Value Added Networks in the United States

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1. THE SETTING

1.1 Introduction

Value added networks do not play the same role in United States policy discussions that they do in Europe and Japan, and it is important at the outset to understand why that is so. The key problem that leads to value added networks as official services is the potential resale of leased transmission to third parties. This form of arbitrage by a service reseller leads to loss of control by the basic network provider, and to a reduction in revenues, at least in the short term. In the United States, such resale is possible and widely practiced. Lessees can do almost anything they want. The regulatory constraints that do exist are largely to prevent the basic carriers from extending their market power over the basic network downstream into the applications stage by internal subsidies. In other countries resale is prohibited--though it seems to exist unofficially in many instances. However, some of these countries have realized that the use of leased lines can provide communications applications of a sophisticated nature for use by third parties, and they do not wish to prevent these services from emerging. Thus, some countries lean towards permitting the provision of "value added" services, where something has been added to

basic transmission. This technical addition legally transforms what would otherwise have been a resale into a sale. (Another alternative is to establish usage-sensitive pricing to eliminate the incentive for retailing of services. But this creates other problems in efficient pricing.) However, the problem, as in any kind of attempt at price discrimination that is not cost-based, is that one cannot underestimate the ingenuity of arbitrageurs. Thus, those who wish to resell basic transmission (or switching services) but can only sell "value added" service may try to add a trivial amount of value or an entirely unnecessary amount, solely to become legal. In order to prevent this, it is then necessary to license value-added networks, after scrutinizing the nature of their "value added." Hence, a formal approval process is necessary, together with some form of ongoing monitoring, to protect the system of price discrimination. This restricts the range of services, and limits the licensed VANs' operating flexibility.

In the United States, as mentioned, such procedures do not exist, and VANs are hence merely a functional description and not a regulatory category. Being undefined officially, they have in consequence different meanings for different people, and often simply refer to packet switching networks. It is true that there is a regulatory distinction in the U.S. affecting VANs, between "basic" and "enhanced" services. But it serves an entirely different purpose. Whereas PTT countries seek regulation of VANs to prevent the resale of leased capacity, i.e., to protect

the PTT service monopoly, the U.S. categories are to prevent the cross-subsidization by a dominant carrier of its value added services through revenue gained in those dominant activities. In other words, the American "basic/enhanced" dichotomy is established in order to prevent the dominant carriers' exercise of market power.

1.2 A Conceptual Framework for the American VAN System

The American VAN system is ever-changing and dynamic, but also organizationally complex and interrelated--the word "incestuous" comes to mind--to the despair of tidy minds. Terminology on VANs is fuzzy, which points to unclear thinking. Therefore, some attempt at order is in order. Conceptually, it is useful to think of U.S. VANs as a system of multiple levels of resale and transformation. The first level consists of the basic common carriers such as AT&T or the local exchange companies, in particular the Bell Bell Operating companies (BOCs). All of these carriers lease lines to basic value added networks such as Telenet or Tymnet, who are level-2. These basic VANs include AT&T, a level-2 carrier itself, through its service AT&T Accunet Packet Service. Many of the BOCs have their own VAN equivalents. These VANs essentially provide basic packet switched transmission service and some basic protocol conversions as common or private carriers. Their services are bought by the third layer, the generic services stage, by firms who are also, confusingly, called VANs, and who provide the additional software

and organizational features that truly make for added value. The third level providers can be identical with the second level providers, and the operations can be functionally integrated. Conceptually, however, the distinction needs to be made. In the case of AT&T and the BOCs, in fact, any third level service must be provided by an entity that has to keep strict accounting separations from the rest of the firm, (i.e. from its levels-1 and 2.) AT&T offered level-3 service under the name of Net 1000, for which it leased time from its level-2 Accune Packet Service, which in turn uses AT&T network decdicated lines, (level-1).

Of course, things are never neat in this business. Level-2 VANs can also resell their capacity directly to end-users, who then provide their own Level-3 enhancements as private networks for their operations; typical charges are 3-5 cents per kilocharacter. In effect, these users create intra-firm "private" VANs. They can also make their private VANs available to their customers, suppliers, or business partners, and thus create a private closed-user group VAN. Level-2 VANs also often resell their transmission capacity to other level-2 VANs when these have not established access of their own to a particular region. (This adds another layer to the resale hierarchy.)

The level-3 VANs in turn sell their services. Buyers can be end-users of the generic applications, but they can also in turn be providers of specific applications who add specific applications to the generic services. They can also be simply resellers of the level-3 generic services. For example, a

level-4 VAN can be a network of electronic mailbox service--a generic offering--this is made to fit the specific needs of the insurance industry as a level-4 insurance network. A combination of several generic services may be involved in such an application. Another example are networks connecting automatic banking teller machines. The provider of these network services often retail them to a number of banks, which thus need not set up a system of their own. The banks, in turn, give access to their forth-level VAN to their customers. Through open or hidden service charges, they in effect resell electronic banking services to the public. Thus, when a customer uses a bank teller machine to withdraw money, the communications may easily involve four layers of communications services, involving several firms, all contributing to end-service in a distinct way.

Because of the peculiarities of the American divestiture, one can often add to this scenario a long-distance carrier (which in turn may lease its capacity from another), and at the other end another local BOC which has, in turn, another set of VAN relationships. This would not be the case in other countries.

The system is "incestuous" in that competitors habitually are at the same time each others' suppliers and customers of software and hardware on each level. They can compete on level-1, collaborate on level-2, and compete on level-3. All this sounds complicated, and it is, but unavoidably so, just as the production and distribution of almost any sophisticated product is complex. Rarely are all stages of production of a

complex good vertically integrated within one company.

The total level-2 VAN market has been estimated to have been $310 million in 1985, up 13% from the previous year. One frequently cited firm predicts a growth rate of 40% for the next few years, to revenues of $850 million by 1988. In light of past growth rate, this seems to be over-optimistic. But even a steady 15% growth rate would lead to a significant size.

These figures are only for Level-2 VANs. The range of enhanced Level-3 and -4 VAN services has been estimated to reach $1.5-2 billion by 1988, [Yankee Group.] This does not include private system VANs.

2. LEVEL-2 VANS; BASIC PACKET TRANSMISSION

2.1 The Big Two VANs

In the United States, Level-2 VANs in the form of packet-switching networks have existed since the early 1970s. The identity of the two concepts is such that they are often used as synonyms.

It all goes back to the Pentagon, whose Defense Advanced Research Projects Agency (DARPA) had the Cambridge, Massachusetts firm of BBN develop the "Arpanet" nationwide network to link researchers with each other. Arpanet was and still is a major success, and it induced BBN (Bolt, Beranek, and Newman) to start the commercial network Telenet, which has been in operation since 1975.

Basic packet switching transmission has two main

about 38% of the market, Uninet had 12%, and Tymnet 31%, [Source: Yankee Group.]

Telenet had grown in the period 1978-83 by rates of up to 40% annually. Present growth is estimated at 28%, [Yankee Group.] Nevertheless, it broke even only after 1983. Expansion to 350 American cities had been costly. Today's revenue estimates are somewhat above $100 million. It has about 2000 host computers connected, and in 1984 averaged 200,000 sessions a day. [Source: Link, "Competition in Value Added Networks," New York, 1984.]

Telenet is linked to many countries. In Europe, it connects directly to the PTTs in the UK, Switzerland, Italy, and since 1985 to Germany. For many other countries, it has to go through another recognized carrier. Uninet, now in the process of absorption into Telenet, operates since 1981. Local access is available in over 300 American cities, and in 1983 revenues were $40 million.

Tymnet, with its parent Tymshare, was similarly acquired by a large firm, the aircraft manufacturer McDonnel Douglas and its automation division, known as McAuto. Tymnet has local access in more than 500 American cities, and averaged in 1983 320,000 daily sessions, more than 5200 simultaneously at peak periods. Tymnet was originally an internal operation of Tymshare. 1985 revenues were about $85 million. Tymnet's initial advantage of a customer base of time-sharing computer users turned out to be a problem later on, as time-sharing went into a steep decline with the

advantages: the first, technical in nature, is error detection and correction, which is enormously useful for data transmission. The second advantage is economic/regulatory in nature, the ability to slice transmission time into minute quantities, which in turn can be resold and provide a profit where there is a differential between retail and wholesale prices. On the other hand, data transmission rate is not high enough for high-traffic users of data. That, with LANs' tendency to charge by volume, means that for large users the leasing of private lines may make more sense than the use of a "public" VAN. (However, packet switches have become faster--from 1,500 packets/sec to 5,000 packets/sec soon, and even to 60,000 (Netrix) anticipated through parallel processing.)

Other entrants were Graphic Scanning (Graphnet), PCI, and Tymshare (Tymnet). PCI soon failed. Tymnet made some profit since it had computer time-sharing (level-3 service) customers and the VAN was a way of serving them. The most "public" of the networks, (i.e. untied to level-3 applications), Telenet, struggled along with its revenues growing slower than it had predicted, and it was eventually sold to GTE. In 1986, GTE Telenet, (level-2), together with the long-distance carrier GTE Sprint, (level-1 and also a reseller of AT&T's level-1), was put into the GTE's joint venture with United Telecommunications, which in turn contributed its own Uninet, (levels-2 and 3), and a substantial fiber optic physical network, (level-1). The two firms have been merging the operations. In 1985, GTE Telenet had

advent of inexpensive mini and micro computers. Tymnet's network architecture is said to result in slightly faster response-time than Telenet, but its prices are a bit higher, [Yankee Group.] Its transmission is actually not pure packet switching.

Access to the VANs' "nodes" has normally been either by leased lines (digital or analog), or a regular public dial-up line. The latter was the weak link in the network. In 1985, Telenet and Tymnet announced systems of dial-up synchronous X.25 access over public lines, which has major technical and economic advantages for many users, because it makes unnecessary expensive leased lines for synchronous X.25 connections. Nor is it subject to the error rate of asynchronous public line transmission. Asynchronous access at 2.4 kbps is available on Telenet since 1985.

Another way of avoiding the public network and Tymnet is to use the microwave transmission technology DTS (digital termination service) developed initially by Xerox, which is beginning to provide local digital transport. Several of the VANs have applied for a large number of DTS licenses. Typical charges are 3-5 cents per kilocharacter.

2.2 Other VANs

CompuServe Network services is owned by the large fax accounting firm of H&R Block, and has much credit card

authorization business.

Autonet is a subsidiary of the large computer processing company ADP (Automatic Data Processing) founded by New Jersey Senator Lautenberg. The VAN grew out of ADP's providing services to its customers, and became public in 1983.

Graphnet was one of the earliest VANs and specializes in facsimile.

Computer Sciences Infonet. Primarily a remote-computing service.

MarkNet, owned by General Electric Information Services Co. (GEISCO), was partly designed to use the excess capacity of GE's own internal network. It was based on GE's 1964 development of time-sharing systems with Dartmouth College. With the remote time-sharing computing market weakened, MarkNet has been increasingly offering a good number of level-3 and 4 applications. Its 1985 market share was 5%. (MarkNet has an extraordinary network, with extensive international reach, satellite transponders, submarine cable, etc.

Cylix, acquired by RCA in 1982, is based on satellite transmission.

IBM Information Network is available since 1982 in part to extend the reach of its SNA computer inter-linking system. IBM had been in that market before, as a time-share service, then sold out (with a provision to stay out for a while), and reentered in 1982. IBM's aims are apparently not to dominate the service market, or to use VANs as a staging ground for becoming a

telecommunications carrier. Its primary goal is to provide such services that would make its equipment more attractive to buyers. Like early radio set manufacturers, it provides programs to sell hardware.

MCI Data Transport provides service customization and a limited number of nodes. It is aimed at large users, and since 1985 has offered, together with the Security Pacific National Bank, the national financial network SPAN for a variety of financial (level-4) applications such as auto loan financing, credit card verification and billing, and cash management. MCI has been actively trying to become the interconnector of BOC-VANs.

All of these networks are relatively small in terms of market share. IBM had 2%; MCI and CompuServe 1.5%.

2.3 AT&T

AT&T's involvement in VAN service was tumultous and so far unsuccessful.

It began it 1975, when AT&T still felt secure as a monopoly. Its intention was to provide an "Advanced Communications Service" (ACS) with packet switching, protocol conversion, message storing and forwarding, and private network provisions. Technical development took its time. AT&T had wanted to have a large-scale star architecture, so that all the data would come to one central location. This did not work technically. It took the years 1978-1982 to rearrange the

network and write the very complicated software. The legal status of the ACS, also known as Bell Data Network, offerings was part of the FCC's First and Second Computer Inquiries. Eventually AT&T was permitted to offer "enhanced services," and on an unregulated basis, but only through an organizationally fully separated subsidiary (which it eventually named AT&T Information Systems, ATTIS), in order to reduce the potential for competitively unfair cross-subsidization of the enhanced services. AT&T then created "Net 1000" which provided packet switching, computer time sharing service, and other services. Because of the Computer II restrictions, AT&T offered the underlying basic packet switching service (BPSS) under the name of Accunet Packet Service (APS) a regulated and tariffed service available to other VAN suppliers as well, on a non-discriminatory basis. (Its rivals dispute that it is non-discriminatory.) APS cannot engage in protocol conversion except from X.25 to X.75 to permit internetwork service. APS rates are distance-insensitive. Transmission rates are 4.8, 9.6 and 56 kbps.

NET 1000 pursued some applications, in particular the mortgage and the purchase order segments of the market. It was unsuccessful in both. By early 1986, after major losses, AT&T closed it down, at least temporarily, with the possibility of a future re-opening. Net 1000 losses were estimated to be between $100-500 million. Thus, the telecommunications market leader had failed in this field, largely because it had been too

technology-oriented and not enough demand driven.

2.4 The Bell Operating Companies

Following the divestiture decree in 1982, it was unclear whether the Bell Operating Companies could provide VAN service and whether the Computer II rules regarding separation of enhanced from basic services applied. This was clarified by the FCC when it declared basic packet switching (X.25-to-X.25) to be a "basic" service which BOCs therefore could provide, subject to regulation.

However, this still left the BOCs without authority to provide protocol conversion, even X.25-to-X.75 for purposes of internetworking, i.e., for long-distance packet transmission. These conversions were considered to be "enchanced services," and had to be undertaken by a fully separated subsidiary. Although this structural solution addressed a real problem, it made no sense in operational or accounting terms, and the BOCs petitioned for increasingly expansive waivers of the rules, which they received up to a point. In March 1985, the FCC removed barriers from the BOCs and permitted a bundled provison of basic packet transmission with the "enhanced" protocol conversion asynchronous-to-X.25 and X.25-to-X.75, thus opening an important part of the VAN market to the Bell companies. However, they had to provide such services also to their competitors at non-discriminatory terms; they had to file an accounting plan of separation, and they could not unfairly cross-subsidize their

service. Specific rules were established for cost allocation and pricing. In May 1986, the FCC further decided, in its Computer III decision, to abolish the requirement for a fully separated subsidiary for enhanced services, and subtituted as yet unspecified accounting separations. It reaffirmed, however, the dichotomy between basic and enhanced services; Chairman Fowler, who had been in favor of deregulating any service based on the degree of its economic competitiveness rather than of its technical characteristics must have recognized the tautology of opening to unregulated competition those services that are competitive.

The Computer III ruling established a highly important policy concept, that of open network architecture (ONA), which has not received much attention, and which is furthermore often confused with open systems interconnection, OSI. ONA (also referred to as CEI comparably efficient inter-connection) is a concept according to which the local exchange companies will subdivide their central office switches into its functional sub-building blocks, with these components offered separately for use and resale on an unbundled basis. Different communications services require different configurations of buildings blocks, and outside parties such as VANs can substitute the building blocks of their choice, and add their own blocks to them if these are available elsewhere better or cheaper than from the local exchange company. In other words, competition would exist for the various functions of the exchange switches, by unbundling its

multiple functions.

As a consequence, the BOCs will increasingly be able to be active and flexible in setting up enhanced VAN service, while at the same time they aim to profit from the reselling of their switches' capabilities for the use in other VANs applications.

This is a radical reversal in the thinking of the telephone carriers. Whereas in the past, they had resisted resale, they are now beginning to recognize that with the network as their extraordinary asset they should increase usage rather than control, to the point of encouraging the use by others. The open network concept should hence be a major boost for all kinds of VANs and enhanced services. It will also, over time, lead to a much more decentralized switching and network architecture, and to the replacement of today's mammoth central switches by medium-sized modules provided by many firms, not just the few established ones that everyone seems to assume will dominate the field in the future. The role of the unified central switch may go the way of the central mainframe computer.

How does this relate to ISDN? In technical terms, the open network concept is not contradictory to the ISDN concept, and open network ISDNs are likely to emerge in the U.S. But attitudinally, the ISDN concept, as presently held by its CCITT champions, is very different from ONA. While the open network architecture is another step in the segmentation of networks, the ISDN concept has been used as an argument for PTT exclusivity. After all, a main goal of ISDN integration, it is stressed, is

the abolution of the wastefulness of duplicative networks. The idea of permitting rival network function, such as an open network architecture envisions, hence seems contradictory to the purpose of network unification.

As the regulatory roadblocks were lowered to BOC participation in VANs, they have begun to enter this field. They have established local area data transport service (LADT) which includes local packet switching and basic protocol converstion at speeds of up to 56 kbps. Particularly active have been Pacific Telesis, Bell Atlantic, and Bell South.

Among the existing or projected BOCs VAN services are credit card verifications, electronic mail, bookkeeping services, billing, closed user groups, and LAN interfacing. Furthermore, the BOCs plan to link up in joint ventures with informaton providers for specific VAN services.

The BOCs have taken various approaches to VAN services, a reflection of the lack of centralized control after divestiture. In order to prevent the emergence of incompatible VAN-islands, the BOCs central technical coordination organization Bellcore has made some efforts. Another divestiture-induced question is the long-distance interconnection of the BOCs VAN operations, which must be done by other carriers, for example, by Telenet or AT&T, which are the BOCs' competitors for VAN service. MCI in particular has been eager to enter this part of long-distance service, and established in October 1985 the first BOC long-distance inter-connection. Thus, if AT&T is not alert, it

may be squeezed out of this level-2 BOC-interconnect market.

2.5 Basic VAN Equipment

Equipment used by the BOCs is primarily Northern Telecom SL-10 system, AT&T, Micon, and the Siemens Databit EDX-P switch. The Siemens switch is used, or ordered, by BOCs including Indiana Bell, New England Tel, New York Tel, and U.S. West. Also among equipment suppliers is BBN, the original packet-switched network designer. In worldwide equipment sales, GTE Telenet figures estimate that its systems division holds 20%, Siemens 20%, Tymnet 15%, Northern Telecom 7.5% and BBN 7.5%. Other participants, less successful so far, are Ericsson, AT&T, Amdahl, and NEC.

3. LEVEL-3 VANS; GENERIC SERVICES

3.1. VOICE MAIL

Voice messaging (also known as VSR, or voice storage and retrieval, and not to be confused with electronic mail), is a service that permits a computer to store digitized voice messages, like an answering machine, but of an almost unlimited length, which can then be called up by the holders of the voice "mail box" from any location, including a car; the message can also be routed to others, and forwarded with comments to still others, including the original caller. Patent claims to the invention are disputed, and IBM apparently settled a patent-infringement with a man who claimed to have invented voice mail as a high school student, [Fortune, Oct. 18, 1985, p. 104.] The industry has taken off in the past year, with large users buying voice mail systems as part of their PBXs. Numerous service bureaus resell voice mail service. There are even two levels of resale of voice mailboxes. Instead of putting voice mail capability into the customer equipment, it can also be embedded in the telephone company's central office switch. This can now be done after appropriate accounting separations of this "enhanced service." Typical Level-4 users applications of voice mail (level-3) are: purchase order taking systems; ticket reservations; scheduling of work crews; hospital paging; hotel

reservations and guest messaging; radio paging; sales solicitations; and targeted "broadcast" telephoning.

3.2. VOICE RETRIEVAL (Audiotex)

This service is related to voice mail, but with the emphasis on retrieval rather than on input. A computer typically stores a large variety of information in digital voice form which can then be recalled from afar by calling in for it. Applications are detailed weather forecasts which can be accessed by pilots and selected according to region. Similarly, a theater reservation system can have the ticket availability of each play or its reviews stored separately, together with a brief description of the play and the cast. Other applications are for the telephone ordering of merchandise, as for airline tickets. These services can be lodged in customer equipment or in the network itself. These applications will be considerably boosted as the technology of synthetic voice as an output of computer-stored data matures. This creates audiotex.

3.3. ELECTRONIC MAIL

A good number of firms offer variants of electronic mail, (e-mail); they include MCI (MCI-mail), Western Union (EasyLink), Federal Express (Zap-Mail), GTE Telenet (Telemail), ITT (Dialcom), RCA (RCA-Mail), CompuServe (Infoplex), GE (Quik-Comm), Tymshare (IEMS and On Tyme), and The Source. The U.S. Postal Service was adamant about participating in this market, but its

E-COM was a total financial and market failure and was abandoned in 1984 after 2 1/2 years of heavy losses. The number of potential e-mail users and recipients is greatly enlarged by the many owners of the 15 million personal computers in the U.S. Nevertheless, the widespread use of personal e-mail has happened primarily among computer enthusiasts. At present, it seems that many firms are losing money on e-mail, in the aggregate $80 mil. in 1984. Many of the systems were stubbornly non-interconnected, due to entirely different delivery concepts, but an industry solution is being discussed. In 1986, a Corporation for Open Systems was set up to deal with the problem of interconnection. The approach chosen by the National Bureau of Standards is to establish a format for interlinking "body types" -- i.e., proprietary word processing or e-mail formats -- by registering software with the NXB and getting an address code. They are competing with various features of service, such as message-alert, letterhead and logo printing, pre-timed delivery, laser-printing, connection to telex, etc., not to mention price. At present, the various companies are trying to establish themselves as market leaders. It is not likely to be Western Union, the traditional dominant U.S. telex carrier, since that firm is ailing financially. Electronic mail was one of the contributors to its weakness. MCI Mail appeals in particular to users with personal computers and modems, and provides essentially a standard computer mailbox service. It is cheap (no subscription fee; $1 for 5 pages); it works only on text;

physical distribution exists in the major cities with the sender's letterhead and signatures laser-printed. MCI and CompuServe agreed on electronic interconnection. X.400 interconnection standards are used by Telenet with Telecom Canada. Federal Express ZapMail, on the other hand, operates by faximile and is picked up and delivered by the company's many reliable couriers, but for a charge of $35 per 5 pages, with two hour delivery guaranteed. Prices have come down so that a 5,000 character message cost in early 1986 only $.80, in comparison to telex rates of $4-11. Services that are said to be profitable are the ones of Tymnet, GE, GTE, with MCI just breaking even. ITT's Dialcom was ailing and was acquired by British Telecom in March of 1986. In March 1986, AT&T also entered the e-mail market.

Electronic mail market share, estimated for 1985, are:

ITT Dialcom	13%
Western Union	13%
CompuServe	12%
Telenet	11.5%
The Source	11.5%
MCI	9%
GE	9%
Tymnet	6%
AT&T	(entered 1986)

Others 15%

One estimate of electronic mail messages for 1986 is 209 mil. messages, up from 140 in 1985. (Link) Domestic telex, in comparison, carried only 86 mil. messages in 1986, down from 113 mil. the previous year. (Creatives Strategies Research International). For 1985, the market size has been estimated at $300 mil.

3.4. Data Retrieval and Search

The large number of personal computers, many with built-in modems or inexpensive acoustic couplers and the large number of office desk-top terminals, has greatly increased the parties with ability and interest in access to data banks. This has led to the emergence of an electronic publishing industry known as "on-line" databases, a level-4 application. There are specialized services as well as more general "information utilities" which include a portfolio of data services. In some ways these are similar to a videotex though usually without the graphic capability, but with more data and faster response rates, and with "smart" computer terminals, that can process the called-in information rather than TV screens or dumb terminals. The three major "information utilities" are CompuServe, The Source, and Dow Jones/Retrieval. They also provide electronic shopping, primarily of computer equipment and software (though also with the Sears catalog), take airline ticket reservations, make hotel and other reservations, etc. On-line data services

have been growing 30-40% annually by transmission volume. By revenue, increases have been less steep since prices have been decreasing.

Examples of on-line services:

Lexis provides search potential for legal cases, and increases the productivity of lawyers and the length of their briefs. Nexis can search for a name or a subject mention in hundreds of publications and can substitute for a clipping service. Dow Jones/Retrieval provides financial information, continuously updated, and also has a self-diagnosis medical database. Quotron is an effective stock market quote service whose use is standard by most brokers.

NewsNet distributes hundreds of specialized newsletters. Telerate provides currency and credit market information; Legi-Slate provides the status of every bill in Congress and the votes of legislators; Weatherscan provides weather details worldwide. Games are provided by several services. Others offer advice on cooking, boxes, or provide information on business firms, industries. etc.

The Federal government has put the financial disclosures required by the Securities and Exchange Commission on an on-line database available to any investor. Large firm participants in the on-line market are Lockheed, which acquired Dialog, operator of 200 databases; Mead, a paper company which owns Nexis and Lexis; Dow Jones, which owns the Wall Street Journal; H&R Block (CompuServe); Reader's Digest (The Source).

Subscribers for mid-1985, according to the Yankee Group, were 195,000 for Compuserve (the company's figures are 280,000); 185,000 for Dow Jones News/Retrieval; 62,000 for Quotron; 60,000 for The Source; 55,000 for Dialog. Ranked by revenues, Quotron was first with $190 mil.; Lexis & Nexis $130 mil.; Dow Jones $100 mil; DRI $90 mil; CompuServe $66 mil; Reuters $65 mil; Dialog $50 mil.

The extent of these on-line systems is likely to grow with favorable trends in scanning technology, memory and transmission costs, and user base. An offsetting trend is optical disk storage, which will make distant access less important for information that is not time-sensitive.

3.5. Electronic Data Interchange (EDI)

EDI replaces traditional practices of purchase orders, invoices, bills of lading, etc. that require separately processed documents. Instead, the documentation of an entire transaction is electronic, integrated, and near instantaneous. An important level-4 application for EDI is for "just-in-time" production, such as for automobiles. Some manufacturers (in particular GM and its data processing subsidiary EDS) established an EDI system with their suppliers. Purchase orders are entered entirely automatically, if desired, according to programmed instructions, and sent to suppliers, who confirm, process, ship, bill, advise, get paid, etc. all within the same set of documentation. The system provides some of the advantages of vertical integration

and single sourcing without some of its cost. EDI systems can be provided by the private network of a firm, an industry group, or a public VAN. The EDI market is potentially quite large. A variant of EDI is "logistics data interchange," or LDI, that exist for some firms or industries.

3.6. Telephone (Audio) Conferencing

In addition to the standard teleconference bridges, AT&T has offered since 1985 so-called "700" service under the name "Alliance" for dial-up (operator-free) conferencing, for both voice and data/text, and without subscription. A "meet me" option will be added that permits conference participants to call in to join the conference, without having to wait for being contacted. Enhanced audio teleconferencing provides still picture images.

3.7. Video Conferencing

This is an active but commercially not particularly successful area. Many large firms have video conferencing facilities, but do not use them to capacity. Several hotel chains have nationwide inter-connected video-conferencing facilities (e.g., Holiday Inn (HI-NET), Hilton, and Sheraton). There are also several resellers of satellite transponder time for video-conferencing purposes, such as United Telecom (Isacom, The Meeting Channel) and the Private Satellite Network. AT&T

offers its Picturephone Meeting Service. Point-to-multipoint video-conferencing has been active.

Part of video-conferencing's slow acceptance is the need for expensive dedicated studio-like conference rooms, and of wide-band transmission. Both ot these problems are being reduced by equipment capable of slow-scan and data compression and enhancement, which permit video use in a regular office and require only one regular telephone line. Equipment at affordable price is beginning to enter the market.

3.8. Telemetry

Local telephone companies have been introducing alarm systems based on a new "derived channel transport" which overlays the regular voice channel with a second narrow channel, creating an independent transmission path for low-rate data. In addition to alarms, it can be used for utility meter reading and for pay-per-view cable television control (e.g., AT&T Star 85 PPV). Alarm service is also carried by cable television operators on their cable; they also provide in some instances high speed data on private channels and are experimenting with several interactive services, including electronic shopping and banking.

Personal emergency alarm systems exist for elderly and sick people, who carry a small device around their neck which, with the push of a button, notifies an ambulance service of an emergency.

Pacific Bell has developed a further extension of analog

capability on regular lines, with its "Project Victoria" permitting two analog voice and five data channels on a regular line. This opens up a variety of data uses and indicates that digitalization is not the only way to enhance a network.

3.9. Videotex

Videotex has not been a success in the U.S., partly because on-line data services have pre-empted much of its role in the commercial field. Various trials by joint ventures involving AT&T, Times Mirror, New York Times, Knight-Ridder, etc., do not indicate enough consumer interest at a price needed to cover cost. There are several ventures waiting in the wings, involving CBS, Sears, IBM, and J.C. Penney. Some commercial use of "private" videotex exists. DEC has installed a system in order to reduce the hard-copy distribution of manuals (partly to increase internal security), and to distribute intrafirm news, and updated information.

4. LEVEL-4 VANS: SPECIFIC APPLICATIONS

The services listed below are only part of the Level-4 (specific applications) of VAN-type services that are available. Several other applications have already been mentioned above. As mentioned, there are no formal licensing or registration procedures. A firm leases lines from a common carrier and takes it from there. To keep track of the services requires following the trade press; there are specialized VANs, private-group

VANS, or intra-firm VANs about which one hears only by chance. A survey of applications a valuable through Tymnet in 1984, broken down by categories, is attached to this paper.

4.1. Accelerated International Trade Payments. This service, its providers claim, accelerates international payments often by two weeks.

4.2. International Trade Shipment Data Service. This system helps trade shipment transactions, documentation, billings, insurance, etc.

4.3. Company-Dealer Networks for orders, product information, service problems, billing, customer information. Also referred to as Electronic Order Exchange (EOE).

4.4. Healthcare Providers and Insurance Networks permit transactions between hospitals and insurers.

4.5. Computer Bulletin Board Systems (BBS)

BBSs have proliferated in recent years with the increase in personal computers. In 1985, there were about 4,000 in the country, and 120 in New York City alone. They are run by a "sysop" (systems operator), mostly an amateur enthusiast, and often include a wide menu of subgroups and services, including personal mailboxes. Specialized BBSs include matchmaking services (the major problem for these digital affairs is the

imbalance of men to women among computer users) and professional conferences. There were BBSs of "Computers for Christ," of the terrorist "Aryan Nations," (members of which are wanted for murder), and of a child molesting ring. The latter two examples point to one advantage of BBS -- anonymity in communications. Other BBS exchanges pirated software and stolen telephone credit card numbers (filling a latent but illegal need: BBS use tends to run up high telephone charges). In addition to the more spontaneous and often underground type bulletin boards, there are special interest section, and also several commercial applications, primarily for computer conferencing, such as AIES, CompuServe, and The Source. CompuServe has about 100 bulletin boards.

4.6. Credit Card Verification and Processing. Merchants have terminals that can read credit card magnetic stripes and transmit the information to a central location for approval and processing. Some of it is handled by local banks or bank associations such as VISA for its members. Others are by public level-4 VANs. Credit authorization has been integrated into electronic record keeping and transaction accounting.

4.7. Point-of-Sales Services

These retail services permit merchants to transfer payments, send bills, verify credit, and reorder inventory. Because of the cost involved to set up such a system, several point-of-sale switching networks exist. Some are affiliated with automated

teller machine networks and often are owned by several banks or by more general service providers.

4.8. Manufacturing Design

CAD/CAM computer-aided design and manufacturing has led to private VAN applications. GM's blueprints are electronically accessible by its suppliers (who are thus forced into the electronic mode of design themselves). The high cost of a CAD/CAM terminal ($30,000 and up, plus computer, software, know-how) has been a problem for small suppliers. In response, reselling has emerged in this segment, (CAD/Share).

4.9. Factory Production

Automation produces and requires constant data flows. One development priority for the near future is to permit equipment to interconnect better with each other and with support services. Electronic Data Interchange (EDI) systems offered by several VANs provide some such integration, and permit a "just-in-time" production process, with interconnection with suppliers and programmed purchase orders. GM has adopted a manufacturing automation protocol (MAP). It has acquired the major data processing firm EDS, and they have set up sophisticated networks with dealers and suppliers.

4.10. Spare Part Service

Industrial data base/transaction systems provide information

on and transactions for millions of products, parts, and supplies.

4.11. Service Dispatch

A combination radio beeper/access terminal permits input and communications with service personnel in the field.

4.12. Electronic Banking and Brokering

A number of financial institutions enable customers to access their computers to reach their account information, investment data, and to make stock orders and transfers of funds.

4.13. Electronic Fund Transfers (EFT)

This is one of the earliest network transaction use. Various clearinghouse arrangements exist in New York, the United States, and internationally. There are over 30 automatic clearinghouses for banks in the U.S.

4.14. Automated Teller Machines (ATM) Networks

The popularity and low cost of an automated bank presence by ATM has been spreading; supermarket chains are accepting them on premises. A 1986 Supreme Court decision permits ATM placement out of state, and thus enables banks to move across state lines, which they could do before only to a limited extent. In response, Citicorp has entered agreements with several supermarket chains outside of New York. These forms of banking

services rely decisively on communications links, and on an effective integration with their back office operations.

Large banks can offer these services on a private networks. Smaller and medium-sized banks must depend on VAN intermediates. Several ATM switching networks exist, often owned by a consortium of banks. Large data processors such as ADP also provide such services. In some instances, the ATM of one bank accepts transactions for another.

4.15. Commodity Trading

Trading in commodities and precious metals, where time is of the essence, have been enhanced by networks with brokers. In some instances, AT&T has joined with Quotron to provide the Integrated Financial Information System (IFIS) to permit simultaneous use of a regular voice call while viewing market data, transacting trades, retrieving customer information, and entering notes about the call. The system has been adopted in early 1986 by a major brokerage house.

4.16. Insurance Industry Networking

Because of the widespread system of independent insurance agents which deals with many underwriter firms, it was important (and difficult) to provide them with a network for communications. Such a network had to fit each firm's modus operandi and its business forms, and had to be compatible with thousands of different equipment systems in agents' offices.

The industry had created the ACORD study organization to develop some uniform paper forms. In 1978, the Insurance Institute for Research was set up to facilitate computer interconnection. The two organizations merged, and selected the IBM Information Nework to be their VAN provider. In 1983, IVANS (Insurance VAN Services) was established for initially 25 firms to manage the services. Several large insurance customers have also received direct access to the system for their insurance needs.

4.17. Medical Communications

An information and transaction network exists to connect doctors and drug companies as well as reference services and advanced medical education databases.

4.18. Moving CAT-SCAN Images

Medical CAT-scanning procedures are expensive and very data-intensive. One VAN transmits image data from smaller hospitals to larger data facilities for processing and storage.

4.19. Consumer Information

GEnie provides a variety of consumer information and transactions. TransText provides monitoring and control of energy.

4.20. Job Searches

There are data banks for employment, particularly for data processing professionals.

4.21. On-Line Databases

These have been discussed at length above at sub-chapter 3.4.

4.22. Teleshopping

Several varieties of teleshopping exist: on computer on-line services; on cable television; and by automated phone-in orders. One supermarket chain permits call-in orders with automated reception from a 4,000 item catalog, with the teleshopper picking up the order three hours later.

4.23. Agricultural Networks

Information and transaction systems exist for commodity trading, weather, help and advice.

4.24. Hotel In-Room Services

Services such as "SuiteTalk" and "HotelNet" permit hotel guests to access information and electronic mail from their rooms, and to receive information about city or hotel activities, airlines, etc.

4.25. Grocery Networking

Tymnet provides an electronic data interchange (EDI) for a grocery industry group, which permits them to pool their

purchases and realize bulk discounts.

4.26. Personal Computers Up-and-Down Loading

PCs can be used as data input and output terminals for a mainframe by procedures for software and data exchange, file transfer, and shared software.

4.27. Yellow Page Service

On-line service permits nationwide compilations and searches of businesses.

4.28. Call-Forwarding

The BOCs, it should be noted, have offered for almost 15 years enhanced services as regular "custom calling services." These include call waiting, automatic call forwarding to other numbers, speed dialing, and three-way calling.

4.29. Call Identification

Recently. the introduction by the BOCs of AT&T's common channel signalling system permits an identification of the incoming call, and has made possible several features that will be introduced in the near future: call screening (blocking of undesired callers); a selective call forwarding; identification of incoming call numbers; call-back of last number(s) which had called in but were not connected; and special rings for pre-selected incoming calls, to permit, e.g., a separation of incoming personal and business calls. These services are

important in a broader sense since they give some measure of choice over the telecommunications process to the party that is being called, who in the past has had to guess at the nature of the incoming call.

4.30. Automobile Collision Estimation

This service permits garages and insurance companies to estimate repair costs.

4.31. Animal Breeder Services

Permits matching of livestock.

4.32. Library Shared Cataloguing

Permits inter-library searches, exchanges, acquisitions, and automation in cataloguing.

4.33. Credit History

Several commerical systems permit lenders to check on the credit history of borrowers. This application, more than any other, has been controversial and has led to laws protecting privacy and accuracy.

4.34. Teleshopping

An example is the "electronic mall," with various mail order catalogues on-line.

4.35. Telemarketing

Automatic dialing machines call potential customers randomly or from pre-screened lists. The sales message is taped; responses are given either to a person who comes on the line, or to a voice mailbox.

5. OUTLOOK

The list of VAN services and applications is not indicative of their commercial or technical success. There is no reason to assume that today's mix of offerings is more than temporary. It would not be surprising if half of today's offerings and services would be gone in a few years, but replaced by other services and other companies. Given the rapid developments in hardware, software, and user organizations, the main attribute of a communications service VAN system is not predictability of success, but flexibility of process. The American system is, in effect, predicated on the premise that in this particular market, intelligent intervention is neither desirable nor possible. In the American environment, it is hard to see how restrictive rules on VANs could be effective in the long run. If VAN applications are successful -- and it is important to a competitive economy that they are -- they will dance electronic circles around the restrictions.

What are the future prospects of the various VAN levels?

In my view, the public Level-2 VANs will be seriously squeezed from two directions. On the one hand, the BOCs and the long-distance carriers (and even large users) will provide

similar level-2 basic VAN transmission. Hence, basic VANs like Telenet will try to move their focus increasingly into the high-value applications of levels -3 and -4. Yet there, in the applications stages, in particular in level-4 specific applications, they may find that their large users themselves or user groups are setting up private VANs, and thus preempting these applications. For users, this increases convenience and control, even if it loses some economies of scale. In many instances, these private VANs were established by the level-2 VANs themselves by selling them separate systems, or by dedicating part of their capacity to them (sub-networking).

Private network systems have achieved extraordinary sophistication. A June 1986 special section of the trade journal Communications Week lists the ten most advanced private U.S. networks: (American Airlines; Bank of America; Boeing; Citibank; Ford; GM/EDS; IBM; J.C. Penney; Sears; and Westinghouse). It reveals extraordinary sophistication of usage and expert communications staffs numbering in the hundreds. These accumulated talents have only begun to be felt.

For many firms, providing a transaction VAN to their customers and suppliers provides a competitive strategic advantage. A good example is the airline reservation system Sabre, provided by American Airlines to travel agents, which lists all flights but gives an advantage to American Airlines flights.

Another example is the American Hospital Supply Corporation,

whose computer links with hospitals and suppliers increased its market share tremendously as it permitted its customers direct access to ordering.

In some instances, these private VANs need not even buy capacity from the "public" (level 2) VAN. They can also directly set themselves up with the basic Level-1 common carrier. The rate reductions in high-speed T-1 lines make this increasingly attractive. Private packet switching is not cheap, but prices are dropping steadily.

VANs have had other problems, too. The industry is fragmented and without real standards. The basic VAN market (level-2) has grown slower than its promoters had expected. The AT&T divestiture has created problems of transition. Indeed, the American experience was sobering for the VAN activities of several traditionally near-monopolistic communications organizations. Neither AT&T, Western Union, nor the U.S. Postal Service were successful in it.

But favorable trends are on the way. Demographics are on the side of VANs: each cohort entering the labor force is more computer-literate, adding steadily to bits of transmission. The trend toward the service economy are similarly benefitting VAN services. Even manufacturing becomes, through automation, significantly more data intensive, to say nothing of distribution, service, supply, and staff services.

The advent of small aperture satellite earth stations means that VAN applications can move to field locations, and that

national networks can be set up rapidly and flexibly, with only small cost of expansion. When it comes to policy liberalization, VANs ride on the coattails of equipment. VANs and equipment attachment policies are interlinked. A liberalization of equipment has meaning only when the equipment can be used in varied ways. Conversely, one cannot expect a dynamic VAN development if users are limited in their choices of equipment to a few slowly approved models. VANs can be important to manufacturers because much of pure equipment can become a merchant market, with East Asian countries the low-cost producers. Hence, a link of equipment to services, of hardware to software, and of hardware to each other by networks, is important.

This raises a final question. Are VANs another instance of "supply-side telecommunications," with appeal to computer enthusiasts, equipment manufacturers, and telecommunications carriers and not to regular users? There is no question that many VAN services have been excessivly hyped, and the reality invariably fails in comparison. Overall, the VAN service industry, in the aggregate, is not particularly large in dollar terms. As mentioned, level-2 VANs are in 1985 probably $300 mil. for levels -3 and -4 about $750 mil. However, the market is very innovative, and is developing expertise in fashioning configurations of users, equipment, and services. The present is an investment stage, high on the learning curve. It cannot move much faster than the users do to have a market. Users had to

absorb entirely new systems and work procedures, and organizational patterns. These things take time. Users are steadily becoming more computer applications-conscious; several industries have already reached the stage of dependence on them. Thus, the VAN services sector is riding a favorable trend.

Today, VANs are "discretionary" services, to use Martin Elton's term. However, over time, some of them may become essential basic service, as it has happened to basic telephony. At that point, what is today a value added service may have become basic, and it will be necessary to discuss the emergence of another generation of services.

MAJOR APPLICATIONS/SOFTWARE FACILITIES

TYMNET subscribers offer a wide variety of computer services to the public. Organizations offering major applications and software facilities are listed, below, according to the type of service they provide. For further information about specific applications and software facilities, contact the individual organizations that provide them.

ACCOUNTING
- System Development Corp. (SDC)
- Cybershare Ltd.
- DTSS Incorporated
- Proprietary Computer Systems (PCS)
- Toledo Timeshare, Inc.
- STSC, Inc.
- Bloodstock Research Information Service, Inc.
- Bradford National Computer Services
- National Computer Network of Chicago
- Timesharing Consultants, Inc. (TCI)
- Tymshare, Inc.
- UCCEL Corporation
- Financial Decision Systems, Inc.
- Hardy Associates Ltd.
- I.P. Sharp Associates
- Newsnet, Inc.
- Xerox Computer Services, (XCS)
- Dialog Information Services, Inc.

ACTUARIAL
- Polysystems, Inc.
- STSC, Inc.
- I.P. Sharp Associates Ltd.
- M & R Services, Inc.
- HDR Systems, Inc.
- The Computer Company

BANKING
- System Development Corp. (SDC)
- Data Resources, Inc. (DRI)
- Hale Systems Inc., Remote Computing Division
- Proprietary Computer Systems (PCS)
- Ross Systems, Inc. (RSI)
- I.P. Sharp Associates Ltd.
- STSC, Inc.
- Bradford National Computer Services
- Dialogue, Inc.
- McDonnell Douglas Communications Systems and Services, Inc. (MDCSS)
- Tymshare, Inc.
- UCCEL Corporation
- Commodity Systems, Inc.
- CompuFund
- Gibson Information Systems (GIS)
- HDR Systems, Inc.
- The Info Center
- CompuServ Incorportated
- CompuSource
- The Computer Company
- DELPHI
- Dialogue Information Services, Inc.
- Interactive Data Corp.

BATCH PROCESSING
- Stanford Information for Technology Services
- Statistical Tabulating Corp.
- Advanced Data Group, Inc. (ADG)
- Cornell University
- Datacrown, Inc.
- Hale Systems Inc., Remote Computing Division
- Toledo Timeshare, Inc.
- Proprietary Computer Systems (PCS)
- Bradford National Computer Service
- Electronic Data Systems
- Electronic Data Systems Corporation
- LSW, Inc.
- Martin Marietta Data Systems
- UCCEL Corporation
- Uni-Coll Corp.
- Southeast Regional Data Center (SERDAC)
- The Computer Company
- Neshaminy Valley Information Processing
- Information Consultants, Inc.
- Interactive Data Corp.

BIBLIOGRAPHIC
System Development Corp. (SDC)
Bibliographic Retrieval Services (BRS)
QL Systems Limited (QL)
Pergamon InfoLine Inc.
Pergamon InfoLine Ltd.
Pergamon Press Canada Ltd.
I.P. Sharp Associates Ltd.
The Info Center
Dialog Information Services, Inc.

BOND ANALYSIS
Hale Systems, Inc. Remote Computing Division
Propreitary Computer Systems (PCS)

BUSINESS
Statistical Tabulating Corp.
Timesharing Consultants, Inc. (TCI)
Bibliographic Retrieval Services (BRS)
Toledo Timeshare, Inc.
Proprietary Computer Systems (PCS)
Ross Systems, Inc. (RSI)
Bradford National Computer Services
Dialogue, Inc.
National Computer Network of Chicago
Tymshare, Inc.
Commodity Systems, Inc.
HDR Systems, Inc.
I.P. Sharp Associates Ltd.
Silicon Valley Computer Society (SVCS)
The Computer Company
Computing Resource Center
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Newsnet, Inc.
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The Info Center
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Dialog Information Services, Inc.
System Development Corp. (SDC)

CASH FLOW ANALYSIS
Proprietary Computer Systems (PCS)
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CASH MANAGEMENT
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Newsnet, Inc.
Dialog Information Services, Inc.

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COMPILER WRITING
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Martin Marietta Data Systems
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COMPUTER-AIDED DESIGN
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HDR Systems, Inc.
Sigma Design West, Ltd.

COMPUTER-AIDED INSTRUCTION
Cybershare Ltd.

COMPUTER GAMES
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CompuServe Incorporated
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HDR Systems, Inc.
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The Computer Company

COMPUTERIZED PHOTOTYPESETTING
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Southeast Regional Data Center (SERDAC)

COST PLANNING/CONTROL
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CROSS ASSEMBLERS/SIMULATORS
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HDR Systems, Inc.
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- Silicon Valley Computer Society (SVCS)
- Stanford Information for Technology Services
- Cooperative Library Agency for Systems and Services (CLASS)
- OCLC

LINEAR PROGRAMMING
- Proprietary Computer Systems (PCS)
- I.P. Sharp Associates Ltd.
- National Computer Network of Chicago
- Neshaminy Valley Information Processing
- Uni-Coll Corp.
- Cornell University

MANAGEMENT CONTROL SERVICES
- Proprietary Computer Systems (PCS)
- Infomedia

MANAGEMENT INFORMATION SYSTEMS
- Advanced Data Group, Inc. (ADG)
- Proprietary Computer Systems (PCS)
- I.P. Sharp Associates Ltd.
- Commodity Systems, Inc.
- National Computer Network of Chicago
- Uni-Coll Corp.
- CompuSource
- Cybershare Ltd.
- Financial Decision Systems, Inc.
- HDR Systems, Inc.
- Interactive Data Corp.
- Lockheed Dataplan, Inc.

MANUFACTURING
- Tymshare, Inc.
- Bloodstock Research Information Services, Inc.
- STSC, Inc.
- Electronic Data Systems
- Electronic Data Systems Corporation

MARKETING/ADVERTISING
- Tymshare, Inc.
- Pergamon InfoLine Inc.
- Pergamon InfoLine Ltd.
- Pergamon Press Canada Ltd.
- Proprietary Computer Systems (PCS)
- I.P. Sharp Associates Ltd.
- Dun and Bradstreet
- CompuSource
- HDR Systems, Inc.
- Newsnet, Inc.
- DELPHI
- Dialog Information Services, Inc.
- Interactive Data Corp.
- LSW, Inc.

MATERIALS MANAGEMENT
- STSC, Inc.

MATH/STATISTICS
- Hale Systems Inc., Remote Computing Division
- Proprietary Computer Systems (PCS)
- Science Applications, Inc.
- I.P. Sharp Associates Ltd.
- Dial-Tyme, Inc.
- National Computer Network of Chicago
- Neshaminy Valley Information Processing
- Uni-Coll Corp.
- Southeast Regional Data Center (SERDAC)
- Cornell University
- HDR Systems, Inc.

MECHANICAL ENGINEERING
- Systems Development Corp. (SDC)
- UCCEL Corporation
- ABS/Datanetwork
- Pergamon InfoLine Inc.
- Pergamon InfoLine Ltd.
- Pergamon Press Canada Ltd.
- Enertech Computing Corp.
- European Space Agency
- HDR Systems, Inc.
- Dialog Information Services, Inc.

MEDICAL
- Bradford National Computer Services

METEOROLOGY
- WSI Corp
- Dialog Information Services, Inc.
- Lockheed Dataplan, Inc.

MINING
- UCCEL Corporation
- QL Systems Limited (QL)
- Newsnet, Inc.
- Interactive Data Corp.
- Pergamon InfoLine Inc.
- Pergamon InfoLine Ltd.
- Pergamon Press Canada Ltd.
- Dialog Information Services, Inc.

MORTGAGE MARKET PROCESSING
- Hale Systems Inc., Remote Computing Division
- CompuFund

NUCLEAR INDUSTRY SERVICES
UCCEL Corporation

NUMERICAL ANALYSIS/CONTROL
Data Resources, Inc. (DRI)
Uni-Coll Corp.
Cornell University
Interactive Data Corp.

OFFICE AUTOMATION
Computer Intelligence Corporation

ORDER ENTRY
Toledo Timeshare, Inc.
Bradford National Computer Services
HDR Systems, Inc.

PAYROLL
Toledo Timeshare, Inc.
Bradford National Computer Services
Xerox Computer Services (XCS)

PERSONNEL
Tymehare, Inc.
Hale Systems, Inc., Remote Computing Division
Proprietary Computer Systems (PCS)
I.P. Sharp Associates Ltd.

PETROCHEMICAL
UCCEL Corporation
SACDA
Interactive Data Corp.

PETROLEUM INDUSTRY SERVICES
UCCEL Corporation
Toledo Timeshare, Inc.
I.P. Sharp Associates Ltd.
Enertech Computing Corp.

PIPING
UCCEL Corporation

PLANNING AND BUDGETING
Proprietary Computer Systems (PCS)
McDonnell Douglas Communications Systems and Services, Inc. (MDCSS)
Uni-Coll Corp.
Xerox Computer Services (XCS)
CompuSource
Interactive Data Corp.

POLICY ANALYSIS
Cornell University

PROGRAM DEVELOPMENT
Toledo Timeshare, Inc.
Proprietary Computer Systems (PCS)
Uni-Coll Corp.
Statistical Tabulating Corp.
Interactive Data Corp.

PROJECT PLANNING/CONTROL
ABS/Datanetwork
Data Tek
I.P. Sharp Associates Ltd.
National Computer Network of Chicago
Uni-Coll Corp.
Xerox Computer Services (XCS)
The Computer Company
Icarus Corporation
Infomedia
Datacrown, Inc.

REAL ESTATE
Proprietary Computer Systems (PCS)
Redi On-Line Systems
CompuFund
CompuServe Incorporated
Newsnet, Inc.
Dialog Inforamtion Services, Inc.
Interactive Data Corp.

REMOTE JOB ENTRY
UCCEL Corporation
Proprietary Computer Systems (PCS)
Neshaminy Valley Information Processing
Uni-Coll Corp.
CompuSource
Statistical Tabulating Corp.

RESEARCH & DEVELOPMENT
Battelle Memorial Institute
Bibliographic Retrieval Services (BRS)
Uni-Coll Corp.
The Info Center
European Space Agency
Newsnet, Inc.
Pergamon InfoLine Inc.
Pergamon InfoLine Ltd.
Pergamon Press Canada Ltd.
Dialog Information Services, Inc.

SCIENTIFIC
National Computer Network of Chicago
Interactive Data Corp.

SELECTION SERVICES
Interactive Data Corp.

SIMULATION
Data Resources, Inc. (DRI)
SACDA
Proprietary Computer Systems (PCS)
Science Applications, Inc.
I.P. Sharp Associates Ltd.
Circuit Technology Inc.
National Computer Network of Chicago
Uni-Coll Corp.
Interactive Data Corp.
Southeast Regional Data Center (SERDAC)
Sumex Computer Project
HDR Systems, Inc.

SELECTION SERVICES
Interactive Data Corp.

SOFTWARE DEVELOPMENT
Advanced Data Group, Inc. (ADG)
Bradford National Computer Services
SACDA
Science Applications, Inc.
Proprietary Computer Systems (PCS)
I.P. Sharp Associates Ltd.
Business Information Systems, Inc.
CCS Automation Systems, Inc.
Electronic Data Systems
Electronic Data Systems Corporation
National Computer Network of Chicago
Neshaminy Valley Information Processing
Uni-Coll Corp.
Interactive Data Corp.
Silicon Valley Computer Society (SVCS)
Statistical Tabulating Corp.

STATISTICAL ANALYSIS
Timesharing Consultants, Inc. (TCI)
Data Resources, Inc. (DRI)
Proprietary Computer Systems (PCS)
I.P. Sharp Associates Ltd.
Commodity Systems, Inc.
National Computer Network of Chicago
Neshaminy Valley Information Processing
Uni-Coll Corp.
CompuSource
Interactive Data Corp.
Southeast Regional Data Center (SERDAC)
Statistical Tabulating Corp.
Computing Resource Center
DTSS Incorporated
Datacrown, Inc.
Cornell University
European Space Agency
HDR Systems, Inc.

STRING AND LIST PROCESSING
ABS/Datanetwork
Science Applications, Inc.
Sumex Computer Project
Cornell University

STRUCTURES
UCCEL Corporation
HDR Systems, Inc.

TAX PROCESSING
Tymshare, Inc.
Exchange Data Inc.
Financial Decision Systems, Inc.

TELECOMMUNICATIONS
ABS/Datanetwork
DELPHI
Proprietary Computer Systems (PCS)
Neshaminy Valley Information Processing
Silicon Valley Computer Society (SVCS)
The DMW Group, Inc.
HDR Systems, Inc.
McDonnell Douglas Communications Systems and Services, Inc. (MDCSS)

TEXT PROCESSING
Tymshare, Inc.
BTI Computer Systems (BTI)
Data Resources, Inc. (DRI)
Science Applications, Inc.
Proprietary Computer Systems (PCS)
QL Systems Limited (QL)
I.P. Sharp Associates Ltd.
Silicon Valley Computer Society (SVCS)
Neshaminy Valley Information Processing
Interactive Data Corp.
Southeast Regional Data Center (SERDAC)
Stanford Information for Technology Services