On the Way to the Web: The Secret History of the Internet and Its Founders

ISBN-13 (pbk): 978-1-4302-0869-3

ISBN-13 (electronic): 978-1-4302-0870-9

Printed and bound in the United States of America 9 8 7 6 5 4 3 2 1

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Distributed to the book trade worldwide by Springer-Verlag New York, Inc., 233 Spring Street, 6th Floor, New York, NY 10013. Phone 1-800-SPRINGER, fax 201-348-4505, e-mail `orders-ny@springer-sbm.com`, or visit `http://www.springeronline.com`.

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CHAPTER

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In the Money

. . . we were going to be able to share all the knowledge of the world between all the computers.

—Larry Roberts, ARPANET and Telenet founder

Computers were not originally a mass-market product. They were more like airplanes, in that their cost and complexity ensured that the market wouldn't be huge. With computers, as with aircraft, the first profitable enterprise was producing machines for sale or lease. But other opportunities would be developed by those who could figure out the right angles.

As it happened, it was possible to turn the very factors that limited the market for computers—cost and complexity—into opportunities.[1] Most businesses could not afford to own or lease a computer, so IBM and other manufacturers began offering technical computing services to business and industry. They sold access to computers and to their employees' expertise. These services, which cost hundreds of dollars per hour, required clients to hand off their data processing jobs to the computer companies, which usually delivered results in the form of large printouts several days later.

Early computer service bureau customers had to adapt their schedules to the machine's work schedule because computing jobs were processed one at a time (called "batch computing"). In 1957, a researcher named John McCarthy, inventor of the LISP programming language, built the first time-sharing system.

The basis for time-sharing was the fact that a computer spent much of its time waiting for user input or responses from printers or other hardware. McCarthy devised a way for a computer to work on other jobs during these

[1] *Interestingly, the same thing happened with radio, but in a different way. In 1921, Powel Crosley Jr., on observing that early radio receivers were overpriced and overly complex, determined that he would manufacture simple, low-cost radio sets that anyone could afford, and thereby touched off the broadcast industry.*

waiting periods, thus eliminating the waste of significant amounts of computing power and time. Computer operations were so fast, even then, that any delays caused by time-sharing were not perceptible to humans.

Commercial time-sharing computers made their debut in the early 1960s, and soon became the standard model for computer service bureaus.

Mainframe computer owners were soon copying the manufacturers, selling computer time to organizations that could not afford to own their own systems. Selling time helped amortize the investment, and business was so good that it often paid for the computer. By the mid-1960s, time-sharing had grown into a billion-dollar business—big enough that companies were developed to buy mainframe computers for the sole purpose of selling computer time and services.

Some time-sharing clients needed more than occasional access to computers, though still not enough to justify buying one. Time-sharing services accommodated the heavier users by setting up remote connections to their computers. Teletypes, or more modern terminals with a video display (then called CRTs, or Cathode Ray Tubes), connected with modems (again, available since the 1950s) and telephone lines, allowed customers to operate the remote computer from their site.

Of course, time-sharing clients paid to lease or buy the terminal equipment. And this wasn't the only "extra" income for time-sharing companies. If a client did not have its own system operators and programmers, the time-sharing operation provided them, at a charge. There were also charges for storing data, and for special "conditioned" leased telephone lines to keep a direct link between the terminal and the computer open.

Software development was yet another source of income. Time-sharing companies charged to develop the software, and to maintain and update it. And the more astute time-sharing services recognized that money could be made from their customers' own programs. If a simulation program developed by a client was particularly effective, the time-sharing company might offer it to other clients to use, with a royalty or license fee paid to the client/developer.

The First Online Content

During the 1960s, a new role developed for companies that owned computers. No matter what their primary business, they could put their computer expertise to work for other computer owners. Some organizations that owned computers (as opposed to depending on time-sharing operations for computing tasks) found managing computer systems outside their areas of expertise and interest. Rather than hire trained engineers and programmers, they hired companies like the Lockheed Corporation, Bunker Ramo Corporation, General Electric, and System Development Corporation (the same SDC that participated in the first ARPA computer communications experiment) to manage their computer operations.

Several of these relationships involved the development of databases and remote computer access. In 1966, for example, Lockheed, the aerospace company, received a contract to help compile and manage NASA's Scientific and Technical Aerospace Reports (STAR) database. STAR was a project that NASA had started in 1962, to create hard-copy abstracts and indexes of technical journals that were of interest to the agency.

Lockheed had for several years been developing a data-retrieval system it called Dialog, which gave it the expertise needed for the project and the tools to manage it.[2]

Bunker Ramo was given the contract to provide remote access to the database. Both of these companies would find the experience gained valuable in creating publicly accessible online databases over the next few years.

Bunker Ramo also put together NASA's RECON (short for REmote CONsole information retrieval system), another bibliographic database. RECON is notable for being the first multisite bibliographic retrieval system. It was also the first online search system with the capability of ordering source documents, a standard feature on Dialog and other commercial information retrieval systems today.

Bunker Ramo withdrew from the contract after a two-month trial period, and Lockheed took over. In both contracts, Lockheed retained ownership of the software, a wise move, considering future developments. In effect, the software development was underwritten by NASA.

Concurrent with these developments, SDC was developing information retrieval systems for the U.S. Air Force and the U.S. Office of Education (USOE, predecessor to the U.S. Department of Education). The USOE project was called ERIC (for Education Resources Information Center).[3] Lockheed was given the contract to provide leased-line terminal access to ERIC.

Other database management contracts with various government agencies followed, among them the Nuclear Science Abstracts (NSA) Database and the National Library of Medicine's (NLM) MEDLARS (Medical Literature Analysis and Retrieval System) index of over 2,000 medical journals. (Although MEDLARS was developed by General Electric for NLM, SDC had a contract to back up the database.)

By the end of the 1960s, Lockheed and other organizations had accumulated extensive expertise in developing, managing, searching, and providing remote access to large computer databases. Here again, software development, the building of databases, and the experience gained were underwritten by various U.S. government agencies.

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[2] *Dialog remains in business, on the Web at* `http://www.dialog.com`.

[3] *ERIC was and remains a program of access to bibliographic records of journal articles and other educational resource material. Today it is available on the Web at* `http://www.eric.ed.gov`.

None of these databases were open to the public at large. Each government agency limited access to its employees or a group of fee-paying institutional users—mostly other government entities, libraries, and universities.

In the eyes of the computer contractors, commercializing the databases—offering public access for a fee—was the natural next step. It went almost without saying that elements of business and industry, as well as the libraries and institutions that weren't a part of the original user base for remote database access, would be more than willing to pay to use the vast data repositories that had been developed. Even some individuals would find the information products attractive. It is likely that each contractor had thoughts of offering the databases to the public from the beginning.

The expected conflicts with data owners over making the databases available to the public arose, but in the end both Lockheed and SDC succeeded in going commercial. Royalties were paid to the agencies that owned the databases' content. But the new information retrieval services costs of systems hardware, software, data management techniques, and database content were essentially paid for by government agencies.

Lockheed put Dialog online as a commercial service in 1971. It offered three databases: the NASA RECON database, ERIC, and Nuclear Science Abstracts.

Close on the heels of Dialog, SDC put MEDLARS online as MEDLINE, then went live with a new program called ORBIT (necessary because SDC did not retain ownership to the software it developed as a contractor). ORBIT (Online Bibliographic Retrieval of Information Time-Shared) offered not only the NLM database but also its backup of ERIC, Pandex (a general science abstracts database), and Chemical Abstracts Condensates.[4]

Bunker Ramo took a different approach to commercializing institutional computer development; it went straight to the private sector. Already well versed in automating financial systems, Bunker Ramo began developing the NASDAQ system in 1969 and had it online in 1971. That same year, a partnership between Bunker Ramo and Dow Jones called the Dow Jones–Bunker Ramo News Retrieval Service went online. (This became the Dow Jones News/Retrieval Service, or DJNS, in 1979.) The service provided recent news and other information published by Dow Jones News Service, *The Wall Street Journal*, and *Barron's*.

A few years later Bunker Ramo was responsible for installing the world's largest online bank teller terminal system, interconnecting over 1,000 branches of the Bank of America. The company's ventures into public online information services diminished after that, and it eventually became part of ADP (Automatic Data Processing, Inc.).

Dialog and SDC ORBIT continued adding new databases and customers. As they grew, competitors such as Bibliographic Retrieval Services (BRS) went

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[4] *Orbit is now Questel, at* `http://www.questel.orbit.com`.

online, at times offering some of the same databases. Other commercial information providers, Data Central's LEXIS among them, provided proprietary databases that no one else could offer.

The online information retrieval business was off to a flying start, sowing the seeds of the Internet.

The First Information Superhighway

When SDC, Dialog, and others began putting content online, there were no commercial packet-switching networks like we have today. The connect charges for dialup or leased-line phone access were a source of concern, as users' telephone bills often exceeded charges for computer access.

It was enough of an issue that in 1970 NLM experimented with Teletype access for MEDLINE via AT&T's TWX (TeletypeWriter eXchange) network. A descendent of the nineteenth-century telegraph system, TWX cost less than telephone access, but was slow and cumbersome, operating with speeds as low as six characters per second. (Modem/telephone line connections were 50 times faster.)

Teletype proved to be grossly inadequate, but a better solution was coming from the time-sharing industry. By this time, time-sharing operations had developed various methods to ensure reliable telephone data hookups for their clients. Tymshare, founded in 1966, had in 1968 developed a "circuit-switched" network to carry traffic for its time-sharing clients. This differed from packet switching in that data was sent in a continuous stream, like water through a pipe. The network wasn't the best, but the large-scale use of leased lines meant an economy of scale that greatly reduced data transmission costs.

In 1972 (1973 by some accounts), Tymshare initiated plans to make its network (now called Tymnet) publicly available. This was made possible by a new Federal Communications Commission (FCC) directive that allowed the company to link computers in the manner of an Internet service provider (ISP), as opposed to becoming a regulated data carrier. Tymnet's first customer was MEDLINE/SDC. The charge for Tymnet access was a mere $6 per hour, as compared with $27 per hour for direct-dial phone service. The service offered local telephone numbers in 40 cities. Dialog signed on soon after.

Larry Roberts was still running the IPTO at ARPANET at this time. But it was no longer ARPANET; its name had been changed to DARPANET, the "D" denoting "Defense." Roberts decided that the time had come for packet-switching technology to be developed commercially. He approached AT&T about running DARPANET and taking over development of the technology, but the communications giant felt that a packet-switching network was, as Roberts put it, "incompatible with their future."

Having missed this golden opportunity, AT&T tried several times over the next couple of decades to create their own data network, but failed, according to Roberts, because the company would not put managers who had the

appropriate technical knowledge in charge. (AT&T would eventually buy an existing network and develop it.)

In trying to get DARPANET's technology commercialized, Roberts' mission was to get the technology to the public as soon as possible—his goal from the beginning of the ARPANET project. He knew the demand for computer communications and networking would increase, and that packet switching was the best possible way to meet the demand.

Roberts' vision was a network far larger than most people could imagine—but nowhere near what the Internet became. Some 35 years later, Roberts said of taking the network public: "I thought it would become a worldwide activity that would be very important because my thinking was that we were going to be able to share all the knowledge of the world between all the computers. I didn't envision that everybody would have their own computer, that there would be millions of computers. We thought there would be thousands."

After AT&T turned down the offer to commercialize DARPANET, an FCC official suggested that Roberts set up a packet-switching network as a regulated communications carrier. Among other benefits, this would help control leased-line costs and protect the company against loss claims in case of service outages. Creating such a service had only recently become possible, thanks to the telephone system going competitive and the establishment of companies like MCI.

Roberts took the idea to BBN, which was still DARPANET's contractor. BBN concurred with Roberts, and made the decision to invest in the commercial packet-switching network. Roberts was asked to be president, but could not go to work right away because he had to choose his successor at IPTO. BBN moved ahead with organizing the company, called Telenet, and hired people to work on filing the tariff with the FCC.

By the end of 1974 Telenet was a going concern, under Roberts' leadership. It was up and running as the world's first commercial packet-switched network (PSN) in 1975. (As noted, Tymnet used circuit switching, and other packet-based systems inspired by DARPANET were experimental.)

Telenet not only provided PSN services, but also manufactured switches and other equipment. Before long, a large number of organizations were setting up their own networks using Telenet technology and equipment, among them Southern Bell. Telenet was easily able to interconnect with these networks, which only increased the company's rapid rate of growth. Its customer base went far beyond time-sharing companies, and included corporations like General Motors, government agencies, and just about any other organization that needed computer communications links. International links with British Telecom (BT) and other communications companies were not far away.

Telenet's nationwide system of switches, routers, and leased lines provided a low-cost, high-speed data communications service that was more reliable than simple leased lines and direct dial—and certainly more reliable than Tymnet. Equally important, Telenet created a way to connect computers to the network without a specialized hardware interface like ARPA's IMP.

Taken together, Telenet and Tymnet constituted the world's first "Information Superhighway," particularly in the sense that they were open to the public. The local-number access these networks provided eliminated what might have been a significant psychological barrier to many online database customers: the per-minute charges of conventional long-distance telephone calls. For the same reason, Telenet and Tymnet would be vital to the consumer online services yet to come.

DARPANET had not remained static through all this. In 1972 Ray Tomlinson at BBN developed a program to send small mail messages to users on Digital Equipment Corporation (DEC) PDP-10 computers, and another program that enabled the recipients to read the "electronic mail." With a small hack, he was able to send mail to users on another machine, and decided to try sending mail across the network. He worked out a means of using the file transfer protocol then being developed for DARPANET.

The mail had to be directed not only to the desired recipient, but also a specific computer on the network. This required formatting the address in two separate parts: the user's name and the name of the machine the user was on. A character would be required to separate the user name from the machine name. Tomlinson chose the @ character. It was not likely to appear in a user's name, and it had the advantage of saying "at."

DARPANET users were still left with two separate systems for sending and reading mail. There was no way to reply to a message; to respond to the sender, one had to use the sending program to create a new message. Email wasn't sorted, and was stored in one big file. Some users had to print out all of their email to get at a message.

In 1973 Roberts solved these problems with the first email-handling system. He wrote code that gave users a menu of messages, and allowed them to reply to, delete, or file messages. With 75 percent of DARPANET traffic consisting of email, it was a welcome program.

It was natural that the email concept would carry over to commercial networks, just as other DARPANET elements. Telenet developed Telemail. Some of the information retrieval services made internal email available. Time-sharing services, among them Dialcom and CompuServe, also offered email services to clients. By the late 1970s private email systems connected corporate and government offices across the United States and in many other countries.

As these developments unfolded, DARPANET's developers, among them Vint Cerf and Bob Kahn, began thinking about interconnecting DARPANET with radio and satellite packet networks. TCP (Transmission Control Protocol) and IP (Internet Protocol) were born. Commonly known as TCP/IP, these protocols would replace ARPA's original Network Control Protocol (NCP). (See Chapters 1 and 8 for details.)

At this point the online world consisted of four major elements: time-sharing services, ARPANET, the information highway of public computer networks, and private and commercial online databases.

Each element was a cornerstone in the foundation of consumer online services. Time-sharing services established remote access to computers as a marketable commodity. Along with Telenet, ARPANET validated PSN technology, commercially as well as technically. Tymnet and other time-sharing networks further validated the viability of computer communications. And online databases set the precedent for marketing online content.