Chapter 5

Information Technology Services:

Software, Telecommunications, Data Processing, and Information Services

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SUMMARY

The cliche comes easily: information technology is to modern industrial societies what steel was to the industrial societies of the late 19th century, automobiles to the first half of the 20th. Computer hardware and software, telecommunications, embedded and invisible processors deep inside other equipment—these aid banks in processing huge flows of transactions, make factories more productive, help airplanes fly. The logic built into software tells the processors what to do, while telecommunications systems permit computers as well as people to talk to one another over thousands of miles.

This chapter deals not only with software and telecommunications, but with marketed data processing and information services. The cluster of industries covered—the information technology (IT) services—includes both new applications (database services and videotex, defined below) and businesses that are already relatively mature (data processing). All depend on the ability to store, process, and transmit great volumes of information at ever-lower costs.

Software, something like a service (computer programs have no necessarily fixed form) and something like a good (programs can be reproduced, stored, and shipped) makes the rest of the IT services possible, All the products of digital systems technologies depend on computing capability in one way or another, and computing capability depends on software. Today, for instance, the central switching systems that route telephone calls between distant cities are giant computers; 80 percent or more of the $2 billion-$3 billion cost for developing a new generation of these central office (CO) switches goes for software.[1] Software development costs are likewise becoming a larger proportion of total development costs for both microprocessors and their embedded applications. Very large-scale integrated circuits, the building blocks of computers and communications systems, can only be designed using software for computer-aided design; the same is true of computers themselves. Software, which embodies the logic of complex systems, epitomizes high technology for the latter part of the 20th century.

While computer hardware manufacturers (and users) continue to develop a great deal of software, a rapidly growing independent industry had emerged by the 1970s. The firms in this industry develop and market programs for off-the-shelf sale or lease to customers—packaged software—along with custom products tailored to user requirements. Generally the software company will also provide training, documentation, and at least some software maintenance; over the life of a package, maintenance costs—e.g., updating and error correction—may exceed the cost for developing the original program by several times.

In 1985, U.S. firms had about 70 percent of a world software market worth some $30 billion, with many of their overseas sales through affiliates.[2] The largest portion of these revenues come from the sale of operating systems and applications software for large mainframe computers—much of this software supplied by the original equipment manufacturers—but sales of software for small systems, notably PCS, have been growing rapidly. An applications package for a large system can easily cost $1 million, while many PC programs retail for under

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[1] J. Rippeteau, "GTE's Planned Link With Siemens Worries Customers," *Financial Times*, Apr. 22, 1986, p. 18.

Companies producing CO switches can expect to spend several hundred million dollars annually simply on maintaining and improving the software, particularly on software updates for providing new services.

[2] 1986 *U.S. Industrial Outlook* (Washington, DC: Department of Commerce, January 1986), p. 28-3.

$100, The custom software business consists largely in putting together complex and specialized applications packages for relatively powerful machines.

U.S.-based firms have been market leaders for a long time, but their share of the world market seems bound to shrink in the years ahead. With much of the future growth in other countries, where computer use does not come near to levels now common in the United States, foreign software firms will probably be able to improve their relative positions, particularly as they follow the American lead in switching to packaged, as opposed to customized, software. In particular, the U.S. industry can expect a strong challenge from suppliers in Japan, as that country continues to build its computer industry. With software increasingly influencing or determining the design of hardware, the Japanese realize they need major advances in software; both government and industry have made strong commitments to improvements in software productivity and to new generations of software technology, with the goal of leapfrogging the United States.

Providers of *telecommunications services* give their customers access to an infrastructure of public switched telecommunications networks, along with private leased lines for voice and/or data communications. Developments including microwave systems, communications satellites, fiber-optic links, cellular telephones, and cable TV networks have made possible not only new services—e.g., videotex—but conventional voice and data transmission bypassing the regular telegraph and telephone network. One of the newest elements in this evolving infrastructure, local area networks (LANs), link computers within an office, a building, or similarly restricted setting, while wide area networks (WANs) tie together systems that may be on different continents.

Over the next several decades, many countries will begin building Integrated Services Digital Networks (ISDN) that can handle voice, data, facsimile, and video signals over a common grid—a development that promises rapidly declining costs for transmission, although the worldwide capital costs of building ISDN networks will run into the hundreds of billions of dollars. New services will be possible, if only because most data communications still move over telephone lines, which were never intended for this purpose; ISDN will be much faster, and, for a given volume of data, much cheaper. Choice of technologies for ISDN both internationally and within the United States will have far-ranging impacts on competitiveness (chs. 9 and 10). Should the United States find itself with an ISDN system different from the rest of the world, or with several different ISDN systems, American firms in many industries could be placed at a competitive disadvantage.

Technological changes over the past two decades have already had major impacts on the competitive environment in the United States. Microwave transmission made it possible for new entrants to challenge AT&T's monopoly on long-distance telephone service. MCI and other companies prevailed in the courts and later in Congress, arguing that competition would provide better service, stimulate innovation, and avoid the regulatory confusion stemming from the blurring of boundaries between voice and data communications. The series of administrative, judicial, and congressional decisions establishing the right of other firms to offer services through the AT&T network culminated in the breakup of the Bell System, a process that has had enormous impacts worldwide.

Domestic telecommunications revenues greatly exceed the value of international services; in 1986, only $3.6 billion of U.S. revenues estimated at some $117 billion represented international telecommunications services.[3] Although Japan, and to some extent Great Britain, have begun to follow the U.S. lead in deregulation, telecommunications remains a government monopoly in most countries, with little oppor-

[3]1987 *U.S. Industrial Outlook* (Washington, DC: Department of Commerce, January 1987), p. 31-1. Negotiated formulas divide the charges for international services between the carriers in the countries involved—*Trade in Services: Exports and Foreign Revenues* [Washington, DC: Office of Technology Assessment, September 1986), pp. 91-94.

tunity for competition in traditional telephone and telegraph services. Rather, most of the international opportunities lie in network services that add value to data communications by providing file storage, message switching, protocol conversion, interfaces for different types of terminals, and access to database and other information services. Value-added networks (VANS) providing some or all of these functions, mostly to business customers, have grown rapidly. While maintaining tightly regulated basic telecommunications markets, a number of countries have moved to liberalize value-added services provided over the public infrastructure, enabling American firms to compete in some VAN markets abroad.

In effect, almost any computer network can be viewed as a VAN—the SWIFT (Society of Worldwide Interbank Financial Telecommunications) system for electronically linking banks described in chapter 3; airline reservation systems (some 50,000 terminals in 12,000 travel agency offices worldwide are tied into American Airlines' Sabre system); even ARPANET, designed for the U.S. Department of Defense in the 1960s to link computers in R&D laboratories, and the original source for much of the technology used in current computer and communications networks. a

Videotext/teletext services, known collectively as videotex, consist essentially of VANS providing access to multiple information services; examples include The Source and Dow Jones Information Retrieval, which offer a variety of personal and business information services, including electronic mail, stock market quotations, and airline directories. (Videotext and teletext differ primarily in that videotext services tend to be highly interactive, and to be provided over the telephone network, while teletext is broadcast to television receivers.) Originally targeted at households, videotex services have also sold well to businesses, Outside the United States, government PTTs (post, telegraph, and telephone authorities) or other monopoly telecommunications carriers have generally supplied videotex services; the most successful has been the French Teletel/Minitel system, with 2½ million terminals in service at the end of 1986 and 6 million projected for 1990. Monopoly control of videotex services in other countries will limit the ability of U.S. firms to compete, but they may be allowed in when they have specialized services to offer that would otherwise be unavailable.

Firms providing *data-processing* (DP) services were among the first to take advantage of the telecommunications infrastructure for transmitting digital data. Starting with batch processing, when data were physically transferred (e.g., as coding forms or on magnetic tape) to a facility owned by the processor, DP services quickly expanded into remote processing, with data transferred via telephone lines. DP services firms sell computer time (including time on supercomputers), handle payrolls and accounting for other companies, and in many cases provide facilities management under contract; systems integrators help customers design their own DP facilities (e. g., choosing and packaging hardware and software). OTA places the 1984 foreign revenues of U.S. DP services firms at $2.7 billion to $5.1 billion, while total revenues, domestic plus foreign, came to about $15 billion.'

DP services firms grew rapidly by providing computing capability to companies that did not have equivalent internal capabilities; today, with computing power cheap and widespread, this part of the business is mature. While DP services firms can still provide many specialized functions cheaply, growth will come in new lines of business; many DP services companies are now pursuing strategies that emphasis VANS or information services.

If growth in the DP services industry has slowed, *information services* and electronic databases are poised for rapid expansion. In essence an old industry taking on a new form, electronic databases can supplement and extend print media in many ways. Information ranging from bibliographic citations to the text

[4] On Sabre, see S. Carey, " Europe Bristles at U.S.-Airline Computers, " *Wall Street Journal*, Nov. 21, 1986, p. 36.

[5] *Trade in Services: Exports and Foreign Revenues*, op. cit., p. 62.

of legal decisions to remote sensing data gathered by satellites can now be delivered to the customer on a floppy disk or directly over the telecommunications infrastructure. U.S. information services firms had 1985 revenues of about $1,9 billion, with 20 percent coming from foreign sources; American vendors supply half or more of all database services in Europe. [B] American companies have also had considerable success in Japan; with English in nearly universal use among business customers, the U.S. industry will have a continuing source of advantage in international competition.

[6] 1986 *U.S. industrial Outlook*, op. cit., p. 48-6.
Much of the information in the rest of this chapter not otherwise cited comes from interviews.

COMPUTER SOFTWARE

In the early years of the U.S. computer industry, customers purchased hardware and software bundled as a package from one of the half-dozen or so companies that made computing equipment. Customers could create their own applications software, but normally relied heavily on programming languages and implementation routines developed and supplied by the manufacturer. As early as the 1950s, independent software and systems houses emerged to meet specialized programming requirements. Through the 1960s, as user needs became more specialized, independent firms continued to expand.

A major turning point came in 1969. IBM, already the largest computer manufacturer in the world by far, was forced under intense antitrust pressure to unbundle software, changing its pricing policy so that customers were charged separately for hardware and for programs, The independent software industry gained new credibility, while more customers began to evaluate software purchases independently of hardware. For the smaller computer firms striving to compete with IBM, and particularly the emerging manufacturers of minicomputers, such as Digital Equipment Corp. (DEC), this was an important development. DEC still markets 30 **to** 40 percent of its hardware to systems houses which assemble integrated hardware/software packages to the specifications of particular customers.

Many businesses continue to do some of their own programming. Banks and accounting firms, for example, maintain large staffs of computer specialists. But for relatively standardized needs, the benefits of purchasing software on the outside, particularly packaged software, have become steadily more compelling. These benefits include:

- Availability.—Software already on the market can be quickly evaluated, purchased, and put to work.
- *Lower Risk.—A* firm choosing to develop its own programs may not achieve its functional goals; even if it does, the development effort may cost more and/or take more time than planned.
- *Manpower* Savings .—Purchasing software minimizes the company's internal staffing requirements.
- *Better* Documentation.—Packaged software includes documentation, which can be evaluated as part of the purchase decision. Few companies that do their own programming seem able to enforce high priorities for documentation. [7]

Against these points, a company must weigh the prospects of arriving at better solutions to its particular problems. It must also consider the possible strategic advantages (ch. 8); unique

[7] W. L. F rank, *Critical Issues in Software (New* York: Wiley-Interscience, 1983], p. 166.

software can, like other forms of proprietary technology, be a potent competitive weapon.

Fourth-generation languages, which make it easier for end users with relatively little training to create their own applications packages, sharpen the trade-offs between in-house and off-the-shelf software. Also called end-user-oriented packages, examples of fourth-generation languages include FOCUS (Information Builders Inc.), ADABAS (Software AG), and Ramis-II (Martin Marietta).[8]

Hardware and Software Costs: Productivity in Software Generation

Cost/performance ratios for computer hardware have been declining steeply for years, with no end in sight; today, even the smallest businesses can easily buy and use surprisingly powerful desktop machines. More than ever, purchase decisions for hardware—small systems and large—depend on software availability. Indeed, software has begun to dictate the design of hardware. Computer manufacturers find themselves spending the majority of their R&D dollars on software. Given the decline in prices for equipment, they seek to increase their revenues from software sales; at IBM, software and services have grown from less than 20 percent of total revenues as recently as 1983 to about 30 percent in 1986.[9]

Falling hardware prices, leading to a larger user base, increase the demand for software. This, in turn, means that software suppliers can charge lower prices because they can amortize their upfront development costs over larger unit sales. But at the same time, productivity in developing software has increased only slowly—perhaps 5 to 10 percent per year, far less than rates of productivity increase on the hardware side of the business. Skilled programmers must still write and debug software on a line-by-line basis. While improvements in computer languages and programming aids, including automation, have helped, longer and more complex programs continue to stretch the capabilities of the best people and the best tools. Software maintenance—upgrades as well as debugging—typically accounts for well over half of life-cycle software costs.[10] Documentation is also expensive, while the spread of computing power to new and nonexpert users has made good documentation ever more important for success in the marketplace. The result? A productivity bottleneck in programming, with software now accounting for a far greater percentage of total system costs than in earlier years.

With demand for skilled programmers and systems developers high, American universities have struggled for a decade to keep up, as more and more students sought to study computer science and software engineering. While some kinds of routine software development can be handled by programmers with modest skills, marketplace success often depends on the insights of a few unusually creative people —those who can devise a fourth-generation language, make progress in automating the generation of software itself, or develop expert systems (a form of artificial intelligence, or AI), The growing dependence of hardware design on software places still heavier demands on the conceptual skills of those responsible for the overall design of software packages.

Given the dimensions of the productivity bottleneck, a great deal of software R&13 has been directed toward tools for cutting costs and speeding common programming tasks. In the near term, fourth-generation languages, which

[8]On the advantages of fourth-generation languages, see J. Martin and C. McClure, *Software Maintenance: The Problem and Its Solution* (Englewood Cliffs, NJ: Prentice-Hall, 1983), ch. 11; also J. Martin, *Fourth Generation Languages* (Englewood Cliffs, NJ: Prentice-Hall, 1985). With a third-generation language like Basic or COBOL the programmer's instructions tell the computer i n step-by-step fashion how to proceed, With a fourth-generation language, the (applications) programmer tells the system what the output should be, but not how to achieve that output.

[9]M. Schrage, "III M Reprograms Its Strategy to Sell Software, Servic es, *Washington Post*, Aug. 3, 1986, p. F1.

[10]Some estimates indicate that as much as 8(I percent o f maintenance costs go toward adapting software to customer needs that were not fully understood when the development process began, or that have shifted over time. See *Software Maintenance. The Problem and Its Solution*, op. cit., p. 4. For an idea of the scope of maintenance requirements, note that the worldwide inventory of programs written in COBOL, still popular for business applications, reaches perhaps 75 billion lines of code—" Engineering an End to the Software Nightmare, *Financial Times*, NOV. 20, 1986, p. 14.

can give 10:1 to 100:1 productivity improvements, seem to offer the best hope. Related efforts in the United States include AI techniques for training programmers, as well as expert systems to help them generate new software.

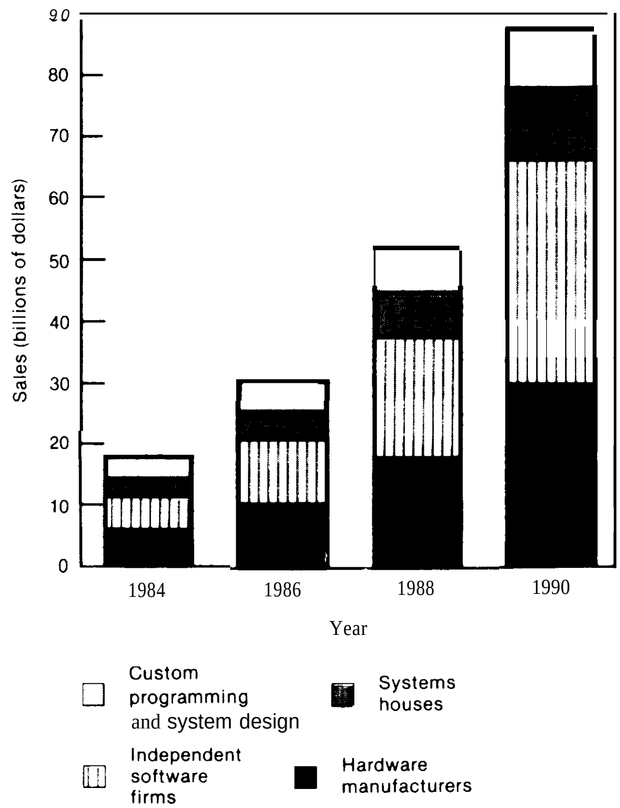
The U.S. Industry

The American software industry is the largest in the world and the biggest exporter. U. S.-based firms reportedly hold more than 70 percent of the global software market, with worldwide revenues of about $21 billion in 1985.[11]

As many as 10,000 American firms, the vast majority quite small, develop and market computer software. As figure 33 shows, in recent years hardware manufacturers and independent software firms have accounted for roughly equal sales volumes, with projections suggesting that the share of the independent firms will grow. Contract programming is expected to drop from over 20 percent of the market currently to a projected 12 percent, a consequence of the continuing trend away from custom soft ware.

Most of the software supplied by hardware manufacturers consists of operating systems and applications software—e.g., for database management—designed specifically for the firm's machines. This is a big market in dollar terms: while mainframes and minicomputers sell in the hundreds or thousands to tens of thousands of machines per year, compared with millions of PCs, software for the more powerful systems costs much more. The sales of the

Figure 33.— Projected Worldwide Revenues of U.S.-Based Software Suppliers



SOURCE: "Review and Forecast The Software and Services Market place," International Data Corp , March 1985

largest of the independent PC software firms, Lotus Development, came to about $225 million in 1985; IBM's software revenues totaled $4.2 billion, and Hewlett-Packard's $500 million.[12]

With few exceptions, foreign firms lag well behind their American competitors in software technology, as well as in sales, The factors responsible for U.S. leadership begin with the vast domestic market, driven by a hardware base that is the largest in the world by far, American software firms can expect to cover their design and development costs at home, giving them latitude in setting prices overseas. Because even a product that is not a great success may sell enough copies to cover fixed costs,

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[11] *1986* U.S. *Industrial Outlook*, op. cit., p. 28-3. Western Europe, Canada, and Australia have been major markets for U. S.-based firms.

The most recent figures on market share, for 1982, show the U.S. industry far ahead of other national software industries:

	Sales (billions 1)/ dollars)	Employment	Percent foreign sales	World market share
United States	$10 3	224,000	50-60%	70%
France	1.3	40,000	24	5-7
Japan	1.2	38,000 +	1	5.7
United Kingdom	07	25,000 +	7	2-3

See *A Competitive Assessment of the U.S. Software Industry* (Washington, DC: Department of Commerce, December 1984) p. 35; the employment figure for the United Kingdom comes from *Policy for the UK information Technology Industry* (London: National Economic Development Office, 1982), p. 61.

The expert systems market is currently in the $140 million range—J. Mead, "Building a Bridge to Expert Systems, " *Datamation*, Jan. 1, 1987, p. 17.

[12] P. Archbold and P. Hodges, "The Datamation 100, *Datamation*, June 15, 1986.

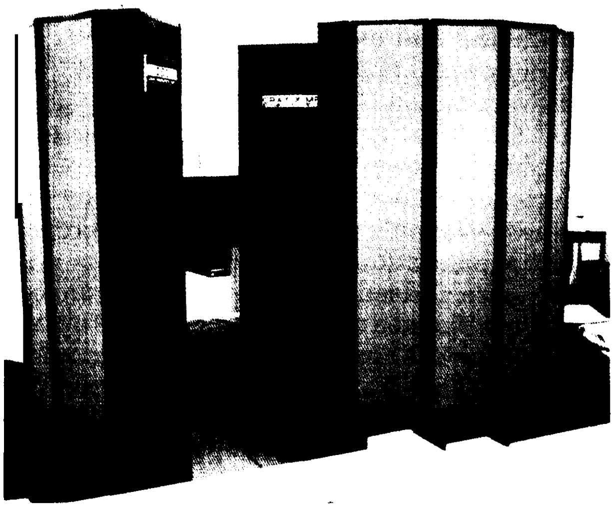


Photo credit Cray Research

Cray X-MP supercomputer, one of the most powerful machines available.

the risks of new product development are lower here than in foreign countries–one reason why foreign firms like Software AG have invested heavily in the United States.

While all signs point to continued competitive strength for U.S. suppliers, their world market share seems bound to slowly decline. Foreign industries where custom programming is still the rule will be forced, sooner or later, to move into the design and production of standardized software. As firms overseas negotiate this transition, some will emerge better able to compete with American suppliers.

Japan's Software Industry and Market

While European software firms have been more visible internationally than the Japanese, over the longer run Japan will emerge as the primary U.S. competitor in software. Today, the major Japanese computer manufacturers sell hardware that compares well with that from American firms. But Japan remains substantially behind in software, with poor applications packages—along with limited sales and service networks—a major handicap in selling hardware internationally, particularly in the office automation and PC markets. In contrast, Japanese systems software, which is based on technology originating in the United States, is usually considered to be quite good.[13]

The Japanese recognize their deficiencies quite clearly, and have embarked on a massive effort to catch up. A few years ago, Hitachi spent only 10 percent of its R&D money on software; now it is spending more than 30 percent.[14] Toshiba has established a "software factory" employing 3,000 programmers to work on products for business and industry. NEC spends $400 million annually on software development. Still, leaving aside these efforts by hardware manufacturers, and leaving aside the government-sponsored fifth-generation project, the Japanese software industry resembles that in the United States perhaps two decades ago—small and not very visible. The independent software houses remain weak. As in many countries, skilled programmers have been in short supply. About **90** percent of Japanese applications software continues to be undertaken on a custom basis, often by firms for their own use; meanwhile, customized programs have already fallen below **40** percent of the U.S. market, and to about 60 percent in the United Kingdom.

Custom programming is inefficient (often costing 10 to 100 times more than packaged programs), and will not persist indefinitely, if only because the burgeoning software needs of the

[13] H.J. Welke, *Data Processing in Japan* (Amsterdam: North-Holland, 1982), ch. 6; D. Brandin, et al., "JTECH Panel Report on Computer Science in Japan," Science Applications International Corp., La Jolla, CA, under contract No. TA-83-SAC-02254 from the Department of Commerce, December 1984, p. 3-1. Both Fujitsu and Hitachi continue to make IBM-compatible computers, while NEC's operating systems trace their ancestry to Honeywell products. The operating systems developed by these companies may have U.S. origins, but today in at least some cases the Japanese versions are superior. One of the objectives of Japan's heavily publicized fifth-generation computer project, discussed later, is to help Japanese companies take the next step in breaking free of their long-standing dependence on American software.

[14] In the past according to Hisao Ishihara, Managing Director of the Japanese Software Industry Association, "Hardware manufacturers have been lazy about developing software," See "Software: The New Driving Force," *Business Week*, Feb. 27, 1985, p. 96.

Japanese economy can only be accommodated through greater adoption of standardized applications packages; the rapidly growing hardware base in Japan, now second in the world after the United States, will force change. Over the next 10 to 15 years, as they respond to these pressures, Japanese software suppliers will markedly improve their competitive positions.

Software Technology

Their overwhelming reliance on customized software contains the seeds of the Japanese industry's future development. In software, as in manufactured goods, Japanese companies have elevated process engineering to a high art. Software factories like Toshiba's reportedly produce large volumes of code with levels of quality (as measured by freedom from errors) and productivity (as measured by lines of code per man-year) substantially higher than in the United States or Europe. These software factories typically specialize in programming for particular classes of applications—e.g., process-control packages for nuclear powerplants and steel mills, aircraft flight control systems—making it easier to re-use blocks of code, as well as to train the programming staff narrowly but deeply.[15] Thirty percent or more of a given package may be recycled from past programs, helping both quality and productivity; Toshiba's Software Workbench claims an error rate of 0.3 bugs per thousand lines of code, a factor of 10 below typical U.S. error rates.

When the Japanese software industry moves, as it must, toward prepackaged applications programs rather than custom and semi-custom products, the software factory experience should prove of considerable value. But releasing a bug-free program means little if the software fails to meet user needs. For general-purpose applications packages, with design requirements that will be fuzzy and ill-defined compared with custom-tailored programs, market success depends first of all on conceptual design. Japanese software firms generally lack experience in developing and marketing programs that can satisfy mass markets. Their strengths lie in the steady improvement, often through painstaking and expensive trial-and-error, of existing products and processes. (Recall their improvements on U.S.-developed operating systems.) On the other hand, if the ideas become available—perhaps from American firms or American software designers hired by the Japanese–Japan's experience base could provide the foundation for future cost advantages in software. Indeed, this is part of the Japanese strategy: a Toshiba executive has said, "To overcome Japan's language problem and compete with the United States, we have to have productivity double that of the U.S."[16] To help surmount their handicaps in conceptual design, Japanese software suppliers will not hesitate to follow electronics firms and automobile manufacturers in establishing design centers in the United States.

At the same time, the generally poor reputation of Japanese applications programs hides real strengths. Efforts over the years to develop Japanese language input/output terminals, and, more recently, word processing software, may help Japanese firms gain the lead in some kinds of applications packages. In manufacturing, many Japanese companies have implemented simple but sophisticated factory automation systems, with software already well-proven in practical applications; Japanese software for numerically controlled machine tools, for automated inspection, and for statistical quality control may be less than innovative—perhaps even derivative of American technology–but it works, and works well. Other examples of successful applications software lie hidden inside many Japanese corporations. In the future, Japanese software suppliers will be able to build on these achievements.

On the other hand, their language will create ongoing difficulties for Japan's software suppliers, particularly when it comes to overseas sales. Japanese programmers, not surprisingly, prefer to work in their own language

[15] The Specialties given are those of the Software WorkBench of Toshiba Fuchu—"JTECH Panel Report on Computer Science in Japan, " op. cit., pp. 3-3 to 3-4. Also see *Information Technology R&D: Critical Trends and Issues* (Washington, DC: Office of Technology Assessment, February 1985), p. 85.

[16] "Software: The New Driving Force, " op. cit., p. 98.

where possible. To export software, they must translate not only codes (commands, prompts and comments) into English or some other language acceptable in the foreign market, but also the accompanying documentation, including training materials. (At present, the U.S. firm Lotus Development supplies software packages in seven languages,) Given the long-term vendor-customer relationships and the turn-key environments typical in Japan, documentation has not been up to Western standards.

There is another side to the matter of language differences, however, one that may eventually have effects on competitiveness in *many* industries. Because written Japanese uses some 2,000 kanji characters, typewriters have been expensive and difficult to operate, Likewise, computer terminals have been beyond the capabilities of people lacking special training. Business communications in Japan depend on handwritten documents to an extent unheard of in the West for decades. Now, with Japanese language capability becoming available in computer systems, Japan's companies, no matter what industry they compete in, will be able to tap a major new source of productivity improvement. During 1985, production of Japanese-language word processors increased from about 30,000 per month to nearly 250,000 per month, while average prices dropped by a factor of 5.17

Moreover, Japanese word processing software is in some respects already quite advanced; the system must interpret keystrokes representing phonetic combinations, "guessing" the operator's meaning based on context and expressing that meaning in kanji. Programs that do this become, in effect, applications of AI. The Japanese companies that have developed this software should be able to transfer some of the techniques to other types of programs, with subsequent competitive advantages.

[17] "Output Outlook by Sector, " *Japan Report-science and Technology*, Joint Publications Research Service JPRS-JST-86-070 -I., oct. 30, 1986, p. 47. Translated from *Nikkei Electronics,* Apr. 7, 1986.

The Fifth-Generation Project

When it comes to technologies like AI, it is the fifth-generation project that gets most of the attention outside Japan. Begun in 1982 under the auspices of the Institute for New Generation Computer Technology (ICOT), the goal of the fifth-generation project is to extend applications of massive computing power to ordinary users by harnessing AI, natural language input capability, and very large databases. The intent is to leapfrog existing—i.e., American—computer technologies. This is not the first time that joint government-industry R&D, a process refined in Japan over several decades, has been turned to the "software gap."[18]

The fifth-generation project's budget, averaging less than $50 million per year, is not large compared to internal corporate R&D spending, or, for example, to the Strategic Computing program of the U.S. Department of Defense. This by no means makes the project unimportant. The technical goals will be very difficult to achieve. But as many other joint projects in Japan have demonstrated, focusing exclusively on technical objectives misses the point. Such projects serve many other functions in Japan's industrial policy system, ranging from conscious-raising and consensus-building to training technicians and engineers, In Japan, where concerted efforts to build an "information economy" go back to the 1960s, the government looks to computers (and communications) as the centerpiece of the nation's future economic structure, a structure emphasizing knowledge-intensive, hence software-intensive, goods and

[18] On Japan's approach to joint government-industry R&D, including the objectives of the fifth-generation project, see *International Competitiveness in Electronics* (Washington, DC: Office of Technology Assessment, November 1983), pp. 416-419.

One of the more important of the early software-intensive efforts, the Pattern Information Processing System [PIPS) project, helped Japanese companies develop technologies for input devices that could accept kanji characters. The recent SIGMA project (Software Industrialized Generator and Maintenance Aids), initiated in 1985 by the Information Technology}' Promotion Agency, seeks increased productivity in programming though software engineering techniques and automation. This effort, scheduled to run through 1989, has a planned budget of more than $150 mill ion and involves nearly 130 companies. See A. Cane, "Japan's $100m Software Boost, ' *Financial Times*, Sept. 18, 1985, p. 14; also S.K. Yoder, "Automating Software, " *Wall Street Journal*, Nov. 10, 1986, p. 33D.

services. The fifth-generation project is one part of this larger effort.

Trade Barriers

As in other industries, direct and indirect barriers have made it difficult for U.S.-based firms to sell software in Japan. For example, many American companies contend that Nippon Telegraph & Telephone [NTT), potentially a huge customer for U.S. software, gives preferential treatment to Japanese companies. After lengthy negotiations and much pressure from the U.S. Government, NTT—now partially privatized—has begun to show signs of opening up its procurement process, with software one of the areas of progress, Time will tell whether this concession represents the first step in what would inevitably be slow progress toward more open procurement, or whether it represents no more than a token concession by the Japanese.

U.S.-Japan friction over copyright protection for software has been as heated as that over NTT's procurement practices. A 1983 bill prepared by MITI and introduced in Japan's legislature, the Diet, called for compulsory licensing of software where the Japanese Government deemed this in the national interest. The intent was clear: MITI wished to aid Japanese firms by making it easier for them to use existing programs, particularly the IBM software that Japan's plug-compatible hardware manufacturers continue to depend on. Lengthy negotiations between the U.S. and Japanese Governments followed; other countries also protested the Diet bill, which was eventually shelved. Finally, Japan's Government promised to implement copyright provisions for software more acceptable to foreign interests.[19] If the Japanese continue to keep out American software firms, and otherwise aid their domestic industry (by, for example, allowing reverse-engineering of U.S. programs), a strong group of competitors could eventually emerge in this industry—from behind barriers much like those that earlier helped the Japanese develop their computer, semiconductor, and telecommunications hardware suppliers.

Europe

While American hardware and software firms have had a much easier time in Western Europe than in Japan, none of the European nations, individually, can compare with Japan as a potential customer (or potential competitor). As a whole, the Western European computer market exceeds that of Japan by perhaps one-third, despite a population roughly twice as great.

Although custom software does not take as high a fraction of sales in Europe as in Japan, customization remains more common than in the United States; European sales of custom software and software consulting services came to $4.5 billion in 1985, compared with $5.2 billion for packaged software,'" By the end of the decade, standard programs are expected to outsell custom software by a substantial margin. As figure 34 indicates, West Germany should continue to be the largest market for packaged software, followed by the United Kingdom and France.

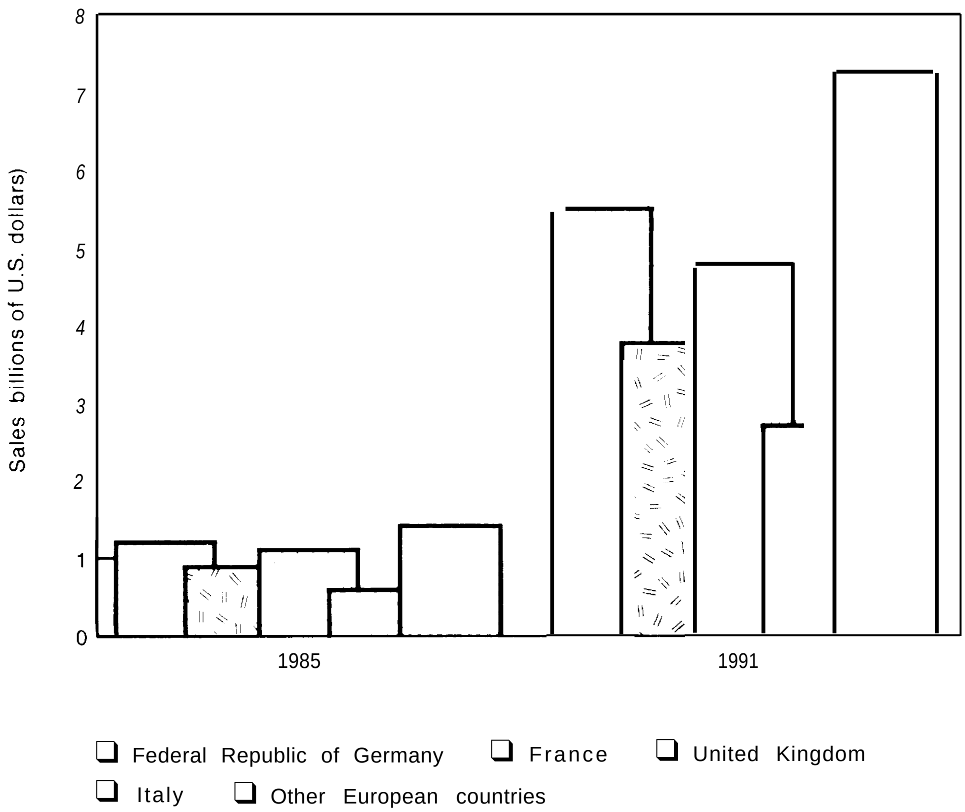
If third as a market, France nonetheless has the strongest software industry in Europe. The biggest independent European software supplier, the French firm CAP Gemini Sogeti, specializes in mainframe programs, doing nearly 60 percent of its business outside France; still, the company's 1985 revenues of about $250 million only slightly exceeded those of the American PC specialist Lotus Development. As in other countries, French computer hardware and telecommunications equipment manufacturers—notably Alcatel, Thomson, and Bull—have been major players in software,

[19] S.Chira, "Japan Plans To Provide Protection for Software,)' *New York Times*, Mar. 19, 1985, p. D13. While the new plan was proposed in 1985, no action had been taken as of mid-1987.

[20] "European Software and Services Market, " *Financial Times*, Sept. 22, 1986, p.III.

For the 1985 revenues of Cap Gemini Sogeti, below, and other European firms, see "French Software Firms Strong in Europe, " *Europe Report—Science and Technology*, Joint Publications Research Service JPRS-EST-86-038, Dec. 8, 1986, p. 22. Translated from *Zero Un Informatique*, Aug. 18, 1986.

Figure 34.— Projected Sales of Packaged Software in Western Europe



SOURCE "Software Packages for Business," *Financial Times* June 27 1986, p I

In Germany, the local industry centers on the hardware manufacturers Siemens and Nixdorf, the latter specializing in turn-key systems, especially for financial institutions. A strong commitment to customer service has helped Nixdorf win a small but growing share of the market; the firm has even penetrated French banks, a difficult feat.

With so much of Europe's hardware base supplied by American-owned companies, much of the software, particularly systems programs, also comes from American firms. U.S.-based computer manufacturers like IBM, DEC, and Hewlett-Packard have substantial presences in Europe. IBM operates half a dozen European R&D centers, each of which undertakes software or related work; in 1983, IBM alone took more than one-quarter of all Western European sales of off-the-shelf systems software.[21] Many independent U.S. software and services firms —Cullinet, MSA, Comshare, ADP—have also invested in Europe. In some cases, their affiliates function as sales offices only. In others, they carry out R&D and/or production. ADP's Dutch subsidiary, for example, has developed software for auto parts wholesalers and retailers that is now marketed through ADP offices elsewhere in Europe.

Over the next few years, the fastest growing portion of the European software market, as

[21] R v. Gizycki and I. Schubert, *Microelectronics: A Challenge for Europe's Industrial Survival* (Munich: R. Oldenbourg, 1984), p. 93; *Financial Times*, May 1, 1985, p. I II. U.S.-owned firms account for five of the top six independent suppliers of packaged systems programs, although European-owned firms do better when it comes to custom software.

in the United States and Japan, will consist of business application programs for PCs. About as many people work in Western European offices as in the United States—60 million. Yet businesses in Europe lag well behind in their purchases of PCs, with fewer than 5 million in use, compared with about 8 million in American offices.[22] Moreover, the home market for PCs in Europe has barely been tapped. As a result, both PC hardware and software sales may grow faster in Europe than in the United States over the next several years—creating attractive market opportunities for American firms,

From their beginnings, the newest generation of U.S.-based software startups, most of whom specialize in programs for PCs, have sought and found markets in Europe. U.S.-based software suppliers invest overseas for two fundamental reasons: to be close to their markets, and to save on development costs. Software for applications like accounting must be tailored to each national market—not only in terms of language, but, in this example, in terms of accounting conventions and standards. American companies often set up local offices or subsidiaries to handle the necessary program modifications. Moreover, software development costs less in Europe, largely because salaries for programmers average about half those in the United States. The U.S. firm Comshare, for instance, does about 40 percent of its development work overseas, mostly in Ireland, where the firm's investments save the company about $4 million per year. While countries like India, Hong Kong, and Hungary also offer lower programming costs, thus far the British Isles have proved most attractive for American firms (including IBM, DEC, Hewlett-Packard, and Prime).

European software firms themselves, with only a few exceptions, remain minor players internationally. Like Japan, the European nations (and the European Community) have begun funding R&D intended to strengthen their capabilities in software; chapter 9 describes both the Community-wide ESPRIT effort and Britain's Alvey Program.

Of the developing nations that have sought to build software industries, India has been perhaps the most aggressive, with software exports growing at 40 percent annually.[23] The country has the advantage (for this purpose) of many chronically unemployed or underemployed university graduates; American firms including Texas Instruments and Citicorp have established software development facilities in India, while other American companies have contracted out programming to local firms. Countries including Singapore and Taiwan have also attempted to establish themselves as centers for software development, but typically face acute shortages of well-trained people.

Competitive Dynamics

Today, software industries in the United States and overseas are in a state of flux; the biggest supplier of PC software, Lotus Development, was founded only in 1983. High-end software specialists have been seeking to expand into other segments of the market, attracted by the many new customers for small computers, while also moving to exploit the advantages of fourth-generation languages. In this environment—highly competitive and technologically volatile—many companies have sought to expand their product lines through mergers and acquisitions (more than 200 in 1985, over 300 in 1986) as well as internal product development. Acquisitions can broaden a firm's customer base; they can also help expand its programming staff—a critical need for rapid growth,

U.S. advantages in the evolving world industry begin with the large domestic market, driven by a hardware base that is still growing rapidly. With the interdependencies of hardware

22 The business penetration figures come from presentations at the 4th Professional Personal Computer Conference, London, Oct. 30-31, 1986, by M. Swavely, Compaq Computer Corp. [for the United States) and B. Morel, Intelligent Electronics Europe.

23 The base for this growth has been small, only $24 million in 1984. "Showing the Way For Developing Countries, " *Financial Times Survey*, Oct. 4, 1985, p. iii; "India's Climate Looks Good to U.S. Software Makers," *Business Week*, Oct. 13, 1986, p. 138-H.

On Singapore and Taiwan, see *International Competitiveness in Electronics*, op. cit., pp. 383-389; also "Asia's Hi-Tech Copy Cat Aims for Lion's Role," *Financial Times*, May 17, 1985, p, 3.

and software design increasing, this should prove a continuing source of strength for the U.S. industry, while also serving as a prod to Japan's efforts.

At present, France probably has the most competitive software industry outside the United States: about half of the 20 largest software suppliers to the European market are French, compared with two British companies, and one from West Germany. But in the longer run, Japanese firms will emerge as the principal competitors for American suppliers, if only because of the growth and increasing competitiveness of the hardware sector in Japan. U.S. software firms could also face somewhat stronger competition if European efforts to foster innovation and entrepreneurialism in software bear fruit.

Japan's Government has begun focusing resources and attention on productivity in the generation of software, an effort that could have substantial long-term implications, as could government-sponsored projects in a number of countries to speed developments in artificial intelligence. Nevertheless, the traditional sources of U.S. strength in software—skilled personnel, strong R&D programs with substantial Federal funding, particularly for burgeoning military applications, and capital markets that are deep and flexible-will persist. U.S. Government policies that ensure access to foreign markets—including effective intellectual property protection for software (see ch. 9)—would help maintain existing U.S. advantages in this industry, one that is critical for future U.S. economic growth and competitiveness.

TELECOMMUNICATIONS SERVICES

Although telecommunications is much the largest of the IT services in terms of revenues and employment, most of the activity is confined to domestic markets. In 1984, revenues for marketed telecommunications services, voice and data, totaled some $109 billion in the United States, nearly $70 billion in Western Europe, and $22 billion in Japan.[24] By definition, there can be no trade in domestic telephone traffic, by far the largest income earner of all telecommunications services, nor for domestic leased lines and data communications, the second largest revenue item for most PTTs.

Governments have closely regulated telecommunications, viewing the sector as a natural monopoly and the service a public good. For such reasons, publicly owned PTTs or publicly regulated private monopolies have been common; most of the world retains the former, while in the United States AT&T's regulated monopoly has broken down only in the last few years. Trade, then, consists largely of cross-border voice, message, and data communications—also regulated (box M). Beyond this, value-added services, mostly supplied through VANS, and including videotex, hold attractive market opportunities. Future competition promises to be heated, both within national markets, where creeping deregulation has in some cases meant that American firms have been permitted to enter VAN markets, and for cross-border VAN services. Intense competition for sales of telecommunications equipment complicates the picture.

The Competitive Environment

Basic telephone service continues to generate most telecommunications revenues .25 However, conventional telephone circuits are ill-suited to the rapidly expanding volume of data

[24]" Telecommunications Survey, " *The Economist, Nov. 23, 1985, p. 8.*

On satellite communications, including the emergence of fiber optics as a potential rival for international circuits, see *International Cooperation and Competition in Civilian Space Activities* [Washington, DC: Office of Technology Assessment, July 1985], ch. 6.

[25]Revenues for other than basic telecommunications came to $8.9 billion in the United States during 1985, including revenues from leased lines—less than 10 percent of total domestic telecommunications revenues. VANS accounted for only $300 million. See P.R. Strauss, "1986 Market Survey: Most Sectors Strong Despite Slowdown Fears, " *Data Communications,* January 1986, p. 73.

Box M.—International Telecommunications

The market for crow-border telecommunications services is one of regulated competition, with, for instance, satellites and undersea cables tightly controlled. Joint ownership by U.S. carriers and foreign PTTs has been the rule for ocean cables terminating in this country. With the advent of satellite links, Comsat (Communications Satellite Corp.) became the privately owned U.S. monopoly carrier and signatory to the Intelsat system (the International Telecommunications Satellite Organization, created by international treaty in 1964). The United States, as the moving force behind Intelsat, provided 90 percent of its capital in the early years; Comsat still owns 23 percent of the international consortium. Regulations and rates on international leased lines vary depending on the countries at the two ends of the line; the Consufor International Telephone and Telegraph (CCITT) of the International Telecommunication Union (ITU) provides a framework for bilateral agreements. Currently, a private Intelsat line between the United States and Britain can cost from roughly $50,000 per year to something over $500,000, depending on bandwidth@ measure of capacity).

Intelsat continues to control nearly all cross-border satellite communications, including television.[1] Although at least nine firms now offer telephone service within the United States using satellite links, Comsat continues to provide the only access to Intelsat circuits. But deregulation promises change. Following a 1$84 decision by President Reagan to permit new entrants in competition with Intelsat, the Federal Communications Commission (FCC) approved conditional licenses for five American companies seeking to provide international satellite services. While the customers of these new entrants would be permitted to resell or lease lines to third parties, the FCC has prohibited interconnection with public switched networks, thereby protecting@ cow of Intelsat's business. [Congress had directed the Administration to avoid economic harm to Intelsat.) Meanwhile, fiber-optic cables have emerged as cost-effective competitors for satellite circuits in many parts of the world. Intelsat has responded to the threat of competition by cutting prices and expanding services.

Further opening of international competition in basic services would require cooperation from PTTs controlling interconnection at the other ends of cross-border links. This is not likely. In 1976, the FCC proposed to expand competition by authorizing resale on international private leased lines—used by many multinational corporations (MNCs) for communications between branches in different countries—as it had done for domestic private lines. The FCC proposal represented a direct threat to PTTs in Europe (where remit U.S. foreign investment is concentrated), and was met by the threat of a shift from flat-rate tariffs to time- or volume-related tariffs (or even disconnection}. This would have raised costs for U.S,-based MNCs, while maintaining revenue levels for the PTTs. The FCC was forced to retract its proposal.

Two years later, the FCC again gave notice of its intent to authorize resale of international leased lines. Other countries considered this a breach of ITU rules because a CCITT recommendation had stipulated that no resale or shared use of international leased lines be permitted. While CCITT recommendations do not have the force of treaty obligations, it again became clear that action by the United States would provoke retaliation. Once more, the FCC backed down.

Such disputes will not disappear, if only because the private satellite carriers authorized by the United States will continue chipping away at Intelsat's monopoly. The issues are essentially the same as in domestic liberalization, with an overlay of foreign policy questions. Is there a need for specialized cervices that Intelsat does not now provide? If either Intelsat or private carriers provide such services—i.e., to MNCs—would costs for other Intelsat customers go up? Deregulation in the United States has meant a move toward cost-based pricing, a choice rationalized on grounds of efficiency. Corporate customers and some household customers benefited from lower rates and a bigger menu of services; others had to pay more. Much the same policy choice presents itself internationally, promising to generate controversy for years to come because decisions will be linked to questions ranging from North-South relations to sales of satellites and ground equipment.

[1] *International Cooperation and Competition in Civilian Space Activities* (Washington, DC: Office of Technology Assessment, July 1985), pp. 180-188.

communications. With digital central office switches—themselves large computers—replacing electro-mechanical crossbar switches, and digital circuits replacing analog, the infrastructure is rapidly becoming a network of computers rather than one of telephones (and telegraphs and telexes). It is this blurring of boundaries between computing and communications that undermined much of the old regulatory structure in the United States, setting the stage for deregulation,

New communications technologies in a deregulated environment permit corporate users to bypass portions of the public telecommunications network. With local service bypass, lines —normally leased from the local service provider—go directly to the long distance access point in a local switching area. Companies with a higher traffic volume may find it cost-effective to invest in local facility bypass, with a link (normally microwave) going straight to the long distance carrier, bypassing local switching facilities completely. With system bypass, the corporation operates its own dedicated network, using private satellite, fiber-optic, or cable links to join its facilities. Total system bypass makes sense only for large organizations.

The AT&T breakup has had major repercussions internationally. With its manufacturing arm, Western Electric, freed from earlier restrictions on sales of telecommunications equipment abroad, AT&T has begun seeking alliances with foreign firms and access to foreign markets. At the same time, Western Electric can no longer count on the business of the regional holding companies (RHCs) and Bell operating companies (BOCs). Divestiture also meant AT&T could enter computer markets for the first time.

The opening of U.S. markets for services and the new competition for equipment sales created pressures for change elsewhere. Foreign firms, particularly larger businesses, saw that following the U.S. lead could result in lower costs and better service. Many grew concerned that their national PTTs might hold back introduction of new technology, putting them at a competitive disadvantage.

Photo credit: DGT/Intelmatique

Terminal for France's Teletel/Minitel videotex system

As in financial services, then, deregulation has begun to spread to other industrialized countries, But, as noted in box N, the pace will be much slower in telecommunications. Government-controlled PTTs—run by civil servants and in some cases operating under laws little-changed since the 19th century—have no wish to relinquish their hold on basic services. Not only do many PTTs cross-subsidize their labor-intensive mail delivery services with telecommunications revenues, but a great deal of pressure for maintaining public monopolies or private regulated monopolies in telecommunications services stems from the desire of governments to protect and strengthen national champions in the manufacture of equipment,

As indicated in box N, procurement policies, formal and informal, have been used to buttress computer and telecommunications suppliers in countries ranging from West Germany (Siemens), to Japan (NEC, Hitachi, Fujitsu, Oki), to Brazil (many manufacturers that remain small by international standards). Import penetration levels for telecommunications equipment range from less than 1 percent in Japan, and under 3 percent in France and West Ger-

Box N.-Regulation and Deregulation *in* Foreign Telecommunications Markets

Events over the past decade in the **Federal Republic of Germany** (FRG) illustrate the potentially high costs to businesses of government policies that shelter all aspects of telecommunications. West Germany's state-owned monopoly, the Bundespost, m a iunchallenged authority over mail, telephone, telegraph, all forms of data (andnradio/TVns, broadcasting; pointat onegencyswent far as to ban MickeyMouse telephones.Now the last remaining major industrial country with a total telecommunications monopoly, pressures for change have mounted rapidly in the FRG, not only from business leaders critical of despost for putting roadblocks in the way of new telecommunications teclbutlogifrom other parts of the government. Meanwhile, the Bundespost and its political allies have fiercely resisted change.

Perhaps the first sign of real loosening in the German regulatory approach came in 1986, when the Bundespost began permitting manufacturers of modems (used for transmitting digital data over the telephone system) to market them directly.[2] Nonetheless, a company wishing simply to link computers in two adjoining buildings must still go through the Bundespost; users must get approvals for each modem, along with private switching systems, LANs, and other hardware installations. Laws governing transborder data flows (TBDFs) also require that some data processing take place in Germany, restricting access to on-line databases maintained outside the FRG, as well as limiting some kinds of VAN services.

The Germans, therefore, despite their generally favorable stance toward liberal trade, have been put in the position of defending a tightly regulated telecommunications monopoly, an irony that does not escape them. An expert committee including representatives of business, political, and technical interests has been established by the government to examine the question of reorganizing the Bundespost. Further slow deregulation will probably follow in the wake of the modem decision; as a next step, private firms may perhaps be allowed to resell leased lines and establish some types of VANs. Several American-owned firms, including IBM, are moving to establish limited-service VANS, but the Bundespost will probably succeed in keeping private firms, regardless of ownership, from supplying services that it expects to offer, such as electronic messages.

Although slow to deregulate, the FRG has been in the lead in seeking European agreement on ISDN, with the Bundespost announcing ambitious plans. Other countries have tended to see German efforts to move quickly toward European standards for ISDN as an attempt to create advantages for the FRG's equipment manufacturers —notably Siemens, traditionally favored by the government. Siemens, which supplies nearly half the equipment purchased by the Bundespost, has made heavy commitments to ISDN hardware design, developing an entire line of products from components to mainframe computers and CO switches to take advantage of its position and experience, As this and other examples suggest, a good deal of trade-related friction concerned with telecommunications over the next few years will mix questions of equipment and services.

In **France**, the Direction Generale des Telecommunications (DGT) maintains a regulated monopoly in basic services, but limited competition has been permitted in value-added services. Private firms can seek approval to offer services through the DGT's Teletel/Minitel videotex system, which makes use of the public telephone network.

hasetel/Minitek l y become the most successful videotex system in the world, thanks to subsidies providing free terminals for home use. The government has also made it easy for private firms to enter the information services business through a vehicle called *Kiosque*. Approvals are simple, and the DGT even offers programming assistance. Of the nearly 2,000 serv-

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[1] P. Cogez, "Telecommunications in West Germany," Berkeley Roundtable on the International Economy, University of California, Berkeley, 1985. Also G. de Jonquieres, "Crossed Lines in an $80bn Industry," *Financial Times*, July 5, 1985, p. 14; R Thurow and P, Gumbel, "Big German Monopoly Ties Up the Telephone and Irks Competitors," *Wall Street Journal*, Oct. 24, 1985, p. 1.

'or background/deregulation primarily in the United States, see G.W. Brock, *The Telecommunications Industry: The Dynamics of Market Structure* (Cambridge, MA: Harvard University Press, 1981).

[2] "Bundespost Reaches Deregulation Milestone," *Financial Times*, July 31, 1986, p. 6. Previously, the Bundespost, as sole source of supply, sold rather primitive modems at double or triple the prices common in other countries, while also prohibiting computer equipment with built-in modems.

ices available, perhaps two-thirds cater primarily to business and professional customers, with the rest directed at households; banking and financial services have been especially popular.[3]

Indeed, the demand for ***Kiosque*** services-now about 50 million calls per month—quickly overloaded the TRANSPAC network (a DGT subsidiary), the primary vehicle for Teletel/Minitel services. Users of the French telecommunications system had been urging faster deregulation, and the DGT's failure to anticipate TRANSPAC's capacity problems added to the pressures. These must be counted as the failures of success. Since most of the ***Kiosque*** services bring in revenues to the DGT (roughly 30 percent of user fees go for billing services and network access), the agency has more than recouped the cost of the terminals it has supplied. Not only has the Teletel/Minitel system stimulated expansion of private IT services in France, but the public has been largely won over, which will reduce barriers to the further spread of information technology in French society.

The French Government approved an ambitious ISDN program in 1982, providing, even in the early stages, for bi-directional videotex service, and has promised liberalization of VANS. Thus far, however, foreign participation in proposed new services has been limited to joint ventures with French companies.

In **Japan, shares in the** domestic carrier, NTT, formerly a public corporation, are being sold to private investors. Under legislation that took effect in 1985, the government will retain 51 percent of NTT's stock; foreigners can only buy shares through joint ventures having majority **Japanese ownership.** The government will permit other companies to compete with NTT in the **market for Class *1* or basic telecommunications services (with foreign interests restricted to minority joint venture-positions). With some half-dozen new Class *1* rivals,** NTT **may eventually face substantial competition; like the** RHCs **and BOCs in the United States, it will have to adjust its rates and reduce cross-subsidization to match the prices of its competitors. However, unlike** AT&T **in the U.S. market,** NTT did not have to subdivide into regional or local operating companies. This should make it easier for NTT to pursue its goal of establishing a nationwide ISDN network.

Japan's Business Communication Law estab**lishes a second category of Class 2 or enhanced services; these include VANS, whether or not they make use of Class 1 network services.** The law provides for two types of VANs, General and Special. Private corporate networks account for most of the General VANS, which have been left largely unregulated. Special VANS, including all inter-firm networks, remain under relatively tight controls. Because of this, only nine applications had been made for Special VANS as of the end of 1985, while more than 175 companies had registered General VANS with the Ministry of Posts and Telecommunications.[4] In a typical application, Nomura Computer Systems supplies ordering and point-of-sale terminal services to more than 2,500 7-Eleven stores in Japan.

As in Germany, telecommunications equipment sales in Japan were, for many years, the province of a small group of firms—the so-called DenDen family, consisting of NEC, Hitachi, Fujitsu, and Oki. NTT, which did not manufacture equipment, nonetheless spent large sums on R&D, transferring the results to its favored suppliers. An intense trade dispute with the United States over the purchase of switching systems and other equipment led to the resignation of NTT's president in 1981. **The** new president was reportedly given a mandate to increase foreign purchases, but progress has been slow: NTT purchased 14 million dollars' worth of U.S. equipment in 1982, $45 million in ***1983,*** and $130 million in 1984 and 1985. With business users beginning to express dissatisfaction with NTT's services, frustration over efforts to change NTT practices from within-coupled with a widely perceived need to respond in some way to the challenge posed by deregulation in the United States-set the stage for the market-opening steps that came in 1985 Liberalization will probably

[3] **B. Tilge,** presentation at **CIT-Alcatel** sales meeting, Charlottesville, VA, July 15-18, 1985. Also see "Output Outlook by Sector," ***Japan Report—Science and Technology,*** Joint Publications Research Service **JPRS-JST-86-070-L,** Oct. 30, 1986, p. 50; P. **Betts,** "Controls Eased on Telecommunications Services in France," ***Financial*** *Times,* **May 21,** *1986,* p. 2; **J.A.** Hart, "The **Teletel/Minitel** System in France," ***Network World,*** forthcoming.

[4] **"Output** Outlook by Sector," **op.** cit., p. 50. **The** number of VAN applications has since passed **250—"Status** of Liberalization of International VAN Reported," ***Japan Report-Science and Technology,*** Joint Publications Research Service **JPRS-JST-86-082-L,** Dec. 17,1966, p. 111. Translated from ***Nikkan Kogyo Shimbun,*** Sept. 1, 1986.

For the 7-Eleven example, below, see T. **Murtha,** "Tokyo Takes Off–Slowly," ***Datamation,*** May 1, 1986, p. 60.

help Japanese firms compete in international markets for services, as well as equipment.

The United Kingdom has also begun to deregulate, with the Thatcher Government separating British Telecom (BT) from the British Post Office in 1981, and, 3 years later, selling 50.2 percent of BT's stock to the publics The government also licensed a private telecommunications firm, Mercury, to compete with BT. Moreover, with the value-added network services licensing act of 1982, and later clarifications, Britain has greatly liberalized its markets for value-added services. Although licensing procedures for VANS remain in a state of flux, some 200 plus had been registered by the end of 1986, more than in the rest of Europe combined. These provide services that include teleconferencing, ticketing and seat reservations for British Rail, theater and concert tickets, access to databases, accounting and statistical packages, telephone information services, credit authorization, real estate information, insurance quotations, and news. Moreover, the rapid pace of deregulation in Britain, compared with the rest of Europe, has attracted many MNCs seeking to centralize their European data-processing and telecommunications operations; EDS, for example, is investing heavily in the United Kingdom, and expects to employ 4,000 people there by the end of 1967.

In some contrast, Britain's videotex system, Prestel, has had little success, in part because Prestel was based on household TVs equipped with expensive decoders. Many services geared to home consumers failed to prosper, although a few—home banking, news headlines, stock quotation services-have survived.

Mercury, BT's new competitor, plans to limit its service to larger urban markets, linking them via fiber-optic cables laid along the nation's railway tracks. Mercury will be able to target business customers, taking advantage of the digital broadband capabilities of its network. BT, much like AT&T in the United States, has a large existing infrastructure-much of it based on obsolescent technology--but gets advantages from the geographic breadth of its coverage. Nor is it clear that Mercury will prove a viable rival. Unlike the Japanese, the British have placed no restrictions on foreign ownership of either telecommunications carrier, but given Mercury's relatively modest plans, and a commitment by the government to restrict the field to these two firms until 1990, liberalization in the United Kingdom has something of a cosmetic appearance. Still, BT has already cut its prices to match those offered by Mercury.

Brazil's telecommunications and informatics policies, which quite openly shield Brazilian computer, software, and telecommunications equipment firms, have led to considerable friction with the U.S. Government.[6] Other developing countries have looked to Brazil's policies as a possible model, while the Brazilians themselves have sought to adapt some features of the Japanese model. Even so, two other relatively industrialized developing countries, Mexico and India, have recently opened their markets somewhat, after earlier pursuing policies more like Brazil's.

As in France, Germany, and Japan, TELEBRAS, the Brazilian PTT, follows a policy of preferential procurement: only if Brazilian firms cannot supply the needed equipment does TELEBRAS turn to foreign sources. Brazil currently imports perhaps 10 percent of its telecommunications equipment. When it comes to computers, Brazilian informatics policy likewise has been intended to strengthen the country's technological capabilities and reduce its dependence on imports. Thus the policy includes direct import barriers as well as preferential procurements-actions that have been widely supported by Brazilian hardware manufacturers and nationalist political groups. In 1984, the legislature passed a measure barring foreign firms from producing or selling most micro- or minicomputers. Imports have dropped precipitously, from about 70 percent of the market to 20 percent.

[5] F. Bar, "Telecommunications in the United Kingdom," Berkeley Roundtable on the International Economy, University of California, Berkeley, 1965; G. de Jonquieres, "The Muddle That Is Slowing VANs," *Financial Times*, Sept. 10, 1S66, p. 19; G. Shaw, Opening Address at World Telecommunication% 1986, London, Dec. 1-2, 19S6.

[6] See *Transborder Data Flows and Brazil* (New York United Nations Centre on Transnational Corporations, 1983). While the title suggests a narrow focus, in fact this study deals with Brazilian telecommunications policy as a whole. Also A. Riding, "'Brazil's Prickly Computer Policy," *New York Times*, Apr. 29, 1984, p. D4; A. Riding, "Brazil's Protected Computers," *New York* Tim#S, Sept. 16, 1985, p. 32; "Only Three Countries' Computer Industries Can Meet Even Part of Needs, Report Says," *International Trade Reporter*, May 21, 1986, p. S9S. Primarily on computers, see C. Frischtak, "Brazil," *National Policies for Developing High Technology Industries*, F.W. Rushing and C.G. Brown, eds. (Boulder, CO: Westview, 1986), p, 31.

Foreign telecommunications firms can offer services so long as these do not challenge the PTT's monopoly. Gateway services like GTE/Telenet operate in Brazil; so do closed user networks like SWIFT and SITA (the international airline reservation system described in box R below). But all leased lines and cross-border VANS must be authorized, there is virtually no intellectual property protection for computer software, and the government restricts access to foreign databases unless a national security need can be demonstrated.

Some users of IT services in Brazil, as well as subsidiaries of foreign firms, continue to press for changes in these policies, but to little effect.

Domestic computer manufacturers matched the sales of foreign firms for the first time in 1984. The military supports the telecommunications and informatics policies, along with nationalists on both right and left politically. Brazil's Government has responded to U.S. objections to its discriminatory policies by pointing to the country's need to reduce imports and keep the economy growing in order to pay off foreign loans. The policies have not been cost-free. Prices of telecommunications services and computers in Brazil are high, quality of products and services poor. But the political costs have been small, and the policies will likely be continued.

many, to 9 percent in Britain, and 14 percent in the United States.[26] Nonetheless, European equipment markets have begun to open up somewhat—in part because high R&D costs for new generations of CO switches are forcing firms into joint endeavors. Deregulation of value-added services has also begun in some countries, but VANS remain government monopolies in at least five European nations, and PTTs view them as threats to revenues from telex services (the electronic mail of an older technological generation).

The Telecommunications Infrastructure

Basic telecommunications—transmission of voice, messages, and digital data—provides the infrastructure for new services as well as those that have been familiar for years. Most of these new, or enhanced, services provide additional data communication functions. Examples include protocol conversions, so that different computers can talk to one another, message storage and electronic mail, and on-line access to large databases. Over the next several decades, current generations of digital equipment –Phase II in table 20–will be supplanted by ISDN systems, able to handle higher volumes of data communications traffic, and, as the name implies, eventually integrating the broadband capability needed for video into the network.

Phase I in table 20 describes the infrastructure in most industrialized countries as of the early 1970s—a system almost entirely analog (also see box O), During the 1970s, software-programmable CO switches—in essence large computers—began to replace electro-mechanical crossbar technology. At this point, network functions began to move beyond simple transmission of messages, while—with declining costs for microelectronic devices—voice transmissions could be sent over digital lines as easily as data originating in digital form. Today, most local U.S. telephone service continues to utilize analog circuits, while digital long-distance transmission has become common. Phase II also brought greater use of satellite links, and the first installations of fiber-optic cables, which transmit via light rather than electrical signals. Satellite and fiber-optic transmission make possible broadband links, capable of carrying video signals along with voice and data. Packet-switching—which breaks messages down into short bursts, or packets, that can travel by varying routes, to be recombined at their destination—helps carriers utilize networks to their full capacity.

With broadband capability, system designers can contemplate an integrated network, one capable of handling voice, data, facsimile, and video signals. The spread of such ISDN systems

[26] "U.S. and Europe Dominate $150bn World Market," *Financial* Times, Oct. 21, 1985, p. 4.

Table 20.—Three Phases of Telecommunications Technology

Phase	Time period	Circuitry	Switching system	Physical infrastructure	Services
I	Into the 1970s	Analog	Electro-mechanical crossbar	Mostly copper cable[a]	Telephone, telegraph, telex
II	Present	Analog/ digital mix	Circuit and packet switching	Above, plus micro-wave, satellite, fiber-optics	Above, plus high-speed data communications and facsimile
III (ISDN)	1990s	Digital	Virtual routing and messaging	Above	Above, plus video and broad-band data

[a]Microwave and satellite links began coming into service during the 1960s

SOURCE Office of Technology Assessment, 1987

will mark the transition to Phase III during the 1990s—a transition that will probably be driven largely by demand for cheaper data communications (rather than, say, video). The range of services will continue to expand, as pointed out in box O, but the transition from Phase II to Phase III will be very expensive—in the hundreds of billions of dollars worldwide over the next several decades—the more so if different parts of the world (or different regions in the United States) adopt incompatible standards.

Value-Added Services

Both intra- and inter-firm communications will become easier and cheaper as the telecommunications infrastructure shifts toward a fully digital system. With ISDN, a customer will be able to plug any terminal device—telephone or PBX (private branch exchange), computer or terminal—into the network and communicate with any other terminal device. VANS of all types will expand, both dedicated networks—as used in banking or for airline reservations—and those such as Tymnet and Telenet that simply provide network services to many of their customers. It will also become easier for corporations to establish private networks. Today, only large companies like IBM and General Motors (whose EDS subsidiary is developing a corporate VAN, box P) can afford these investments. Indeed, as box P suggests, much of the pioneering technical development for ISDN-based VANS will probably be done by private companies, some of which will no doubt seek to use the knowledge gained through internal projects to market services to other firms.

VAN Markets

Today, most VANS in the United States use some combination of private lines (often leased) and the public infrastructure. In other nations, where PTTs may require that all VAN communications use the basic telecommunications network, costs may limit expansion. Even so, the VAN market worldwide provides many opportunities for American firms, as does that for information services (discussed in the next section).

Fundamentally, public VANS (as opposed to private networks for intra-firm communications) offer two types of services: 1) system management for data networks; and 2) system applications, such as electronic funds transfers, videotex, or database access. The first category of firms—systems managers—offer national or international telecommunications on a single-source basis; companies like Telenet (box Q) sell ease of access. It is the VAN provider that deals with PTTs in various countries, centralizes billing, and assembles and maintains the network management software. By leasing lines on a flat rate basis from a common carrier (normally the PTT), and reselling the capacity on a volume-sensitive basis, these VANS offer a package of services at a lower price than customers could provide on their own. Some also design dedicated private network for particular customers; Telenet, for instance, has put together more than 60 such packet-switched networks. Finally, VAN suppliers can create hybrid networks, interconnecting a customer's dedicated network with their public VAN to save on costs for connection to remote sites,

Box O.—Integrated Services Digital Networks (ISDN)

As **table 20 indicates, the current Phase II telecommunications infrastructure mixes analog and digital telephone service, along with digital data transmission, and a telex/telegraph system (plus local cable TV). Fully digital systems, which require low-cost means for transforming voice communications from their naturally occurring analog form to a string of digital "bits" (and back) only became practical during the 1970s. While the costs of replacing the Phase I system mean that some parts of the network will remain analog for many years, all-digital systems should lead to continuing reductions in data communications costs, with particular advantages for business customers. At the same time, the telephone system will become still more highly automated, while the range of services available to households will continue to expand.**

In the United States, at least one of the Bell operating companies in each of the seven RHCs is beginning ISDN field trials.[1] Japan's ambitious plans for ISDN, termed INS, or Information Network System, have begun with a pilot project in the Musashino-Mitaka area of Tokyo, in operation since 1984. Although the basic outline for ISDN standards has been agreed upon in the ITU's Consultative Committee for International Telephone and Telegraphy, negotiations continue over detailed specifications. As discussed in chapter 9, the standards-setting process will be contentious, if only because the stakes are so high. Not only will new generations of CO switches and other network equipment be needed, but a wide range of home, office, and industrial equipment will eventually be marketed in ISDN-compatible form—i.e., ready to be plugged into the network. Governments and PTTs will seek an edge for domestic equipment manufacturers.

[1]For a brief survey of the status of ISDN trials internationally, see T. E. Bell, "Technology '87: Communications," ***IEEE Spectrum,*** January 1987, p. 42.

When it comes to the second category of VANS, the supplier goes beyond the provision of network access and management, offering a package of end-user services. Examples range from Ticketron, to public VAN suppliers like GEISCO and ADP that provide funds transfer services, to networks of automatic teller machines,

SWIFT (ch. 3) links banks for messages, with the actual funds transferred by other means, while SITA (box R) provides services for airlines. Most of these specialized VANS use dedicated networks of leased lines, with their own switching and processing facilities, SWIFT is currently replacing its original system with a decentralized SWIFT II version based on regional processing centers. (Ch. 3 described the scope and function of the SWIFT consortium in relationship to member banks.) In order to provide the end services its members need, SWIFT has developed standard forms of financial messages that can be sent anywhere in the world without risk of ambiguity, as well as software packages for terminals from a range of manufacturers. The consortium maintains as well as supplies all terminal interface software, in part because security is critical (given that much of the network traffic concerns very large financial transactions),

Growing VAN markets offer U.S. firms strategically attractive—if not yet very profitable—opportunities, with companies like Tymnet, Telenet, IBM, and Computer Sciences Corp. (CSC) already significant international suppliers of VAN services. Some of these firms have expanded from a base in data processing or data communications. For DP service firms such as GEISCO and EDS, and for operators of public data networks such as Tymnet and Telenet, services like electronic mail and airline reservations represent straightforward extensions of older lines of business, Likewise, CompuServe's videotex service is based on its existing DP capabilities. Most of these firms have been seeking to expand internationally.

International thrusts by U.S. VAN providers has generally come only after regulatory barriers have started to fall. In the past, with resale of leased lines prohibited in most parts of the world, DP services firms and networks like Tymnet and Telenet could offer little more than an international connection to their U.S.-based

Box P.-EDS and General Motors' Planned Corporate Network[1]

General Motors paid $2.5 billion for Electronic Data Systems in 1964, even though EDS's annual revenues were less than $1 billion. Why? GM felt it needed help in integrating computer and communications services into its sprawling organizational structure, a job that EDS had specialized in for clients during the years that company was building its 13P services business. When it purchased EDS, GM, with a hundred computer centers and as many independent data networks, was spending more than $2 billion per year on its internal data processing and office automation needs.

Founded in 1963, EDS had long been known as a leader in batch and remote processing. Over the more recent past, the company managed to outgrow all the other large U.S. data processing firms. EDS has traditionally negotiated contracts giving it extensive control over clients' 13P functions-in many respects, providing facilities management. This sometimes put EDS in the unusual position of an outside firm that had partially penetrated the organization of its clients; the frictions that devel oped between long-time GM and EDS employees thrown together by the acquisition [GM transferred more than 7,000 of its employees to EDS) have many precedents.

Under GM ownership, EDS remains an independent operating company-in part, an attempt to preserve some of the EDS culture, markedly different from that of its new parent. GM gave EDS responsibility for all the automaker's DP-related operations; EDS will prepare the software for GM's planned worldwide data network system (some of the hardware for which is to be developed by another GM acquisition, Hughes Aircraft, purchased in 1985 for $5 billion). GM aims to integrate all of its computer and telecommunications systems, from vehicle design and engineering through links with dealers. The company will purchase CO switches, rent or buy satellite circuits, and install cable and fiber optic links to enable a network of powerful computers with advanced software to communicate with one another. Eventually, the company's 16,000 dealers, along with some 35,000 suppliers, will be part of a single network also embracing GM offices and plants in some 33 countries. Among its other functions, the network will connect a quarter of a million telephones at GM offices and plants throughout the United States—an example of total system bypass. EDS will handle data processing needs ranging from GM's 40,000 employee **health claims per year to a major new generation of automated design and production equipment. The latter, which has proven particularly difficult-in part because EDS has little experience in factory automation–includes the development and promulgation of standards** for interconnecting **computers, machine tools, robots, and other shopfloor equipment.**

This set of standards, termed MAP (Manufacturing Automation Protocol, also see ch. 9), has been accepted by a large number of outside firms-and not only those wishing to sell to GM-because it will allow simple interconnection of a wide variety of equipment. EDS, along with other companies including Boeing (another pioneer in DP services through its Boeing Computer Services division), is also pursuing an initiative called TOP (Technical/Office Protocol], aimed at standardizing interconnections for office automation equipment.

When complete, the GM/EDS system will handle information including the folIowing:

- **dealer orders, together with customer financing and insurance information;**
- **engineering and design data;**
- **manufacturing data, including software for computer-controlled production equipment;**
- **accounting, financial, and tax information;**
- **personnel and payroll data, including electronic funds transfers for wage and salary deposits;**
- **intra-corporate billings and payments;**
- **employee health insurance and claim information, along with other fringe benefits;**
- **government and financial reporting;**
- **intra-corporate electronic mail; and**
- **voice message and voice storage service,**

[1]S.T. McClellan, The *Coming Computer Industry Shakeout (New* York: Wiley, 1984), pp. 138-145; F. Barbetta, "EDS Building Corn Net for GM," *Electronic News,* May 13, 1&5, p. 1; "Large Corporations Develop In-House Networks in Divestiture Aftermath," *Electronic News,* May 20, 1985, p. 1; J. Holusha, "Acquisition Is Expected To Aid G.M. Plans for Diversification," *New York Times,* June 6, 1035, p. 47; "Survival of the Fattest," *The Economist, Oct.* 12,1985, p. 35; "Electronic Data Systems: Logical Move," The *Economist, Dec.* 21, 1985, p. 94; D.E. Sanger, "E, .D.S.'s prospects In the Aftermath," *New York Times,* Dec. 2, 1986, p. D5.

Box Q.—Telenet

Telenet, established in the mid-1970s, was one of the first public data networks to make use of technology based on the Department of Defense's ARPANET packet switching system. By 1986, Telenet was transmitting the equivalent of more than a million typed pages each day. In the United States, users can tap into the network either through dedicated lines to a host computer or a local telephone call to one of Telenet's dial-up nodes. Telenet also offers services such as electronic mail and credit card verification.

The network makes use of dedicated lines and domestic satellite circuits. With the recent merger of Telenet, Sprint (both previously owned by GTE), and U.S. Telecom to form U.S. Sprint, Telenet will have access to a fiber-optic transmission network that will become the core of its domestic system. The firm provides international access through PTTs (in more than 70 countries) or directly to one of Telenet's international gateways (in 24 nations). In 1983, the FCC designated Telenet an International Record Carrier (IRC); as an IRC, the firm can provide international gateway and network services directly, without going through another international carrier.

Box R.—Societe International de Telecommunications Aeronautiques (SITA)

A cooperative organization of nearly 300 airlines, SITA operates the world's largest specialized telecommunications network. Started in 1949, the SITA network now joins about 16,000 airline offices in more than 1,000 cities. SITA's major switching centers—in New York, Atlanta, Los Angeles, London, Amsterdam, Frankfurt, Paris, Madrid, Rome, Bahrain, Singapore, Hong Kong, Tokyo, and Sidney—make use of dedicated lines leased from common carriers, as well as satellite circuits. In addition to telecommunications, SITA offers its members a variety of data-processing services.

The cooperative's GABRIEL II passenger reservation system, centralized at the Atlanta and London centers, connects with the networks of individual airlines, such American's Sabre, while also providing hotel reservation services, credit card authorizations, baggage and air cargo tracking, flight planning, and weather forecasts from around the world. Some of these services, such as passenger reservations, are indirect competition with those offered by member airlines—e.g., Sabre and United's **Apollo.** But while the airline networks serve travel agents, SITA does not. Much of the general message traffic—flight safety notifications, information on aircraft movements and lost baggage, reservations and ticket sales —still takes place via telex/teleprinter facilities, But with computer-to-computer traffic growing rapidly, SITA has established a new packet-switched network for data communications,

networks. While this is still the case in most countries, VAN providers can now compete directly with PTTs in a few nations—an opportunity that brings with it risks over and above those of competing with other private firms.

With many government-owned or supported PTTs entering the data network business—e.g. the DGT's TRANSPAC in France—private firms will need to offer differentiated services, given that the PTTs will always be able to undercut their prices. Beyond this, some enhanced services, such as electronic mail, substitute for (and supplement) regulated services or monopoly PTT services, such as telex. A number of specialized VANS, notably SWIFT, were established because the PTTs could not cope with demand; the PTTs permitted SWIFT to bypass their monopoly telex services only because the rapidly growing volume of inter-bank messages threatened to overwhelm them. Private VANS threaten PTTs both directly and indirectly, and some PTTs will no doubt use their power to control or limit VANS that promise to compete too effectively.

As box N suggested, U.S. firms will probably have little choice but to enter many foreign VAN markets through joint ventures with local companies. Of those countries that have already established legal guidelines for VANS, Japan has gone perhaps the farthest in restricting foreign firms to minority ownership. Despite the disadvantages of such arrangements, IBM has chosen to enter joint ventures with NTT and Mitsubishi, Tymnet has established a venture with Hitachi, GEISCO with NEC, and AT&T with a group of 18 Japanese firms.

When it comes to telecommunications, U.S. trade policy has generally focused on opening up foreign markets for American equipment manufacturers. Progress in this arena has been slow, with governments unwilling to abandon policies of sheltering domestic manufacturers, and PTTs to abandon their own ties with these firms. Markets for telecommunications services, in some contrast, seem to promise greater openness, particularly for VAN suppliers.

Lacking the deeply rooted obstacles that slow liberalization in equipment and basic services, VANS will probably evolve in a relatively lightly regulated environment in many parts of the world. At the same time, these services will certainly pose threats to PTTs. With VANS heavily dependent on leased lines, for which they now typically pay flat rates, the first reaction by some PTTs will probably be to raise their charges, or seek regulatory approvals for volume-sensitive pricing. With leased-line policies crucial to the success of VANS, both tariff schedules and possible restrictions on entry (or discriminatory tariff rates) become policies that the United States will need to monitor. Although some countries may eventually allow private firms to install their own lines, bypassing PTT facilities entirely, so far only Britain and Japan (besides the United States) have made this choice.

Videotex

Videotext and teletext—or videotex, referring to both—provide information services ranging from news and weather reports, to business and financial information, teleconferencing, electronic stock trading, on-line shopping, and even computer games. In essence, they are specialized VANS.

Teletext refers to one-way transmission of text—e.g., news information. Typical videotext services—now available over the telephone to anyone with a PC—combine text and graphics interactively, Videotex services differ from information and database services intended for professional and technical markets largely in the type of information provided, with the professional/technical products tending to be specialized and expensive. Many videotex systems provide a single gateway to a wide variety of services, as exemplified by the hundreds of offerings available through Teletel/Minitel in France (box N].

When the videotex business began to grow in the United States during the early 1980s, Dow Jones News Retrieval and The Source each offered a wide range of easy-to-use services, with CompuServe quickly following. These three firms now split the great majority of the U.S. market, continuing to match each other's offerings. Videotex, particularly for household subscribers, has been a domestic business almost entirely; with the more successful products supplied over phone lines to PCs, foreign subscribers must be willing to pay high charges. Because cross-border service will probably continue to be expensive, videotex suppliers that wish to penetrate foreign markets will have to invest overseas. In some countries, American firms will probably be limited to providing specialized services to the PTT's own monopoly videotex system.

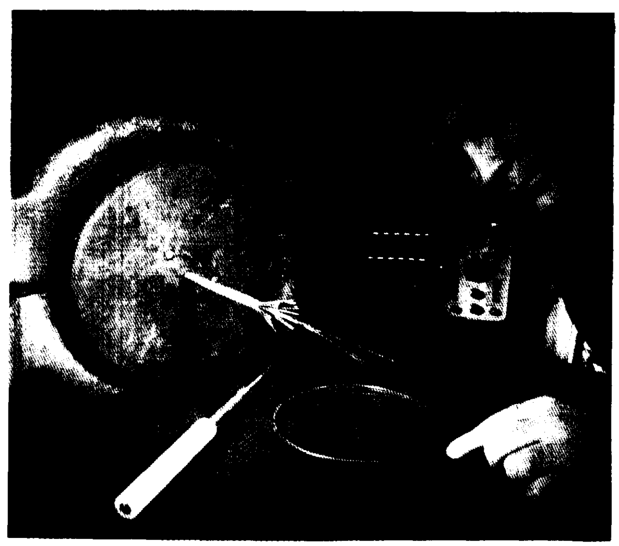

Photo credit: AT&T Bell Laboratories

Optical fibers emerging from pressure vessel simulating deep sea conditions.

DATA PROCESSING AND INFORMATION SERVICES

As the costs of computing equipment dropped, companies that once contracted out some processing began doing more of their own. Widespread availability of packaged software for standardized applications contributed to this trend. While falling data communications costs work in the opposite direction, the DP services industry has nevertheless been suffering from stagnant or even declining demand. The number of firms in the industry has dropped, along with their average size. Information and database services have replaced processing as a growth sector.

The DP Services Industry

With computing applications continually expanding, DP firms have needed to search out ways of keeping ahead of their customers, offering services that will attract even large and sophisticated end-users of computing equipment. As the market for more routine processing stagnated, they have sought new ways to capitalize on specialized expertise or equipment. Beginning with batch processing, and later time sharing, many have diversified into support activities including system design and management. Early entrants like McDonnell Douglas, Boeing, and Martin Marietta—primarily aircraft and aerospace manufacturers—began offering services to take advantage of the experience they had accumulated in their primary businesses. Today, all three are moving, along with other DP firms, into information and network services. Others train personnel for clients, write software, install and maintain large government or corporate computer/telecommunications systems, and provide consulting services to companies contemplating purchase of large-scale systems. Some help firms set up intra-corporate VANS, or increase the efficiency with which they use existing equipment. Others sell time on supercomputers. CompuServe, a remote DP specialist now owned by H&R Block, used its spare capacity to become the leading provider of videotex services to small computer owners. With the hospital market dominated by two well-established companies, Shared Medical Systems and McDonnell Douglas, Amherst Associates carved out a niche by adding financial planning and modeling services tailored for medical centers, For other examples, see box S.

The largest DP firms are American, led by ADP with 1985 revenues of $1.1 billion, EDS at about $980 million, and Computer Sciences Corp., $800 million.[27] As in the software industry, the more typical DP firm, in the United States or abroad, is a relatively small company providing specialized services, but it is the large firms that account for most of the international trade and investment. As table 21 shows, the global market exceeds $26 billion. However, only 2.6 percent of all U.S. DP establishments (173 of 6,700) reported export revenues when surveyed for the 1982 Census of Service Industries.[28] OTA estimates that total foreign DP services revenues of U.S. firms came to $2.7 billion to $5.1 billion in 1984.

The larger DP companies rely heavily on raw computing and telecommunicating power. To compete for processing jobs involving the manipulation of vast amounts of data or very demanding computational problems takes clusters of large mainframe computers, perhaps supercomputers, operating, if possible, around the clock. This in turn leads to marketing approaches that include reduced prices for off-hours business use, and geographical diversification to attract customers from different time zones. Heavy capital equipment costs in this part of the business limit the competition to a relatively small number of firms operating clusters of networked computer centers.

Most of the new international opportunities for DP firms will probably be found in VAN and information services. Companies with an existing network of computer centers will start

[27] "The Datamation 100," op. cit.

[28] *1982 Census of Service Industries: Miscellaneous Subjects* (Washington, DC: Department of Commerce, December 1985), p. 5-142. Foreign receipts accounted for 8.8 percent of total industry revenues.

For the OTA foreign revenues estimate, below, see *Trade in Services: Exports and Foreign Revenues*, op. cit., p. 62.

Box S.-Data-Processing Service Firms: Two Examples

ADP:[1] The world's largest independent DP services supplier, Automatic Data Processing Inc. (ADP) has been seeking to adapt to marketplace shifts by developing new products based on its traditional strengths. For more than 35 years, the company has specialized in back-office automation—not only accounting and payrolls, but counting, labeling, sorting, and otherwise processing documents including stock certificates, canceled checks, sales receipts, and credit-card slips. Not surprisingly, their strongest competition comes from the in-house DP departments of large firms—one reason for a strategy built around many smaller customers (in contrast to EDS, which gets most of its business from a few big contracts).

ADP began by automating payroll processing for its customers, relying primarily on mechanical sorting and printing machines; by the early 1960s, the firm had become an intensive user of large mainframe computers. Today, nearly half of ADP's revenues come from its Employer Services division: the company handles about 10 percent of all U.S. private sector paychecks. ADP has also been diversifying into front-office brokerage services, as well as processing data for car dealers, banks (including ATM services), and insurance companies. In 1983, the company purchased the stock quotation unit of GTE's Telenet subsidiary, and 2 years later added Bunker Ramo Information Systems, a firm with 30 percent of the on-line stock quotation market. Besides moving aggressively into brokerage services, ADP is trying to win sales in data processing for automobile insurers and repair shops, by, for example, offering a database containing information on 35 million automotive parts to speed repair estimates. The company has extensive overseas operations, particularly in Western Europe, where it has followed generally similar strategies.

GEISCO:[2] General Electric Information Services Co.-established in the early 1960s to operate GE's remote processing facilities—has been a major force in the time-sharing market, as well as in network services. While GEISCO once maintained more than a dozen regional centers and operated several dozen time-sharing systems to supply services to major customers, decreasing data communications costs have led to a more concentrated system. Like other firms with extensive networks, GEISCO has moved its remote processing centers from urban areas into regional clusters servicing numerous cities. Today, the firm operates "supercenters" in Rockville, Maryland, Cleveland, and the Netherlands, where 35 mainframes have recently been replaced by just 11 still more powerful machines.

Because many companies want to link their own systems so that all offices have access to a common corporate database, GEISCO now offers its customers VAN services. The firm has also become a major provider of network services to banks (ch. 3). GEISCO has thus evolved from providing a menu of relatively discrete remote DP services to operating a farflung integrated network with links to customers available through both private and public telecommunications systems. GEISCO has recently purchased several smaller companies to add to its capabilities in accounting/financial software, oil and gas company services, and ATM services.

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[1] "A Number-Cruncher Wants Out of the Back Office," *Business Week*, Dec. 9, 1985, p. 86; P.W. Barnes and A. Monroe, "Automatic Data Processing To Acquire Bunker Ramo From Allied-Signal Inc.," *Wall Street Journal*, Nov. 18,1985, p. 6; p. Archbold and p. Hodges, "The Datamation 100," *Datamation*, June 15, 1S86, p. 95.

[2] OTA interviews; also C. Wiseman, *Strategy and Computers* (Homewood, IL: Dow-Jones Irwin, 1985), pp. 148-151 and "The Datamation 100," op. cit., p. 93.

Table 21.— Data Processing Services Markets, 1986

	Revenues (billions of U.S. dollars)
United States	$19.5
Japan	3.5
France	1,5
Federal Republic of Germany	1.0
United Kingdom	0.9
	$26.4

SOURCE *1987 U S Industrial Outlook* (Washington DC Department of Commerce January 1987), p 471

with advantages in VAN markets. At the same time, the technological lead of the United States in specialized applications—e.g., use of supercomputers—should mean continuing new opportunities for firms choosing to remain active in this part of the business.

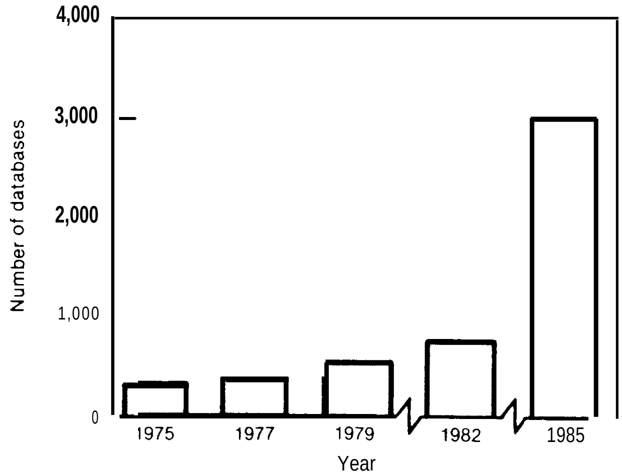
Database and Information Services

This subset of the IT services starts from a much smaller revenue base than data processing, but has great potential for growth—in part through close ties with VAN and videotex markets. Indeed, on-line database services—those available via computer terminals—are simply one type of VAN service. Once again, reduced costs for computer hardware and advances in telecommunications, will make it easier and cheaper for customers to tap on-line databases and for suppliers to provide interactive services (for instance, models for predicting economic growth that the client can exercise under differing assumptions). Figure 35 shows the growth in the number of machine-readable databases available worldwide, The rapidly increasing installed base of PCs, which provide cheap and convenient terminals for many of these applications, has contributed to the swelling demand for database services suggested by figure 35—and also by figure 36, which shows the rise in on-line searches of these databases over the past decade,

With many small computers being purchased for home use, as well as by businesses, two types of products dominate the information services industry:

1. Professional and technical on-line services (Quotron, Mead Data Central's NEXIS/LEXIS, Standard and Poor's COMPUSTAT, Lockheed's DIALOG, Datastream in the United Kingdom and DATEV in Germany), which offer such products as business and economic data, or scientific citations.
2. Videotex or similar services (CompuServe, Dow Jones News Retrieval, The Source), oriented primarily to small business and household users.

Figure 35.— Publicly **Available Databases Worldwide**



SOURCE M E Williams "Database Data, " prepared for OTA under contract No 633-3210

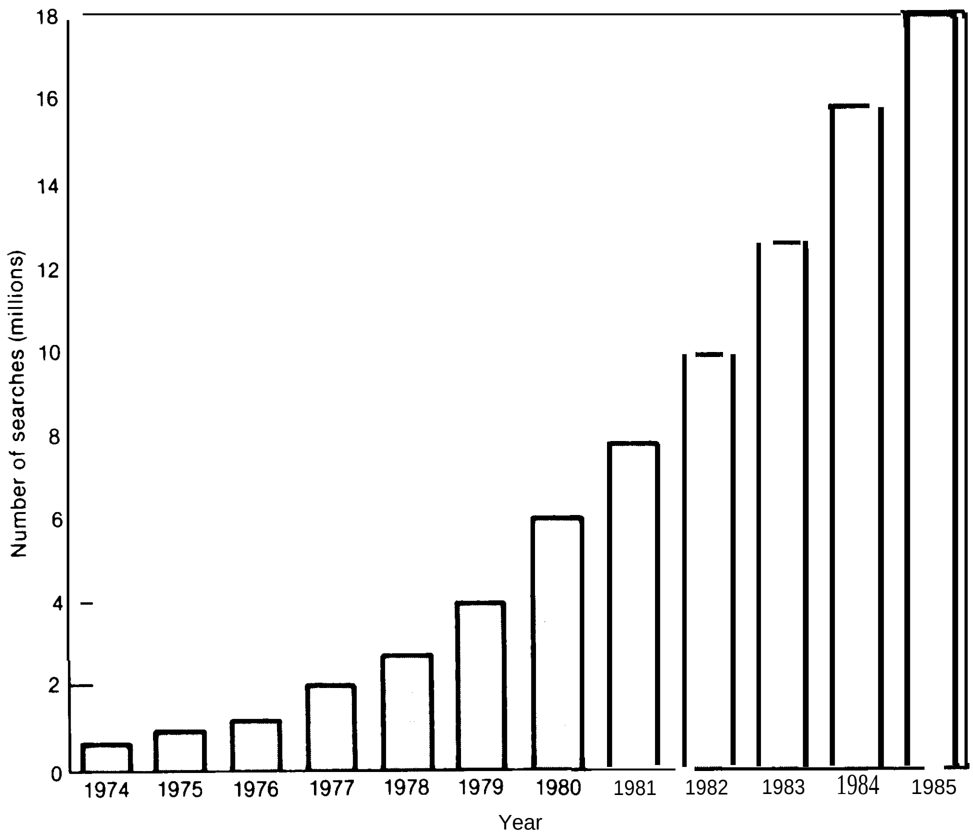
As table 22 shows, professional and technical services remain the largest markets, with credit, financial, and economic information accounting for two-thirds of total industry revenues in 1984.

Table 22.—U.S. Markets for Electronic Information Services

	Revenues (millions of dollars)		
	1984	1989 (projected)	Projected annual growth rate
Business and consumer credit	$ 447	$1,050	19%
Financial	389	720	13
Economic	222	320	8
Legal and government	184	350	14
Scientific	102	220	17
Business news	98	330	27
Marketing and media	69	150	16
Personal and household Information services	78	470	43
	$1,589	$3,610	18%

SOURCE *Electronic Information Industry Forecast 1984-1989* (New York LINK Resources Corp May 19851

Figure 36.—On-line Database Searches



SOURCE M E. Williams "Database Data, " prepared for OTA under contract No 633-3210

COMPUSTAT provides detailed firm-specific information of interest to investors. NEXIS supplies the complete text of news stories. LEXIS lists judicial cases and decisions, a service widely used by lawyers and legal researchers. NewsNet, a relatively new full-text service, provides on-line access to over 250 specialized newsletters. Such databases must be constantly updated. They also demand substantial investments in initial design and development. Competitive success depends on understanding the needs and demands of end-users. Firms that have grown up supplying information services in print form have sometimes had trouble moving into electronic database markets, as illustrated in box T. Staff must be retrained and people with new skills—e.g., in computer systems –hired. The design phase tends to be especially demanding.

As figure 37 shows, two-thirds of all databases available on world markets originate in the United States. The number of on-line databases available from U.S. sources grew by a factor of 10 over the years 1977 to 1985, from 212 to 2016; those originating in the rest of the world increased more slowly, from 154 to 824.[29] Nearly 20 percent of the revenues of U.S. database suppliers come from foreign sources, three-quarters from Europe. The Japanese market for on-line services, like that in Europe, has been

[28] "Database Data," prepared for OTA under contract No. 633-3210 by M.E. Williams.

[29] On the foreign revenues of U.S. suppliers, see *A Competitive Assessment of the U.S. information Services industry* (Washington, DC: Department of Commerce, May 1984), p. 23. Half or more of database services in Europe are supplied by U. S.-based firms. On Japan, see "Info Industry Expanding Rapidly," *Japan Economic Survey*, September 1986, p. 12.

Box T.—Moving Into New Information Markets: InfoBase Corp.[1]

InfoBase Corp. (IBC) supplies bibliographies, indexes, and related services to scientists and technologists around the world. The company, established many years ago, has distributed its products mostly in printed form, selling primarily to libraries in universities, large corporations, and government agencies.

IBC staff receive some 8,000 technical journals. Through a systematic pre-editing, coding, and keypunching process, each article is given a unique access number and address in the firm's computer system. For scientific indexes, some of the critical text abstraction work is performed at IBC's Bombay offices. Scientists stay with the firm longer in India than in the United States, particularly important to the company because of the high costs of training in IBC methods.

While the company's managers do not feel that IBC has fully exploited the potential market for its traditional products, they recognize they must develop new products as well. "Somewhere there is a company controlling just about every type of document being published, " noted one senior manager. "I don't think we can only do more of the same." Another added, "The new anxiety is that scientists feel they have too much brought to their attention already. The need is for a level of interpretation layered on top of the data." IBC has begun to experiment with three new approaches: software search tools that complement its print and on-line database products; custom databases; and interpretive or editorial products:

- *More Conplex* ***Search*** Tools-IBC has developed and begun to market a software search aid that helps users sift through many databases without the need to learn specialized methods for each. The system contains a file manager with which the user can create a personalized bibliography while offloading references from each database. IBC must develop new ways to sell this product. The company's print products were subscription items, relatively self-explanatory and inexpensive. Software, in contrast, requires active selling. The package is perceived as expensive; customers must also invest time in learning to use it. "People lack confidence," one manager said. "They know they should buy the product, but its a major investment. We have to do a lot of personalized education, which is expensive for us. " The educational effort does not end with a sale. IBC has trained a group of customer service representatives to trouble-shoot problems and help customers use the system.
- ***Custom Databases—IBC*** has sought to market specially-tailored databases to corporations, academic institutions, and government agencies. Again, this has posed difficulties. One IBC manager said, "Our sales force needs to break out of the library, and begin calling on other places where research is done—or where there is a need for information, such as stockbrokers and group health practices." But another noted, "We can't just send our sales reps out to industry without retraining. They're too academically-oriented." It has also proven difficult to estimate the cost of customizing a data tape for a customer,
- Interpretive Tools–Here, IBC has introduced a new series of products—an encyclopedia of science, Again, the company has been faced with a good deal of new learning. Its standard citation indexes are entirely objective in structure. Interpretive work means that IBC must hire writers with legitimacy and standing in the scientific community. The company has set up advisory committees of well-known scientists to help it penetrate the social network of researchers and scholars.

As these examples suggest, in moving into new, high-value-added information products, IBC must:

- retrain its sales force so that they can deal with a broad spectrum of customers, and with more complex purchase decisions;
- put together a new force of customer service representatives, who can help ***scientists*** directly, as well as deal with librarians and information specialists;

[1]**Drawn** from a **case** study prepared for OTA under contract No. 533-597o by L. **Hirschhorn.** The name of the company, and some of the details, are fictional.

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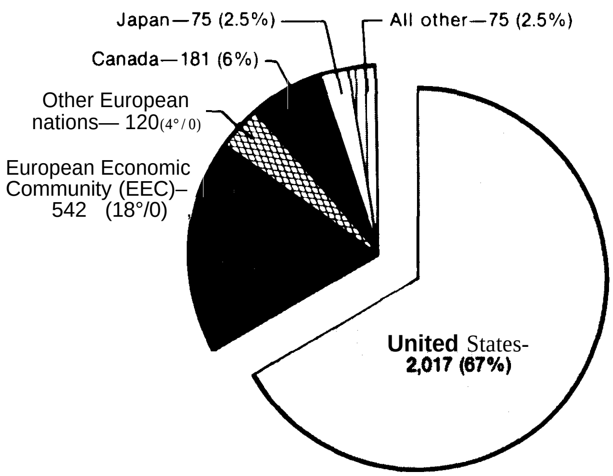
- **develop abetter understanding of how and why different end users acquire and utilize information; and**
- **extend and deepen the company's existing ties to the user community, so that its interpretive work will be accepted.**

For IBC, this means a new product development and marketing stretegy, one based on deeper understanding of its customers needs, along with a more active and sophisticated sales effort.

Figure 37.—Publicly Available Electronic Databases by Country of Origin, 1985



SOURCE M E Williams "Database Data," prepared for OTA under contract No. 633.3210.

growing rapidly, Currently, almost 80 percent of the databases available in Japan originate elsewhere. Continued expansion of videotex systems will drive growth in markets for database and information services.

As the costs of international telecommunications continue to decrease, and more countries begin to deregulate value-added services, further opportunities for American firms will emerge, Under such conditions, U.S.-based suppliers should be quite competitive, particularly those that remain sensitive to the more specialized needs of overseas users, The major policy issues likely to arise center on possible TBDF restrictions, questions of customs valuation, and protection for the intellectual property embodied in information services—as summarized below and discussed in more detail in chapter 9.

CONCLUDING REMARKS

U.S. firms have been highly competitive in the major IT services. Traditional data processing has become a relatively mature business, but software, telecommunications, and information services are in the midst of rapid growth and rapid technological change. In computer software, the United States leads the world. Trade will grow as packaged programs take over from custom software. This shift will help foreign suppliers, particularly the Japanese, in their efforts to catch up with American software firms. Liberalization of VAN markets, reduced costs for telecommunications, and steadily growing reliance by companies doing international business on both intra- and interfirm data communications point to growing telecommunications trade as well. U.S. firms offering enhanced services—e.g,, VANs—should benefit. So should American DP firms, which remain highly competitive even as they seek new lines of business. Videotex, database, and other information services—all closely related to VAN services and likewise a U.S. strength—will be perhaps the fastest growing of all the IT services over the next 10 or 15 years.

Still, it would be most unfortunate if the competitive strength of the United States led to complacency, particularly in terms of policy. The American software industry faces competitors that benefit from foreign government supports and subsidies, Weak protection for intellectual property, making it easier to copy U.S. products, also aids foreign firms. Software is expensive to develop and cheap to produce; illegal copying and counterfeiting have been endemic. For reasons outlined in chapter 9, current forms of legal protection seem inadequate. Indeed, intellectual property issues cut across many of the IT services.

A multiplicity of technical standards issues also emerge in the IT services—for ISDN, for computer interfaces, for programming languages. Given the PTT monopolies on telecommunications that still exist in most parts of the world, governments will have a major say in technical standards for ISDN—standards that will influence competition in world markets for equipment as well as services. If different parts of the world (or different regions in the United States) adopt different standards, the transition to ISDN will be more expensive.

TBDF restrictions may become a factor in more countries, along with pricing that works to the disadvantage of American firms. In the United States, congressional decisions on regulation/deregulation of telecommunications will have international ramifications. Countries that restrict transborder flows of data, although they may rationalize such policies in terms of privacy, typically seek little more than new tools to influence patterns of trade and investment (ch. 9). In the absence of major new efforts to impose TBDF restrictions abroad, the issue has receded somewhat, but it will probably reappear —if only as a reaction to continuing growth in international data communications and the fears this will create among some people and groups. Moves toward volume-related pricing could likewise prove troublesome, if foreign PTTs continue to propose pricing schedules based on the volume of data transmitted, rather than connect-time (ch. 9).

International trade in telecommunications services remains fairly small in value—seemingly disproportionate to the policy debates concerned with satellite communications or TBDFs. One reason for the heat generated by these debates is simply that new services, notably VANS, will be more tradeable than traditional services, especially if major industrial nations continue to liberalize their internal markets. Beyond this, telecommunications has become a locus of concern for European governments worried that their high-technology goods and services industries are losing the ability to compete with the United States and Japan; policy makers in Europe may be willing to pay a considerable price in terms of efficiency in the name of jobs in telecommunications.

All the IT services depend on computing capability in one way or another, The global market for computer hardware and software, already well over $100 billion, has, despite a recent slowdown, been growing at close to 20 percent annually for many years; worldwide markets for telecommunications equipment are comparable in size. But IT services (and equipment) have significance for the creation of wealth and employment going well beyond their direct impacts: competitive success in other manufacturing and service industries will depend heavily on the IT services, The links are perhaps most obvious for the many consumer and producer goods that embody smart electronics, and therefore software. Software development costs are growing as a fraction of total development costs for applications of computing power, wherever these are found. Indeed, software today is the primary determining force in the design of many digital systems.

Other links stem from the growing use of computing and telecommunications services for managing dispersed manufacturing and service activities both within and across nations —in turn, a function of the greatly decreased cost of hardware. The General Motors corporate network described earlier provides one example; chapter 8 includes many others. Finally, as pointed out in chapter 3, banks now use online databases to help manage risks on investments and currency transactions, while electronic clearinghouses and expert systems for securities trading are moving swiftly ahead. Although only relatively large companies earl afford many of these applications today, in the future, marketed VAN services of comparable power and usefulness will be available to companies regardless of their size. The point is simpie: continuing U.S. competitiveness in the IT services will be critical for maintaining U.S. competitiveness in a wide range of other manufacturing and service industries.

Nonetheless, although many American companies—as well as those with headquarters in Europe and Japan—know that adoption of new information technologies will, in some sense, be vital for future success, few at present have a very clear view of which technologies should get the highest priorities, and of how to integrate new services into their ongoing operations. In the United States, the deregulation of telecommunications has contributed to the confusion by suddenly increasing the number of options. over the next few years, any firm operating in international markets will likely feel pressured to at least match the investments and innovations adopted by its competitors.

Companies will eventually learn to effectively use local and wide area networks for linking geographically dispersed operations; some will link their computer systems with those of their customers. In such ways, new information technologies are changing old industries—a process that can be termed dematuration. Take, for example, the shoe industry. Shoe producers in industrialized countries now compete with those in low-wage, less-developed countries by using computer-aided design and manufacturing systems (CAD/CAM) to speed product development and styling changes, and to reduce costs; small incremental changes in the design, say, of athletic shoes can help a firm respond to or create shifts in demand. Design changes can be transmitted via data communications links to a plant in Asia. The firm can quickly acquire and analyze information on market trends using data from point-of-sale terminals in retail outlets. Managers can correlate sales information with that on shipping and distribution to monitor stock levels. The IT services play a crucial role in these dematuration processes, in this and other industries.

In U.S. automobile production, to take a different example, perhaps the most vital impacts of information technology have been in reducing design/development time for new vehicles. so Twenty-five years ago, a new car could be designed and brought to production in little more than a year; since then, the design cycle has stretched to 5 years or more. In attempting to keep up with their Japanese competitors, who have been flooding the U.S. marketplace with a seemingly endless stream of new products, American automakers have turned to computer-intensive design and engineering methods, as well as computer-aided manufacturing. These strategies hinge on networking and communications among hundreds or thousands of terminals having access to common databases.

National security offers a final set of examples illustrating the critical nature of the IT services. During the 1950s and into the 1960s, the U.S. computer industry gained its position of world leadership in large part as a result of spending by the U.S. Department of Defense, Much of this spending, for R&D as well as procurement, went toward early warning systems, intended to detect possible attacks by aircraft and rockets. Today, military systems of many types—from fire-and-forget missiles, to aircraft flight controls, to the planning for the Strategic Defense Initiative (SDI)—depend on digital systems technology.

Missiles like the Exocets that threatened the British navy in the Falklands War, and the laser- or wire-guided rockets that are becoming standard equipment for the foot soldier, have already had major impacts on conventional military tactics and strategy, not to mention nuclear strategy. Strategic command and control, guidance systems for ballistic and cruise missiles, the Navy's submarine tracking systems, military satellites—all demand advanced IT technology, including man-machine interfaces and software that can determine what information is important, how it is displayed, and in some cases what it means, Pilot's aids in future aircraft will extend the capabilities of military fliers, helping them cope with information overload and maneuvers at and beyond their skill envelopes. Beyond this lie not only the daunting SD I software and hardware requirements, but the quite different needs of huge data-intensive information systems such as those of the National Security Agency.

[30] See the articles in the March 1986 issue of *Automotive Engineering*.