and *The Internet for Everyone* have shorter and better-organized discussions, though the former is somewhat simplistic.

There are also a number of on-line documents that discuss history. A column from Bruce Sterling, originally published in The Magazine of Fantasy and Science Fiction in 1993, and found at gopher://

gopher.isoc.org:70/00/internet/history/short.history.of.internet provided the impetus for this article; it is well-written, interesting, and suitably provocative. Ronda and Michael Hauben (at University of Michigan and Columbia University respectively) have developed an on-line manual (http://www.cs.columbia.edu/~hauben/n etbook) with some history and an excellent set of references.

There are a number of first-hand accounts -- from the developers in the 1960's and 1970's -- that can be found with a bit of searching. Still, the primary source for Internet history has to be the Internet Request for Comments. Anything you need (or want) to know can be found here.