Chapter 2

Present and Future Technologies Supporting the Financial Service Industry

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Introduction

Quite simply, the financial service industry could not provide the level of service it does without the support of advanced information processing and telecommunication technologies. The numbers of checks (over 37 billion annually), credit card drafts (over 3.5 billion annually), and securities trades (over 30 billion shares traded annually) would swamp any manual system that tried to handle them. In fact, during the 1960's, trading days for the New York Stock Exchange were shortened because the broker/dealers were unable to handle the workload.

Yet, even with all of its sophistication in the application of technology, the financial service industry has not yet exhausted the potential of the technologies now available. Even though large computers support check reader/sorters handling thousands of items a minute, all other aspects of check processing are manual, and telecommunications is not used in the check-processing cycle. Checks are still manually encoded with the amount by proof operators at the bank of first deposit or, in return for a reduced processing fee, at the retailer location. Return item processing remains a manual operation. Similarly, credit card drafts are manually encoded before processing, and the securities industry still processes millions of stock certificates manually.

As the economics of the technologies continue to improve, market pressures to apply them more extensively increase. They help and encourage further migration from paper- and labor-intensive implementations to electronic, self-service, and remote-based banking.

Operational considerations limit more widespread realization of the potential of the technologies. For example, only in recent years has the annual rate of growth in the number of checks slowed, from about 7 percent to about 5 percent. The fact that many are unwilling to forgo return of the physical check to retain as proof of payment limits the possibility of implementing meaningful check truncation programs. Similarly, many still take delivery of physical stock certificates, even though book-entry systems for recording the stock ownership provide an alternative.

In the future, the costs of hardware used to implement advanced systems for delivering financial services will continue their long-term decline. New technologies such as the processor in a card and new systems to establish the authenticity of the order to execute a financial transaction will become available. In general, the ability of the financial service industry to take advantage of the technology is not likely to approach the rate at which it becomes available. There is little chance that technology will limit the industry any time in the foreseeable future.

Historically, the initial applications of technology "automated' existing processes. For example, the application of computers to account maintenance simply translated existing manual processes into automated ones. The adoption of MICR* encoding on checks has done little to change the way checks are used. Thus, early application of automation in the financial service industry had little, if any, direct effect on the users of financial services. On the other hand, systems now being deployed are changing the fundamental character of the financial services consumed by users. Automated teller machine (ATM) networks,

*MICR—magnetic ink character recognition.

for example, enable users to obtain cash at locations that cannot be served directly by the financial institution holding the account. Moreover, funds are accessible around the clock.

Technologies waiting in the wings have the potential for changing the basic character of the systems used to deliver financial services and, as a result, the structure of the financial service industry. Remote banking via such diverse technologies as teletex, home computers, and multifunction transaction work stations installed in the offices of financial institutions could be implemented with technologies now available.

The so-called smart card, lingering just over the horizon, has the potential for changing the basic character of currency from paper to electronic. Market viability remains to be demonstrated and sufficient developmental capital allocated. In addition, an infrastructure of terminals capable of supporting the smart card, either supplementing or replacing the existing infrastructure for handling magnetic stripe technology, must be put in place before this technology can become a significant factor.

In order to understand present and future trends in the financial service industry, it is essential to have a grasp of present and emerging information processing and telecommunication technologies and of their relationship to present and future products and services. This chapter describes the basic technologies that are and could be applied for delivering financial services. The purpose is to create an appreciation for the potential and the limitations of the technologies for facilitating change in the financial service industry. Yet, one must understand that the technologies constitute but one of a number of forces operating to shape the financial service industry and that their potential may not be realizable because of other constraints that are operating.

Computer Hardware Systems

The providers of financial services have been among the leading users of medium- to large-scale processors, and only the very largest scientific computers have not yet been widely applied for the delivery of financial services. These large computer systems generally require dedicated facilities and support from an onsite team of information processing professionals. For all practical purposes, providers of financial services can buy computing power appropriate to their needs from a number of well-established manufacturers. Further, because of the way computer manufacturers design and enhance their product lines, organizations are able to have reasonable expectations that they will be able to make the transition, as needed, to machines of greater capacity with a minimum of operational disruption. However, even with the decreases that have occurred in the costs of medium- to large-scale computer systems, they are still priced beyond the means of many of the smaller financial service organizations that could benefit from having access to them.

Microcomputer Systems

Changes in the technology of computer processors at the low end of the capacity spectrum (i.e., those with the most limited capacity) are having the greatest impact on the operations of the financial service industry. Both users and providers are using them heavily. Microcomputers range in price from less than $100 to almost $10,000 (for some of the more elaborate systems now on the market). However, a $100 unit has only limited capacity to participate in a financial service system because it has neither communication nor significant data storage capacity. Additional capabilities must be added if the user wants to use the various financial application packages being marketed for personal computers. These include, for example, such diverse applications as home

Phofo credtf Mfcro Genera/ Corp

Two widely used microcomputer systems

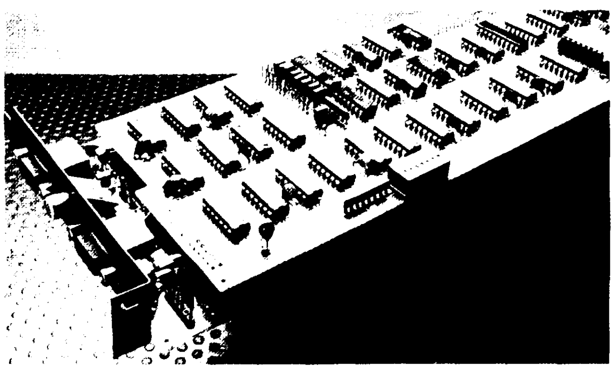

Photo credit. L/S/ Computer Products

Printed circuit card of the type used in microcomputers. Each of the rectangular cases contains a circuit that consists of the equivalent of several thousand transistors

budgeting and accounting systems, checkbook balancing programs, securities price trend analysis, portfolio analysis, and income tax preparation.

A cassette recorder costing about $50 would permit the user to load prerecorded programs and save intermediate results so that they would not have to be reentered into the computer manually every time they are to be used. A disc drive offering faster and more reliable access to data and programs can be purchased for some units for about $250. A printer that can be used to make paper records for users would cost another $250. Applications the user may wish to run may require the addition of memory expansion modules that cost more than the original $100 price of the computer. The user will, in some cases, have to spend $200 or more on an accessory required for making the connections between the peripherals and the computer. Yet even with all these additions, the user would still have a system limited to local use and applicable principally only to recordkeeping and analysis of data entered into the computer by the user.

To take advantage of home banking and stock market transaction services, information utilities, and home shopping services that entail interaction of a personal computer with a computer operated by the financial service provider a **personal** computer must be equipped with suitable data communication equipment. These include a feature that does the processing required to establish and maintain a telecommunication connection (RS-232 interface) and a unit (modem) connected to the telephone line for converting digital pulses used internally by the computer to analog signals that can be transmitted over the conventional telephone lines of a switched telephone network. In addition, programs to support the communication function or to handle the financial application would have to be procured, at a cost ranging from under $100 to $250 or more, depending on the complexity of the application. Although a disc drive and expansion interface might be required for such a function, a printer would most likely be a discretionary purchase.

Thus, while computers can be acquired for $100 or less, the person who would like to use them either to receive financial services and/or to perform financial analysis is more realistically looking at an investment that is closer to $700 or $800. However, this situation is not likely to persist in the long run. The prices of all computing equipment are falling. Some vendors are selling modems for under $100, and the price of disc drives continues to fall. Computer modules that work with widely distributed video games are on the market, and they are expected to offer the user significant improvement in the performance-to-cost ratio for equipment that could be used in conjunction with various future financial service offerings. In addition, small, battery-powered, portable computers that can be carried in a briefcase and have a built-in modem and RS-232 interface are now available for under $1,000, a price that will undoubtedly be lower in the future. Therefore, computers that can be used by individuals to receive financial services both at home and work are likely to be well within reach of a large portion of the population within the 1988 to 1993 time frame.

Another alternative would be development of very inexpensive specialized devices oriented to users of financial services. These could use cartridges similar to those used with television game machines, very simple control mechanisms, and a television to display the data. Some providers may even develop applications that use a TV game machine as the key processing element. In this environment, users may actually have several terminal devices to interact with financial service systems, each of which is dedicated to the offerings of a particular provider. Simple, inexpensive, dedicated devices may find extensive application in point-of-sale (POS) systems as well as those designed to deliver services to consumers. The availability of terminals for users at little or no cost could be a strong impetus to increasing significantly the rate of adoption of advanced systems for delivering financial services.

People have demonstrated repeatedly that they will spend substantial sums if they perceive utility in a product. Historically, this has been true with television; more recently, with video recorders. However, it remains to be seen whether a large number of individuals will be willing to invest in information processing and telecommunication equipment capable of interacting with systems for delivering financial services to the home. Success of financial service offerings may depend on minimizing the investment of potential customers and, perhaps, what other services may be available through the same systems.

Large Computer Systems

While there will be significant changes in the capabilities of computers at the low end of the spectrum that will enable a larger number of people to access the technology, changes at the high end of the scale will also occur. Speeds of computation and the basic architecture of computers will change so that there will be a marked increase in the performance-to-cost ratios over those now available. The raw computer power for applications such as image and voice processing will become available. Both applications have potential for the financial service industry. Voice recognition applications could be used as an alternative to key input particularly in telephone-oriented systems in which the user would use voice to issue payment and other directives to financial service systems. Applications of image processing systems, some of which are now be-

Photo credit: NCR Corp.

Modern mainframe computer system

ing tested, could range from processing fingerprints for identifying the user of a remote service device to reading information on checks as part of check processing. As the cost of equipment continues to fall, more providers of financial services will find the equipment affordable. In addition, customers will become better equipped to take advantage of the various services offered (see table 1).

Future Computer Hardware

During the coming 10 years, changes in computer hardware that are generally invisible but beneficial to users will occur. Functions such

Table 1.—General-Purpose Application Processors

	1982	1987	1992
Small:			
Cost (dollars in thousands)	12	8	5
Storage (megabytes)	0.5	1	2
Speed (millions of instructions per minute)	0.05	0.1	0.4
Medium:			
Cost	100	60	40
Storage	1	2	8
Speed	0.2	1.0	4
Large:			
cost	1,400	600	400
Storage	8	16	48
Speed	4	8	24

SOURCE Arthur D Little, Inc "Application of Technology for Providing Financial Services," April 1983

as those needed for system control and the processing of some programing languages now implemented in software will be moved to the hardware. Special-purpose machines featuring applications built into hardware will be assembled from a variety of general-purpose building blocks at minimal cost to meet the needs of specific applications. As a result, not only will the computers used to deliver financial services be less expensive, they will also be more reliable.

From the users' point of view, this will reduce the complexity of computer systems, while at the same time enabling him to select a computer that is more or less tailored to the applications it must support. For example, suites of special-purpose machines in facilities operated by financial institutions, mixed to meet the needs of the customers using them, will be possible. Some devices could be used only for balance inquiry and the kinds of transactions now performed through an ATM. Others could be used to submit loan applications and/or initiate securities transactions. A single cash dispenser/deposit acceptor* could serve multiple user stations, thus keeping overall system costs down. Financial institutions may find it in their interest to provide customers with terminal devices specifically oriented to the package of products and services being provided, thus overcoming any hesitancy to acquire and use general-purpose computer hardware that requires some specific knowledge of the technologies.

Computer architecture will be increasingly modular, with functions divided between and among various system components. On the one hand, this will make it possible for users to configure systems to meet their specific requirements, while on the other, it will tend to increase system reliability and integrity. If one component fails, the probability that system operation will continue at some degraded level of performance is high. Providers and users of systems for delivering financial services will benefit from an increase in the availability of

*A deposit acceptor would have the capability to count cash and read the amounts of checks as they are deposited.

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fault-tolerant systems to support online applications. The mean time between failure for such systems is measured in years, since they are designed to continue operating without degradation in performance in all but the most catastrophic circumstances.

Alternatives to keyboard entry will increase the flexibility and attractiveness to users of self-service financial systems that are accessible from remote locations. For example, the user will be able to communicate instructions to a computer by touching one of a few control buttons or an image on a screen. Already, touch screens are available on devices that range from wristwatches to computers, and greater application of these in the future can be expected. Limited voice input capabilities will be available, but continuous speech language processing will not be possible before the turn of the century, if then. Optical character recognition technologies will continue to become more cost effective, and there will be some capabilities to process handwritten input. Systems that use the signature to identify the user rather than a personal identification number coupled with a machine readable card could come into use by the middle of the coming decade. On net balance, these alternatives will reduce the use of multiple keystrokes needed to respond to requests for information, and hence will reduce barriers to use and increase efficiency of the new systems for delivering financial services.

Greater use will be made of color and graphics in computer output. The ability to transmit pictures easily will mean that the user will have less need to read. Video disc technology could be coupled with computers, especially in such applications as home shopping and others that require catalog-type data. Video "catalogs" could show the shopper multiple views of an item and could be updated frequently to show newly arrived merchandise and to reflect price changes. Voice synthesizers have become very affordable, and they will be used both to support graphics displays and to provide computer output through the standard voice telephone. Displays will become more compact and will blend more completely into the background than is now the case, thus making them more acceptable in both the home and office. The telephone will become a multipurpose instrument capable of receiving alphanumeric as well as graphic data, in addition to its conventional use for voice transmission. Such devices are already on the market for applications in the business environment.

The key to the future will be ease of use. As new terminals become available and are capable of presenting and transmitting information in a multiplicity of formats, user anxiety relating to the technology used to interact with systems for delivering financial services should approach the level now experienced with the telephone or the handheld calculator.

Future providers and users of financial services will have the choice of using networks of small processors or the minicomputers and mainframes that will soon become affordable for them. To some extent, they, like everyone else who acquires information-processing capabilities, will be able to choose the equipment that best meets their requirements for processing and their philosophies of product design and management. Factors such as system security, reliability, and integrity will be taken into account. Other factors will be the availability of appropriate software packages and the costs of telecommunication services.

In some specialized applications, however, the large computer system will continue to dominate. For example, significant computer power is required to support the check reader/ sorters used widely throughout the financial service community. While electronic banking will lessen the growth in check volumes, they will remain high. Therefore, requirements for supporting check-processing equipment will continue into the foreseeable future. New applications implementing processing of voice and/or handwriting will also require the power of mainframe computer systems. In addition, microcomputers may not be capable of man-@g future telecommunication functions that will become even more significant to the financial service industry.

Online POS systems will consume substantial processing and communication resources. Interchange networks that serve ATM systems are designed to handle 4 to 10 transactions per second and provide a response time that ranges from 30 to 90 seconds. Paul Hefner of First Interstate Bancorp of California, points out that POS networks will have to handle hundreds of transactions per second and provide a response on the order of 6 seconds. Thus, the processing capacity required to support these networks may begin to approach the limits of the technology, if they begin to handle the transaction volumes foreseen by some.

Already, both users and providers of financial services have put in place a considerable portion of the hardware infrastructure that will be key to delivering financial services. Banks and other financial service providers have been long-time users of computers, as have the major dry goods retailers. However, an increasing number of small stores are installing electronic cash registers and computers from which they will be able to build in the future. Some grocery chains have made heavy use of computers to automate the checkout process and inventory systems for individual stores. Major firms regularly use automated systems to generate payrolls and pay suppliers. Smaller firms are increasingly turning to data service bureaus or installing small computers to obtain comparable services. Also, considerable numbers of consumers are acquiring computers that could be configured to perform the processing required to interact with financial service delivery systems.

One of the factors that has limited the degree to which advanced systems for delivering financial services have been accepted has been the lack of processing capabilities in the hands of many potential users and suppliers. The fact that many potential participants in the financial service industry are installing computers for a variety of reasons is creating a latent capability for either using or delivering financial products because the marginal cost of such a move could be minimal.

The long-term impact of changes in the capabilities of computers on the users and providers of financial services is not so much that the raw computational capability of the equipment will increase. Rather, an increasing number of individuals and organizations are buying equipment because its cost is dropping. The result is a decreasing marginal cost of entry for potential users and providers of advanced financial services systems. Higher potential levels of participation will encourage the deployment of advanced systems and, in the absence of other barriers to their acceptance, will result in their achieving a greater level of economic viability than would be possible with the present level of equipage.

Generally, the financial service industry has not demanded access to the largest computers to handle its applications. Advances in computer technology will most likely continue to outpace the demands of the financial service industry, and therefore, lack of sufficient computer power will not be one of the factors that will limit the development of new systems for delivering financial services.

Software

A computer is useless without software: the programs that instruct a computer to perform operations. The development of software depends on the careful and precise definition of requirements by those for whom a system is being built, thorough testing before declaring a program to be operational, and an ongoing program of maintenance to ensure that the software remains responsive to user needs and to remove errors that are almost invariably identified after a program is declared operational. All of these operations are labor-intensive, and therefore very expensive. The cost of software is determined by its complexity rather than the size of the machine on which it is to operate or the volumes of data that are to be processed. Generally, however, larger machines are needed to use the more complex software packages that support the larger data bases.

Although the cost of computer hardware will continue to decrease, the cost of computer software may not, or may not decrease as much. Software development remains a labor-intensive activity and is likely to remain so into the 1988 to 1993 time frame. However, more widespread use of software packages will lower costs for individual users.

Until now, resources for software development have fallen short of demand. The advent of new tools for software development, however, should increase the productivity of software professionals somewhat. Furthermore, a greater tendency to purchase and modify application packages to meet specific needs as a substitute for the development of application packages by each end-user organization will reduce the apparent shortfall of software development resources in the future.

There are three basic classes of software—systems software, support software, and applications software. Systems software controls the minute-to-minute operations of the computer by allocating resources and scheduling tasks. Support software is typically used for such functions as controlling a communications network, monitoring transaction processing, managing the data base environment, or furnishing tools intended to improve the productivity of programmers and, in some cases, end-users. Applications software directly interfaces with the end-user and is designed to carry out functions unique to the particular situation.

Systems and support software, including data base management systems, are discussed in appendix 2B to this chapter. Applications software and its use for delivering financial services is described in the sections that follow.

Present Applications Software

The acquisition of applications software has always been the responsibility of the user organization. Today the computer user has three options for acquiring software. First, the user can retain either in-house staff or a consultant/contractor to build application packages uniquely tailored to his needs. Because program development remains labor-intensive, this can be a costly process, a significant portion of which is the cost incurred-after the system becomes operational-for maintaining the programs, correcting errors as they are discovered, and making changes as the needs of the organization evolve. For operators of large scale computer systems, such as those used by many providers of financial services, this has been the only option considered. Large staffs of highly trained professionals have been assembled and supported to handle the tasks of system development and maintenance. Experienced organizations have found that over 70 percent of the resources spent on these staffs is for maintaining existing systems, leaving only 30 percent for developing new applications programs.

Financial service organizations have developed a huge body of proprietary software over the years. Included are applications that range from internal accounting systems to those that support home banking products. When a new product such as a money market mutual fund is offered, its introduction must often be preceded by a significant software development effort. Regulatory changes such as the imposition of Regulation E* can also result in major software development efforts or the need to make significant changes to existing software systems.

However, just as the advent of small computers has brought the power of the technology within reach for the individual user, it has also had an impact on the costs of system development and maintenance. Consumers now identify applications in which the small com-

*Regulation E is the Federal Reserve Board Regulation implementing the consumer protection provisions of the EFT Act of 1978.

puter can provide significant benefit and either write the programs themselves or with help at minimal cost. Generally, the small packages for personal computers which result are used for analytical applications that are often tailored to the specific working habits of the individuals using them. To some extent, the personal computer has replaced the worksheet and personal file system that have always been the tools of the professional analyst and decisionmaker. This software is not suitable for account maintenance and other administrative tasks that require the manipulation of large data bases and the processing of a large number of transactions. On the other hand, a portion of these applications depend on being able to access the major corporate data bases that are maintained by the large, central computer facility.

In one example, a microcomputer is used to help farmers generate the information required to support applications for loans. Another application using a voice response unit and input from a 12-key telephone has been developed by a financial analyst to process market data and generate information used for portfolio management. Automated spread-sheet programs running on microcomputers have also become popular tools among users and providers of financial services. Users have found that for some purposes the information generated by a microcomputer running all night can be just as satisfactory as the same data produced in a few minutes on a large, centralized computer. Further, the user of the microcomputer may be able to avoid hassles often encountered when a data processing department is asked to implement an application.

Over the years, the usefulness of applications packages has been recognized across an industry, and significant numbers of packages are now developed and offered for sale or lease to a variety of users. In some cases, the packages were developed by organizations for their own use and later offered to others. In other cases, the package was developed to be marketed commercially. In this environment, all benefit because the costs of development and maintenance are potentially spread over multiple users.

Systems for processing checks and servicing deposit accounts and outstanding loans have been developed by both financial institutions and data-processing service organizations and are widely used throughout the industry. Organizations that have developed the software for home banking applications are actively marketing it to providers.

Thus, as a second option, the user can acquire an application package that comes as close as possible to meeting his needs and then either modify it with internal resources or retain the original developer or another party to make the required changes. This approach has the disadvantage for both the vendor and the user that multiple versions of a basic package must be supported. Costs and difficulty of maintenance are both increased as, almost invariably, the modifications made periodically to the basic package and the changes made to meet specific user needs generate conflicts that require basic changes in the software to resolve. Some marketers of software systems mitigate this problem by including features that permit the user to customize the package at specific points in the processing cycle without actually modifying the basic program.

The third option for the user is to acquire and use an application package as is. This option is more often used by users with small computers than with large. However, operators of large installations are turning with increasing frequency to generalized software packages. Prepackaged software for microcomputers has enabled significant numbers of users in the financial service industry to apply information processing and telecommunication resources to the operation of their businesses without needing to become proficient technically in the operation and use of the technology.

To use these various packages, the user need not purchase or lease the computers on which the applications run. Time on systems operated by others can be purchased, an option that has enabled many smaller providers of financial services to take advantage of available technologies. In many cases, banks and service bureaus that develop application packages also sell the machine time required to run them. In others, those with excess processing resources available sell them. For example, the largest processors of bank card transactions are service organizations, not banks. Check processing and account maintenance is often performed by other than the institution offering the service.

Conventionally, the medium for distributing software is either floppy disc or magnetic tape. Telecommunication links between computers are also used for transferring software. This technique is used to distribute programs for large computer systems and for providing programs stored on large central computers to small peripheral ones in distributed processing environments.

Experience has shown that safeguards against copying or modifying software can easily be circumvented by individuals who have a moderate degree of technical sophistication. This presents a problem to operators of systems for delivering financial services electronically to a large number of people. If the software used to access a service from the customer's premises can be altered, a compromise of system integrity or security could result, causing damages for both the system operator and other users.

One way to avoid this problem is to distribute software in cartridge form, in the form of hardware, a technique that is being tried by at least one marketer of home banking services. Although this minimizes the chances of modifying the software, users whose computers do not accept cartridges are eliminated from the market. Moreover, it does nothing to stop the potential intruder who obtains the functional specifications of the cartridge or is able to copy the program from the cartridge to another medium. In these cases, the intruder could modify the program to perform unauthorized functions, just as it is possible to modify software distributed using other, more conventional media. On the other hand, a major computer manufacturer has announced a microcomputer that accepts program cartridges; this is likely to provide the impetus needed to make this medium of software distribution more widely accepted for financial services.

Applications Software in the Future

The evolution of applications software in the future is likely to be relatively slow because of the huge base of operational programs, representing an investment of billions of dollars, that is now installed.' Language development will be constrained because in many areas new languages will have to be compatible with those used to implement the installed base.

Even though there is considerable inertia in the form of installed application systems, application programs will continue to evolve. In the near term, the emphasis will be on modifying batch applications* to operate interactively where it is reasonable to do so. Specific attention is being given to providing the most up-to-date information possible to both users and providers of services in order to improve overall management of financial resources. Even where batch processing is most desirable, transaction data will be entered interactively and accumulated until a batch processing program designed to handle the accumulated data is run. Eventually, however, interactive processing will dominate and up-to-the-minute data will be available to all who need it.

Most programs today have been developed to meet the needs of classes of individuals on the assumption that the requirements of members of a group for computer support are approximately the same. This assumption holds for people engaged in routine activities, but it tends to break down at the upper levels of organizations. In the future, generalized sys-

[1]The material in this section draws heavily on the report, "Future Information Processing Technology -1983° prepared for the Institute of Computer Science and Technology and the Defense Intelligence Agency.

*Batch applications are those when data are assembled over a period of time and are processed periodically, frequently on a fixed cycle.

terns and capabilities will be more easily tailored to the specific needs of individuals. Users will be provided the facility to set application parameters to meet their individual needs. Obvious examples that already exist are the ability to request the detail to be used in prompting the computer user online and the format to be used for displaying data. The user unfamiliar with an application can be led through it step by step, while those who have mastered the operations required can be freed of the burden of detailed instructions.

Applications *will* be self-teaching to a great degree. Many, as already illustrated by the systems that support ATMs, will be menu-driven; users will not be required to learn and use commands. Today, a growing number include tutorial features; but in the future the user will have greater facility in selecting the specific points where instruction is needed and w-ill be able to obtain help without interrupting the ongoing flow of processing. Audio-visual display technology, heavily dependent on video discs, may figure greatly in implementing this capability.

Users will have a larger variety of options in selecting the format in which data is presented. Color graphics will come into more widespread use and users will have greater capabilities to manipulate graphic images in addition to already existing facilities for manipulating and analyzing combinations of numeric and alphabetic data. For example, the capability of manipulating a trend line for one variable and seeing its effects on other trends will be possible. Mice, * light-pens, and voice input/output will greatly facilitate interaction between the user and information system.

*A mouse is a small device attached to a computer that is used instead of keys to control the movement of the cursor, the indicator on a video display that indicates where the next character will be formed.

"Windowing" technologies that permit the user to display the results of multiple processes simultaneously on the screen will improve the utility of the technology to the users. They will allow the users to concurrently view data from multiple sources and select those items most useful to the task at hand. For example, the user may use one window to review the status of a transaction account, a second to project cash flow, and a third to enter an order with a broker/dealer to buy or sell a security using a telecommunication line that connects directly to the broker/dealer's computer.

More of the processing capability will be resident at the user site and will therefore be much more of a personal tool. Large systems may be limited to being repositories of data to which the user is provided access on a "need to know" basis. At the start of a problem-solving session, a microcomputer will be used to access a data base on a large computer system, retrieve the data needed to address the problem, and store it locally on a small disc. Applications running on the microcomputer will perform the required analysis, and after this has been completed, the central data base will be modified as required. In fact, in some organizations, this mode of problem-solving is already quite commonplace.

Knowledge-based systems, one of the areas in the general field of research known as artificial intelligence, will become more generally available. For the financial service industry, this could mean that financial advisors and counselors will be augmented, or possibly replaced, by automated systems. Research in artificial intelligence and expert systems has shown some valuable results. However, there is considerable uncertainty about when such systems will be sophisticated enough to have an operational impact on the financial service industry.

Telecommunications Technologies

Telecommunication technology provides an indispensable lifeline to users and providers of financial services. Of the number of alternative telecommunication technologies from which suppliers and users of financial services are able to choose, the most common is the switched telephone network. But, both providers and users of financial services also construct and use a variety of alternatives, which include such diverse technologies as private microwave links, satellite transponders, video cable, public packet switched networks, leased lines, and local area networks.

The divestiture of the operating telephone companies by American Telephone & Telegraph (AT&T) in 1984 substantially changes the communication environment in which providers and users of financial services operate. Both local and long-distance telephone rates are likely to change. Competition from non-Bell suppliers of telecommunication services and equipment is already significant and is likely to increase in magnitude and kind in light of the divestiture. Those who enter markets as providers of equipment and services are likely to intensify competition further.

Both suppliers and users of financial services are heavily dependent on telecommunication services, and as systems to deliver financial services directly to customer premises become more widely deployed, this dependency will increase. Securities markets, card and check authorization systems, and cash management services are now totally dependent on telecommunication. Products such as remote banking and shopping and off-market securities trading have a dependency equally great. The premium placed on timely financial information is increasing, and the only way to meet this requirement is through the application of communication technologies. Changes in the technologies, policies, and economics of communication will directly affect the design of systems for delivering financial services, the cost schedules facing both users and providers of financial services, and, hence, the structure of the financial service industry.

Photo credit Racal-Milgo Corp

Network control console like those used to manage major financial service telecommunication networks

The Switched Telephone Network

The most widely available communication facility is the switched telephone network that serves virtually every place of work and residence in the United States. Only a limited number of locations can send and receive telecommunication traffic without using this network for a portion of the route. Subscribers to non-AT&T long-distance networks generally access them through the facilities of local operating companies. In fact, some of the alternative services actually use long-distance circuits provided by AT&T.

The switched telephone network is basically designed to handle analog voice traffic. Generally, digital data sent between computers and between computers and terminals must be converted from digital to analog format for transmission through the network. Network facilities capable of carrying the digital signals and thus eliminating the need for this conversion/reconversion process are now coming into use and will eventually replace the analog links in the system. In this environment, voice as well as data will be transmitted through the network using a digital format.

The switched telephone network was designed to handle a relatively large number of calls of short duration in which the parties are speaking a high percentage of the time the connection is maintained. A circuit is established between the parties for the duration of the call. Whether or not there is traffic on the connecting circuit, the facilities used to maintain the connection are denied to others. A POS terminal connected continuously through the switched telephone network may be used only intermittently. Although this constitutes an inefficient use of network resources, a merchant may desire to maintain such a connection in order to minimize the time required to process a transaction at the point of sale.

The common telephone is by far the primary terminal used with the switched telephone system. Although it functions well for voice communication, its capabilities as an instrument for data entry are limited, and those for receiving other than voice response are almost nonexistent. The 12-key tone pad is a moderately effective data entry device that can be used to transmit numeric data to a computer with relative ease, but it transmits alphabetic data awkwardly. It has been used for applications such as telephone bill paying and balance inquiry. In those locations where tone service is not available, an easily acquired attachment to the traditional dial telephone or widely available dual-mode instruments allows the user to transmit the tone codes required for certain services. This operation requires use of either a tone generator placed over the microphone of the handset or a type of telephone now available that can switch between dial pulse and push-button tone operation. With either, the customer can make a connection using conventional dialing and then switch to tone output to communicate with an electronic device. If financial service providers' applications can conform with the capabilities of the voice telephone as a data communication device, a significant portion of the Nation could have immediate access to computer-based financial services. Marketers of such services have been limited in the past by the lack of capabilities of the stand-alone telephone as an input/output device. If successful market penetration occurs, home computers may offer a more viable alternative for delivering service.

Presently, commercial users in some areas have specialized, switched digital service. In the future, virtually all customers will have digital network service available, primarily through the digital termination services planned by operators of the switched telephone network. As outlined in greater detail in the next section, each digital line will have substantially more capacity than is now available in the conventional voice circuit and will be considerably more versatile.

Wide Area Telephone Service (WATS) is a specialized service offered through the switched telephone network. This service allows a fixed number of hours per month of calling for a specific geographic area. IN-WATS permits incoming calls at no charge to the caller, and WATS, or OUT-WATS, permits the subscriber to originate calls using the service. IN/OUT-WATS permits both. Financial institutions and others use this service to expand their markets geographically without establishing physical presence in the targeted areas. The availability of toll-free calling encourages the remote customer, who might be unwilling to incur a toll call charge, to contact the institution. The service is particularly valuable to depository institutions that face restrictions on the geographic areas in which they can establish facilities.

In addition to the common voice telephone, many other types of communication devices can be attached to the switched telephone network. Included are computers, simple terminals, and facsimile terminals. These can provide for interaction with humans and/or unattended operation. However, all currently cost more than the voice telephone. Service providers must recognize this cost differential when planning the deployment of a system that depends on the user acquiring the required terminal equipment.

Private-Line Telecommunications Facilities

Many commercial organizations and government agencies use leased circuits for their internal communication needs. Providers of financial services are among the heaviest users of such facilities, and some operate large global networks for moving funds and information.

A leased circuit guarantees access to a circuit between the points that meets specified electrical characteristics. This eliminates the problems of uncertain quality and relatively slow access* when dial-up lines are used. While there is no assurance that the same physical circuit will be made available at all times, or that the signals will not be multiplexed with others between various points along the route, the quality of the line becomes invariant from the user's point of view. This minimizes the variability of one of the elements critical to overall reliability and integrity of financial service systems.

Institutions with sufficient need and funds can install their own circuits; in some cases, private microwave networks have been established. Fiber optics and coaxial cables are used for networks confined to a limited area, such as an office building or factory complex. Some have leased transponders on communication satellites, and others have leased circuits on video cable systems. Financial service organizations are among the heaviest users of the video cable that runs from midtown Manhattan to the Wall Street area in New York City. Aetna Insurance Co. is one of the three primary partners in Satellite Business Systems, a major communication venture. New technologies will increase such options. For example, the installation of teleport facilities will make satellite communication available to a larger community of users and offers the opportunity to bypass local telephone facilities completely. Merrill Lynch is one of the major backers of the teleport installation planned for New York.

*The time required to dial a number and go through the log-on procedures that must be used in a dial-up environment.

Fiber optics offers greater capacity and security of transmission than do copper conductors of comparable size, properties that are particularly attractive in areas like the financial district in New York, where the available space in conduits for wires has been almost exhausted.

A communication technology of growing importance is local area networks, which are installed within an organization's facilities to provide a variety of communication services, including the transmission of both voice and data. Digital, private, automated branch exchanges are being installed to manage some of these networks. Others have been developed by manufacturers of office computer equipment and emphasize such features as sharing of data resources and electronic mail. * Characteristically, all of these networks provide gateways to the switched telephone network, including the private, value-added carriers and any private networks to which the user may have access. The user of a local area network with gateways to the switched telephone network has access to all of the data and processing resources that comprise the local network and, using the same terminal equipment, to other facilities that are external to it.

All of the classes of equipment that will operate with the switched public network will also operate with private networks.

Alternatives to Switched Networks

Because the switched telephone network, where "hard" connections are established and maintained for the duration of a conversation between the parties, is not particularly well suited to traffic that is characterized by relatively short bursts of activity separated by long periods of silence, alternative technologies more suited to data traffic are used by providers and users of financial services. POS, ATM, and home banking systems, as well as others that use interactive computer facilities

*Electronic mail is the technology Of Sending messages electronically between computers. Messages are stored on the addressee's computer system to be retrieved, read, and disposed of at his/her convenience.

to deliver financial services, are characterized by this kind of bursty traffic pattern.

One of these is packet switching, in which messages are broken down into small packets, each of which is routed separately through the network. One property of this technology is that the cost of communication becomes more a function of the volume of traffic handled than the distances involved. Also, there is minimal penalty for having a network that includes a large number of points between which only limited traffic volumes pass. Because it is oriented to handling messages that are fairly short in length and are spread over considerable periods of time, packet switching is particularly suited to the type of traffic likely to be generated by providers and users of financial services. POS systems and systems for trading securities are candidates for this technology.

Multiplexing, a well-established and widely used group of technologies that permit a communication circuit to be shared more or less simultaneously by multiple users, is also of interest to providers and users of financial services. These technologies permit a single, high-capacity circuit to be used for various applications, none of which could alone justify the expense of a dedicated line. For example, if local communication costs rise, as some predict, the operator of a shopping center could establish a connection to a financial network or a specific financial institution that would permit the merchants access to POS services at lower costs than if communication services were paid for independently. This could be done by connecting to a specific institution, thus eliminating choice of a financial service provider for individual tenants of the shopping center. On the other hand, the shopping center owner could conceivably provide access to a gateway that would permit individual merchants almost unconstrained freedom in selecting financial service providers.

Video-Related Communication Technologies

Considerable attention has been given in recent years to using technologies built around some modification of the common television set for distributing information, including financial services. The services offered are generally built around alphanumeric displays of information that fill one television screen. The quality of graphic capabilities varies from system to system, but none presently offers any significant degree of animation. However, with some systems, computer programs will be transmitted to the user's terminal at relatively low speed and then executed in the customer's terminal to produce animated graphics. One application for this technique is the distribution of video games; other applications are likely to follow.

While video-based systems have been somewhat accepted in Europe, they are still in the experimental stage in the United States, where only a limited number of systems is in operation. One of the principal drawbacks encountered is the price of a modified television set or specialized terminal capable of participating in the system. Three general types exist: teletex, videotex, and cable television.

In teletex, frames are transmitted over the air during the blanking pulse in the television signal, the period when the raster on the television returns from the lower right comer of the screen to the upper left. Because the technique repeatedly transmits a limited number of frames that can be selectively captured by the terminal equipment, the capacity per channel for offering adequate response to users is limited to about 25 to 100 frames. This is essentially a one-way system because there is neither a path over which the user can respond to the system nor a means for sending a signal to a specific receiver. Users can, however, use a telephone connection to transmit to the systern. Conceptually, an address routing message to a specific receiver could be added to the transmitted frame, but the limited capacity of the channel would effectively limit such an application. Full-frame teletex, an alternative to transmitting the textual information during the blanking pulse, is the dedication of a channel to a telex application. Capacity could then increase to about 1,500 frames per channel. Application of this technique is generally limited to dissemination of advertising and bulletin board type of information. Included could be price quotations, but it would not be possible to tailor the information to the needs of a specific subscriber. Transaction initiation, except through the use of an auxiliary channel such as telephone, is not possible because there is no direct path from the user to the source of the information.

Videotex generally uses the telephone network to transmit the required information to users, who are able to interact with the information source, selecting material from a large library that is directed only to the user's television set or personal computer display. A very large number of frames is available, and it is possible to charge for each frame viewed (the user requests specific frames). Some applications, such as those related to financial services, permit the user to enter data that is then processed (e.g., a mortgage amortization schedule is produced when the user enters principal, term, and interest rate). Because data is directed only to a specific terminal, personal information such as account balances can be delivered using this technology. The capacity of the telephone channel limits the degree of animation that can be offered, and the data transmitted is generally confined to text, numeric tables, or fixed graphics.

The third technique, cable television, uses video cable, with all of the transmission capacity inherent in that medium. The Warner-Amex QUBE system that has been operating in Columbus, Ohio, for some time offers considerable capabilities for delivering text to specific users and a low data rate return channel for reacting to specific user input. It therefore has considerable potential for delivering financial services. This system includes provision for interactive response from users to questions posed by the program being transmitted. Applications include all of those possible with videotex and others that can make use of the capacity of the television cable. Large amounts of data, such as historical stock market information, can be transferred rapidly and loaded into a user's computer for processing at a convenient time.

Future Telecommunication Technologies

Generally, telecommunication technologies will continue to provide the means by which financial and payment information is transmitted rapidly from point to point. In many ways, the specifics of telecommunication technology are of minor interest to users and providers of financial services. As long as sufficient capacity is available at an affordable price, the needs of the financial service industry will be met.

While voice communication will continue indefinitely to dominate the traffic handled by the common switched telephone network, transmission technology is changing. Digital transmission will replace the analog signals now used most commonly. Voice will be digitally encoded and will share circuits with data, video, and facsimile transmissions. This will mean that users of telecommunication services will be able to interweave voice and various forms of data on the same circuit. Systems that offer these capabilities to commerical customers are being marketed. For example, a financial service consultant is able to send a table of data showing the expected results of alternative investment opportunities for display on a client's terminal in the midst of a normal conversation. Even now, terminal devices capable of supporting such usage patterns are coming on the market.

The concept of a telephone industry ISDN (Integrated Services Data Network) is emerging and will reach fruition sometime before the end of the century. An ISDN is a network in which all traffic is represented digitally, and various types are freely mixed as traffic passes from origin to destination. However, because of the magnitude of converting the installed plant, ISDN capabilities may not be available to significant portions of the subscribers to switched telephone services for some time beyond the turn of the century. Further, while there is now no compelling reason for making ISDN generally available to consumers, there is a distinct possibility that a force driving in that direction will emerge and will hasten the deployment of ISDN. For example, if consumers become heavy users of information utilities, their needs for transmitting and receiving significant volumes of data could stimulate development and deployment of ISDN facilities.

Users of telecommunication systems built in accordance with the ISDN concept, or a less general one called "Digital Termination Service, " that shares many concepts with it, may be provided with a single high-capacity communication line. The capacity of this line would then be allocated among various applications at the user's discretion. Some may choose to use it for multiple voice lines, while others may allocate a portion to data and another to voice. Allocations could be changed dynamically in response to user needs. At one point, several people could be using the facility for a number of simultaneous conversations, which could include conference calls. At another point, a single user could use part of the capacity to carry on a conversation, while the remainder is used to access information resources. Using advanced software technologies, the user could also interact simultaneously with multiple information providers. For example, an individual may review account balances, along with economic statistics and historical data provided by independent vendors of information services, in formulating investment decisions.

Although one could assume that the vehicle for implementing ISDN will be the framework provided by the switched telephone network, there is no technical reason why this need be the case. Most private locations, such as homes and places of business, will be able to have telecommunications delivered over at least two types of networks, switched telephone and video cable. Either could be used to implement ISDN-like concepts. The cable television systems may enjoy some cost and bandwidth advantage over the telephone network. The transmission capacity of a cable is much greater than that of most ordinary telephone circuits, and the cost of serving a subscriber is less.

Designers and users of financial service systems will be able to choose from a variety of telecommunication technologies in designing and accessing services. Some new telecommunication technologies will have greater capacity than the switched telephone network of today, but development of new techniques to extend the capacity of the present telephone plant are evolving. For example, dial telephone lines are now routinely used to transmit at *2,400* bits per second, a rate that could not be realized with acceptable error rates several years ago, and rates as high as 9,600 bits per second are becoming possible. Switched telephone networks are expected to evolve slowly from conventional copper wires to fiber optic circuits. Fiber optics have transmission capacities far greater than those of the present copper conductors. However, as is now the case, some network segments will always be carried by radio transmission, as exemplified by the use of microwave and satellite facilities.

Technologies such as cellular radio and digital termination services are now being offered commercially for the first time. These are expected to come into widespread use by the mid-1990's. In addition, direct broadcast satellite systems will soon become operational and may be used in some systems for delivering financial services.

There will be a diversity of telecommunication networks in the coming years. Various vendors of telecommunication services and technologies will try to offer systems that most effectively serve certain classes of users. While there is a proliferation of systems, vendors recognize that they will have to provide for the interoperability of communication facilities. Gateways between private networks and public transmission facilities are now almost mandatory. Thus, users and providers of financial services will be able to communicate between and among themselves with minimal concern for the particular technologies used in implementing financial service systems. The emergence of other alternatives to conventional switched telephone services should be expected over the coming 10-year period. These new services will almost certainly offer opportunities of value to both users and providers of financial services.

Now, and probably more so in the future, numbers of telecommunication options available to all users, including individuals, will be available. Users will be able to closely align services procured with needs. But the full benefits of the ability to choose from a range of options will be realized only if the customer expends the effort needed to evaluate the alternatives. In all likelihood, independent development of system designs and seeking the vendor best able to meet the need will be required. Not all potential users who could benefit from this approach will be prepared to take it, with the result that they will probably settle for something much less than the best available communication facility at the most advantageous price. To the degree that communication costs become relatively more significant for providers and users of financial services, this shortfall could affect their basic ability to compete in the market with others not carrying a similar burden.

System Security and Integrity

Security has long been an area of concern to providers and users of financial services. Traditionally, banks have been characterized by large metal doors and imposing vaults with massive and complex locking mechanisms. Financial service providers stress the safety of assets in attracting customers, and customer trust is a keystone of the financial service industry.

Increasing use of telecommunication and information-processing technologies in conjunction with financial services raises two areas of concern that relate to the basic soundness of the financial service industry: system security and system integrity. System security deals with the problem of those who would attack the system from the outside, including those who work with the system but would attempt to invoke operations they are not authorized to perform. System integrity addresses the problems that arise with recovering a system without loss of data in the event of a failure.

System Security

As demonstrated by the young people in Milwaukee in 1983, it is not difficult for individuals with minimal equipment and training to penetrate some computer systems which contain sensitive information. In the Milwaukee caper, one of the computers compromised, using a common home computer and telephone line, belongs to a major west coast bank. Other instances of penetration of computers used by providers of financial services are on record; and some experts believe that only a relatively small portion of the security breaches that occur are detected, and fewer are reported outside of the victim organization.

Historically, embezzlers from within and check forgers and confidence artists from without have threatened the financial service industry. Computers, particularly those accessible through telecommunication networks, add new dimensions to the vulnerabilities of financial service providers. In a high-technology environment, the assets of an organization and the proprietary information on which it bases its business operations are subject to remote-access thefts.

Attacks on financial institutions through their own processing systems can directly victimize those institutions' clients. A thief who robs a bank at gunpoint steals from the institution; the electronic thief can reach directly into the accounts of individuals. The burden of detecting the crime, reporting it to the organization holding the account, and recovering the lost assets could shift from the institution to the account holder. When the thief's booty is information rather than financial assets, neither the specific individual nor the institution affected may ever become aware of the fact that the system has been penetrated.

Threats to a system can materialize both from within and outside the target organization. Employees throughout an organization can individually or in concert attempt to compromise a system. Technical personnel can modify operational programs or write new ones to perform improper operations. Similarly, nontechnical personnel can seek to perform operations not authorized to them or misuse powers with which they are entrusted.

Programmers have written codes that credit the fractional cent from an interest computation to their personal accounts and fail to report properly the overdraft conditions in those accounts. Some programs to perform unauthorized operations destroy themselves after completing their task, leaving no trace of their existence. A few people used computers to create and maintain millions of dollars worth of bogus insurance policies in the Equity Funding case, a task that would not have been possible without the technology.

Conceptually, it is possible for anyone to use international telecommunication facilities to attack financial institutions without ever coming within the jurisdiction of American law enforcement officials, much less being in close physical proximity to the institutions they are attacking. With relative impunity, individuals or organizations could launch their attacks from any telephone, including those in motel rooms and pay stations, from which they could operate undisturbed for brief periods. At least one computer now on the market fits nicely into a large purse and can be used to initiate an attack on a financial institution from any location where a standard modular telephone connector can be found. Some devices can be set up to operate unattended, and then retrieved.

Not all attacks on financial service systems must be so sophisticated. Individual consumers of financial services and various user organizations have demonstrated a marked yet unwitting ability to aid the thieves who would victimize them. Personal identification numbers (PINs), given to account holders to use in depositing and withdrawing money from ATMs, are written on access cards. Telephone numbers and key access codes are written on communication terminals and bulletin boards in clear view of those unauthorized to have them. In one instance, an enthusiastic user of an ATM demonstrated the use of the machine to a complete stranger and, in the process, revealed his PIN to all within *20* feet. A variety of comparatively simple scams, that range from asking individuals for PINs and the use of their cards to retrieving used carbons showing account numbers from the trash cans of organizations that accept cards in payment of accounts, have been used to compromise financial service systems.

Computer-to-computer communication is now used to initiate and execute a substantial number of financial transactions, a practice that will become more widespread in the future. Therefore, the problem of authenticating the "signature" of a computer that participates in financial transactions in order to authenticate the transactions will become as critical as that of establishing the identity of human users. Although under study, no such technique has emerged that shows promise for wide adoption by the financial service industry. Finding a solution that will be acceptable for use by individual consumers and others not sophisticated in the design and operation of advanced technological systems constitutes the most difficult subset of problems in this area.

Providers of financial services, aware of the threats to their systems, are taking steps to tighten security. Various devices and techniques exist for minimizing the vulnerability of computers and communication networks used to deliver financial services. The use of data encryption techniques is growing, and a system in which the PIN is never accessible in clear text to any human is available and in use by many financial institutions. Physical security around computer facilities is the focus of considerable attention, and research designed to overcome the known weaknesses of the PIN as an access code is continuing. Nevertheless, human ingenuity and fallibility will probably counteract attempts to provide foolproof security for computer systems.

System Integrity

All systems, whether manual or automated, will at some time fail in the sense that operations will be interrupted for a period of time. Such interruptions may be the result of attack by an outsider, natural calamity such as an earthquake, or the inadvertent error of an authorized user of the system. Thus, systems must be built so that they can be restored to full operation without loss of data or transactions in process at the time of failure. This is a particularly important factor in delivering financial services because lack of system integrity could result in a situation where the level of confidence so essential to the viability of such systems is degraded.

The problem of providing for system integrity is largely a technical one. Increasing use of telecommunications adds new dimensions to the problem, but a number of well-accepted practices aimed at ensuring system integrity exist. It remains for the operators of financial service systems to ensure that those practices are followed during the design, implementation, and operational phases of the system lifecycle.

Specific Technologies for Delivering Financial Services

Applications of general-purpose information processing and telecommunication technologies specific to the needs of the financial service industry have been developed. Included are technologies for accessing systems and handling items such as cash and checks that are unique to the financial service industry.

Card Technologies

Embossed/Magnetic Stripe Card

The embossed plastic card with a strip of magnetic tape embedded in the back has become almost ubiquitous. This device provides the primary means for accessing credit and debit services that are delivered through both paper-based and electronic systems. Commonly, the card is presented at the point of sale, and an impression is taken on a paper document that is then processed. Most often, the consumer is making use of a credit service and is billed by the credit provider. Today, embossed plastic cards are also used to originate debit transactions that are processed over the same network as credit transactions.

Generally, the data are recorded on the magnetic stripe on the card by the card issuer before it is sent to the account holder and they are not changed during the life of the card. This striped card has room for about 1,000 bits of data. Allowing for the information that must originally be recorded on the card, there is just not enough room to record transaction data. Technologically, however, there is no reason why data on the stripe could not be altered after issuance. On the other hand, the limited capacity of the stripe and the cost of deploying sufficient terminals with the capability of recording data on the stripe makes this device generally unsuitable for applications that would require changing the data repeatedly. Also, the stripe is easily readable, eliminating the possibility of building security into the card.

However, the same basic technology is used in the Washington, D. C., subway farecard system. When a farecard is purchased, the amount is recorded by the machine dispensing the card. Each time it is used, the starting point of the trip is recorded, and when the passenger exits the subway system, the amount of the fare is computed and deducted from the balance on the card. In this system, the magnetic stripe is mounted on a paper backing, and the card is generally disposed of after only a few cycles, a lifetime that would not be suitable for a card that is to be used repeatedly over an extended period.

Data on magnetic stripes are read by ATMs and special terminals used by some merchants at the point of sale. Merchant terminals primarily facilitate the process of obtaining a transaction authorization from the card issuer by eliminating the requirement for either the clerk in the store or an authorization clerk at the issuer's facility to key in the account number. Some merchant terminals also print the necessary information on the paper document, further reducing clerical workload.

Among the problems with the embossed/magnetic stripe card is that it is relatively easy to copy or counterfeit. Several technologies have been developed to overcome this problem. Data can be recorded in the laser card by burning pits in a reflective material that can be sensed by an appropriate reader. Once recorded, the data can be neither altered nor erased. Holography is being used on some card blanks to create a background image that is very difficult to reproduce.

Laser Card

The laser card, or memory card, is just making its debut. At this date the laser card is not used by the financial service industry; however, its potential use is likely. As described by S. Berton Latamore:

> The card can store digital data signifying the bearer's fingerprint, voiceprint, or even the pattern made by capillaries in the retina. A stand-alone card-reading machine, equipped with a microprocessor, would check whether this biological data on the card matched that of the card-holder. The card is being developed by Drexler Technology of Mountain View, Calif. The company's Drexon card stores 1.2 megabits, or roughly 30,000 words–nearly 1,000 times more than a magnetic stripe card.
>
> The Drexler cards are coated with a two-layer plastic film. The top layer is embedded with microscopic pieces of silver, giving the material a highly reflective, metallic look. To write data, a low-power laser melts pits in the top layer to expose the unsilvered—and unreflective-bottom layer. To read the card, a laser scans the surface, and a photodetector senses the presence and absence of pits as highs and lows in the intensity of the reflected light.[2]

Unlike the magnetic stripe, the laser material cannot be erased and rewritten; pits are physical holes that cannot be refilled.

Electron Card*

Electron cards, first distributed in early fall of 1983 by VISA, U. S. A., combine three encoding technologies on the back of the plastic card-the banking industry's magnetic stripe, the retail industry's optical character recognition, and the universal product code bar code.** The card, which is not embossed and cannot imprint paper forms, is an attempt to embrace both the banking and retail environment with a move toward a more secure electronic environment than presently exists. The card will feature a direct debit option but will

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[2] J. Berton Latamore, "Putting Intelligence in Your Market," *High Technology*, published by High Technology Publishing Corp., June 1983, p. 16.

*"Electron" card is a trade name for a VISA card.

**Optical character recognition (OCR): the process of reading a stylized type face with an optical sensor. Universal product code (UPC): a bar code now imprinted on many items that is read by a suitably equipped terminal.

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also have the capabilities of a credit card. It presently replaces proprietary ATM access cards. A full-scale POS project is expected to get under way in mid-1984. The card will migrate to full-service use at points of sale.

Use of the electron card is intended to reduce the number of paper checks, resulting in lower processing costs, less fraud, and faster service at the point of sale. Cardholders will have electronic access to cash through a global network of ATMs and to goods, services, and cash at many locations. Authorization will be provided electronically at the time and point of each transaction and will be fully controlled by the card issuer.

The processor card, or "smart card, " developed in France, contains a tiny embedded computer chip with about 1,000 times the storage of the conventional magnetic stripe. However, once data are recorded in the memory, they cannot be simply altered, and their memory cells cannot be directly reused. The smart card contains processing capabilities that enhance its security and flexibility. A standard for its format has recently been adopted, eliminating some of the uncertainty that may have been limiting its adoption. The user plugs the card into a terminal that then queries the card memory as part of the processing to validate the transaction. Once authorized, the transaction data can be recorded in the card's memory for later retrieval. With present technology, the card costs in the range of $5 to $10 and is good for approximately 200 transactions before its memory is full.

Even though Carte Bleu, a group member of VISA International, France, has begun

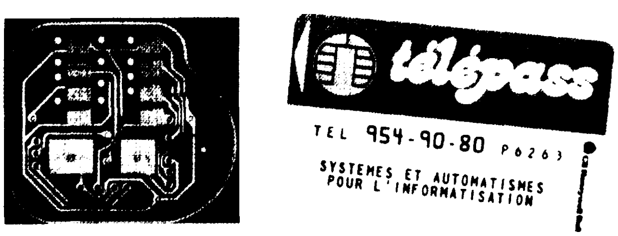

Photo credit: High Technology, June 1983

The French smart card contains a microprocessor capable of interchanging information with another computer

placing chips in all its VISA cards, the future of the smart card is uncertain. Some suggest that it represents the wave of the future, while others see it as a technology in search of an application. If it is to come into widespread use, merchant terminals will have to be generally available. Development of a card with reusable memory could also enhance the utility of the concept.

In its current form, the smart card is a modification of the conventional plastic card it is intended to replace. It contains a microprocessor chip, but because it includes neither a keyboard nor display, it can be used only with a terminal device that provides power and the appropriate input/output capabilities.

However, there is no reason why a smart card that includes a keyboard and display could not be built. Calculators that are no larger than the card are available with such features; and an interface to a merchant or financial institution terminal could be provided. Such a card could include in its functions the ability to determine the balance remaining and to review the transactions for which it has been used. Multifunction cards that contain more than one processor could also be built.

The smart card could evolve as an alternative to cash following the general model of the fare card used by some subway systems, including that in Washington, D.C. The user could "charge' the card with funds from a depository account and the funds would be decremented for the amount due each time it is used. Terminals for recording value in the card could even be located at home, giving the consumer the ability to obtain the equivalent of cash. Card readers could be provided at each cash register or POS terminal to allow a consumer to verify the card's balance. Hard currency dispensers, rather like the common change machine, could allow the smart card to serve as the equivalent of a large-denomination bill.

In the future, applications of card technology will become more widespread. Already, there are telephones which accept magnetic stripe cards and other vending machines may

Photo credit: IEEE Spectrum, February 1984

A newly designed pay telephone produced by Flonic-Schlumberger in Paris accepts smart cards. It is being deployed by the French Government's Telecommunications Administration

be designed to accept them also. As the facilites for online transaction authorization and direct debit of accounts from point of sale are deployed more widely, the utility of card technology will increase. In the long run, however, the plastic card could be displaced if a secure, practical means of user identification that depends on the physical characteristics of the individual could be developed as an alternative. Signature dynamics, fingerprint readers, and sensors that process the pattern of blood vessels in the retina of the eye are technologies that show some promise. It remains to be seen which, if any, will ever be operational.

However, all of the security features that could be implemented have flaws. For example, if an intruder can capture the digital representation of a fingerprint before it is encoded and inject it into a system being attacked, the user's "key" will have been compromised. When this happens with a conventional PIN, a replacement code is issued and the old one invalidated. The question that follows the compromise of a fingerprint or a retinal pattern is: "What replacement code is to be issued?" On the other hand, if the data stream associated with a system that uses the signature dynamic is compromised, a possible replacement could be some alternative phrase with which the user identifies himself.

Document and Currency Readers

The cost of processing billions of paper items is becoming prohibitive for an industry losing some of its principal sources of revenue, and the pressure to find lower cost processing alternatives is intense. Reading of checks encoded with magnetic ink has been commonplace for over a decade, and credit card vouchers are generally transferred to magnetic tape for processing. However, aside from some limited applications such as making change, financial document readers are in very limited use in the United States.

One of the major suppliers of ATMs has announced a model that will accept and time-stamp individual checks. It will also be able to dispense currency and coin in any amount. Models that accept and count Japanese currency are already in use. Thus, the technology to provide deposit verification by the ATM is

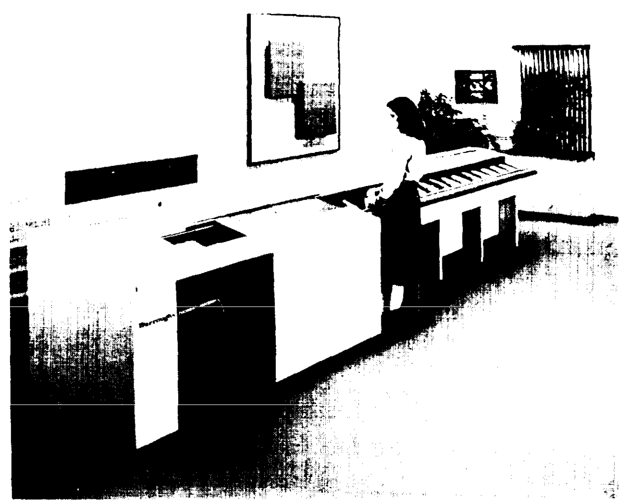

Photo credit Burroughs Corp

Reader/sorter processes checks and other documents at the rate of 1,625 per minute just over the horizon and is likely to increase the utility of these machines substantially.

Systems that process credit and debit card transactions already truncate the paper flow at the earliest practical time. Instead of moving paper, the data are recorded on magnetic media and transferred electronically for processing by the card issuer. Documents are coded so that they can be retrieved if necessary. Moreover, credit unions and savings and loan associations generally do not return drafts on NOW accounts to the account holder, also truncating paper flow. However, with relatively few exceptions, commercial banks still return canceled checks with monthly statements; and attempts to stop this practice at least for individual accounts have met with considerable resistance.

In the long term, however, banks and other depository institutions will develop and deploy systems in which checks are truncated or terminated at the bank of first deposit. Issuers will be provided the means for retrieving either the original or an acceptable photocopy if needed. The issues standing in the way of such a change are related more to legal and market problems than to lack of suitable technologies. For example, who in such a system would be responsible if a forged check were processed against an account? Consumers use and hold canceled checks in lieu of receipts, especially for tax purposes. What alternatives would be acceptable to the Internal Revenue Service?

Photo credit Burroughs Corp

Document encoder used to record data on checks in a machine-readable format

Customer Service Equipment

Cash dispensers were the first terminals made available for customer use by financial institutions. These were followed by the multifunction ATMs now in widespread use that are capable of initiating bill payments, transfers between accounts, and other types of transactions, in addition to accepting depos-

Photo credit: Diebold Corp

Inner workings of an automated teller machine its and dispensing cash. The functional capabilities of these machines are continuing to increase and they are becoming capable of handling increasingly diverse kinds of transactions. Counter to this trend, however, some institutions are making available specialized machines to perform balance inquiries and are supplementing full-service ATMs with cash dispensers so that customers requiring only cash will not have to wait behind those with more complex transactions.

There may be a movement to customer service machines that have a wide range of capabilities. Some may be of limited purpose, for such applications as cash dispensing and balance inquiry. Others may have the capabilities of the ATMs of today: accepting deposits, moving money between accounts, paying bills, and dispensing cash. Still others may be used for time-consuming but infrequent transactions, such as the filing of a loan application or ordering securities transactions.

In the future, a number of "customer work stations" could be available in a lobby area. These could be configured so that the customer could sit at a desk and accomplish a number of tasks, including making a deposit or withdrawing funds. Then, when the bulk of the work is finished, the customer could go to a device supporting many terminals that accepts the deposit or another that would dispense cash. Express terminals for customers with limited needs could also be provided.

Bank branches without human tellers are operating, and some institutions are shrinking their networks of full-service branches. Some of these automated branches provide only telephone communication for the customer in need of assistance. Others are manned by a customer representative who is available to answer questions and market services, but who performs none of the teller functions, such as accepting deposits or paying withdrawals.

Technology and the Structure of the Financial Services Industry

One of the impacts of present and future technologies on systems for delivering financial services is that there is a real possibility of redistribution of function between and among traditional suppliers and potential new entrants. Whereas the payment system has been reserved largely by the banks, because only they have access to facilities for clearing and settlement, movement of funds electronically makes it possible to avoid the traditional payment system and to effect net settlement directly between members of a community that have agreed to the necessary implementing conventions. Alternative means of distributing information could diminish the role of brokers for such varied products as securities, real estate, and insurance. Telecommunication systems that are capable of message switching are implicitly capable of performing the interchange function for payment networks. Retailers and other cash-oriented businesses, such as gas stations, are motivated by losses from bad checks and card fraud to take steps that minimize their exposure. For example, an ATM in a supermarket has the potential for relieving the requirement to cash checks while minimizing the amount of currency and coin that is held at each store location and subject to theft.

On the other hand, what is technologically feasible may be neither possible nor desirable. Consumers may balk at accepting new service delivery mechanisms. Legal/regulatory constraints may limit options, and the potential providers of the services may opt not to implement them for any of a variety of reasons. Further, changes in the technologies modify the parameters that bound system design alternatives. Those that are attractive now may become undesirable in the future, while new alternatives not now feasible may emerge.

Appendix 2A: Hardware Components

Chip Technology

The fundamental building block for information processing and telecommunication is the silicon chip. Many thousands of electronic components, constituting an infinite variety of electronic circuits, can be fabricated with these chips. The newest computers have memory chips capable of storing 64,000 bits of information; chips capable of storing 256,000 bits of data are now emerging. Chips with 1 million electronic components are in the laboratory stage of development.

Processor chips used in today's large microcomputers tend to include only the functions needed for performing the required logical and arithmetic operations. Memory for data storage and circuitry to facilitate the movement of data between the processor and various peripheral devices such as disc drives and telephone communication links usually require additional chips mounted on the same printed circuit board as the processor. A single chip which includes the processor, memory, and other supporting circuits, is in widespread use for many appliances and devices. But most of the home computers and larger units separate this functionality into several separate chips.

Silicon chips in use today tend to be less than one-quarter inch on each side. Dr. Gene Amdahl has suggested that it maybe possible to fabricate economically chips that are several inches on a side. If so, performance-to-cost ratios for electronic equipment could rise significantly because the larger size would limit the need for physical interconnection between chips which is one of the major costs of fabrication. One of the major factors reducing the cost of consumer products, such as home computers and video games, has been the decrease in the number of chips required in these devices as it has become possible to pack more and more onto a single chip. Also, because the speed of an electronic circuit is limited by the distance between its components, the ability to manufacture very large chips could translate into significant increases in processing speeds for the devices that use them.

Computer Systems

A computer system consists of a number of subassemblies that are collected in much the same manner as a component high fidelity system. It includes a central processor, high-speed random access memory to which data and programs are moved when they are active on the system, and peripheral storage devices, such as disc and tape drives that store data and programs not immediately needed by ongoing processing operations. Additional components, depending on the system configuration, might be printers, card readers, and devices specifically designed to handle the telecommunication function.

The heart of any computer system is its central processor. It is the subsystem that performs the instructional program written to support a specific application. Processors can be fabricated on a single chip or may require several cabinets of components. For any type, the key to increasing speed and minimizing costs of fabrication and operation is to minimize the physical dimensions of the processor and the number of discrete components required.

Most modern systems use more than one processor. In a small desktop computer, for example, one processor on a chip may perform the primary work of a machine while other processors perform supporting roles, such as generating the characters on the screen of the terminal through which the user communicates with the system. Large systems may use networks of processors to perform the variety of functions required of a machine. Small systems are capable of tens of thousands of operations per second, and some larger commercial systems can perform millions of operations per second. Computer systems capable of billions of operations per second are just over the horizon.

The central memory of a computer contains the program instructions and data that comprise the elements of an application system when it is active. A small desktop computer may have storage for as few as 1,000 characters of information, while large systems used by providers of financial services may have main memory capacity measured in tens of millions of characters. More commonly, desktop computers with main memory capacities ranging from 48,000 to 256,000 characters are used for financial service applications both by individual users and providers of financial services. Even though some financial service applications can run on computers with as little as 16,000 characters of main memory, computers with memories much smaller than 48,000 characters tend to be too small to conveniently hold the programs and data required for serious financial services applications. Larger systems used by providers of financial services include main memories that commonly range in capacity from 1 million to 8 million characters.

Disc drives, another system component, have large capacities relative to the main, random access memory of a computer and permit processors to access individual records in a fraction of a second. For example, the interchangeable floppy discs used with a computer having 48,000 or so characters of main memory will have a capacity of 100,000 to over 1 million characters. Hard, noninterchangeable discs used with such systems can have a capacity of 5 million to 40 million characters. Discs used with large-scale computers have capacities of hundreds of millions of characters, and many can be attached to each system.

Appendix 2B: Systems and Support Software

Present Operating and Support Systems

The sophistication of systems and support software generally varies directly with the capabilities of the computer on which it is to be used. Large mainframe computers are supported by comprehensive software packages that provide extensive capabilities to those capable of using them. This is to be expected because the larger computer can be utilized effectively only if most of its operations are controlled automatically. At the other extreme, software for microcomputers is much more rudimentary in its scope of functions. The user of a microcomputer is in direct control of virtually all operations, and the services of a complex operating system would be of only limited benefit. However, operating systems even for the smallest computers are expanding in terms of the capabilities offered.

Twenty years ago, systems software and some support software were furnished free to users by the manufacturers of computer equipment. However, unbundling of software and hardware has been common industry practice for a number of years, and today's user pays for each of the system and software support modules used. Operating system and support software is expensive both in terms of the direct cost and overhead imposed. These software packages can soak up a considerable portion of available computer resources. Thus, a small system with support facilities limited to a single application may, in some cases, be more effective than a large machine burdened with large amounts of overhead. One manufacturer, in fact, had to expand significantly the available memory on one of its larger models to accommodate the burden of operating system and support software.

Data Base Management Software

Data base management systems constitute a specialized software technology of particular importance to providers and users of financial services. This software facilitates the tasks of organizing and accessing large quantities of data where relationships between the various elements comprising a data base are complex and where diverse communities of users access various subsets of the data base. By permitting the sharing of data throughout an organization, the costs of data collection, maintenance, and dissemination are controlled, and all users are able to base their decisions on a common body of information.

Data base technology insulates data bases from the application programs that access them and can significantly improve system integrity and security. Depending on the data base system, users can be limited to accessing only specific data elements, and further, the operations permitted them can be controlled by the data base administrator. Audit trails that record the identity of all who access data and the operations performed can be generated. For example, some users may be permitted only to retrieve data, while others may both retrieve and change a specific set of data elements. Permission to add new elements to a data base can be denied both of these groups and given, instead, to other units within the organization.

On the other hand, data base management systems "put all of the eggs in one basket" in that much of the data critical to an organization is concentrated in only a few data bases. Compromise of a data base management system can lead to significant damage to the organization that is affected. In such an environment, the organization can become vulnerable if management does not fully use those data base management system features which are designed to ensure system security and integrity. Although there is no such thing as perfect security for any system, data base management technology can allow a higher degree of system security and integrity than possible when collections of individual files are used by each application system.

Software Development Tools

The rate of productivity increase for application programmers in the past has been small relative to the rate of increase in the performance-to-cost ratios of computer hardware. However, a new group of tools is becoming available to help alleviate this problem. Data base management technology discussed in the previous section is one such tool. In addition, there are interactive, terminal-oriented systems that support application programmers by minimizing the steps they have to execute to write and test new programs and modify existing ones. Management techniques that emphasize modularity in design and make extensive use of procedures for controlling systems configuration have also proved beneficial.

In addition, advanced languages have made it easier for programmers to develop the required computer codes. Procedure-oriented languages permit the end-user to interact directly with generalized systems and minimize the need for application programmers to develop applications customized to the needs of each user.

Perhaps the major breakthrough has been in programmerless application generators. For example, general-purpose spreadsheets, such as Lotus 1, 2, 3 and VisiOn, allow nonprogrammers to develop complex models and display their results graphically.

The Future for Operating and Support Systems[1]

Support functions such as telecommunication, data management, allocation of hardware resources, and job scheduling will be performed by highly modular support software. More functions now performed by the operating system will be performed in hardware. New emphasis will be placed on the security features and the user will communicate with the operating system through higher level commands.

Users will be able to select capabilities that are tailored to their needs and pay only for those. Generally, ease of use will increase and users will not be required to learn separate ways for dealing with various classes of applications. For example, all terminals will be able to communicate will all applications because the required protocol conversions will be performed automatically. It will be possible for major systems to operate in multiple sites as a single entity because access to and allocation of resources will be controlled by the system and support software. Worldwide distributed networks will be feasible by the mid-1990's. The ability to distribute functions among multiple cooperating processors will serve to increase system reliability and integrity. In addition, the various support packages will develop so that they have great facility to recognize and recover from errors and will be able to notify the appropriate user of transactions that could not be successfully processed because of either a hardware or software error. A key feature of operating system and support software will be its ability to diagnose system problems and dynamically reallocate system components. User installations will have to expend minimal effort to support software packages.

One manufacturer of microcomputers is already marketing an operating system that provides the user with the facility of moving easily from one application to another without the need of explicitly terminating one and initiating a second. As additional applications are added to the repertoire, they can be integrated with operating system so that the user is faced with a single, integrated entity rather than a number of disjoint applications. Integrated, multifunction software packages for microcomputers are well established in the market; and although they do not constitute operating systems, they offer some of the features one would expect to find in an operating system.

This trend toward easing the burden of detail on the end-user of computer systems is expected to be a major theme in the development of system and supporting software into the indefinite future. At some point, the user will no longer have to recognize the existence of a discrete operating system and will be able to focus all attention on the applications that are being used.

Many of the features of the operating systems for large computers are already becoming available for microcomputers. Some of the software development tools that are now available on large com-

I Most of the concepts relating to the future of system and support software are drawn from, *Future Information Processing Technology, 1983,* prepared jointly for the Institute for Computer Sciences and Technology and the Defense Intelligence Agency.

puters are being implemented on small ones. One manufacturer has added to its product line a microcomputer that will run a variant of the virtual memory operating system used on its large systems. Networks of small computers will become the functional equivalents of large central systems in many operating environments. The emergence of such capabilities is foreshadowed by some of the office systems that are already being deployed by some manufacturers.

By the mid-1990's, large computers may function largely as repositories of data and support only the largest processing systems. Small computers directly controlled by end-users will perform most of the processing functions and report generation that will be required. Some installations are already approaching this state.

Tools for system development and maintenance will be of growing importance over the coming decade. As more generalized functions are moved into the hardware, the operating system and support software, the tasks required of applications programmers will be simplified and, hence, less costly to accomplish. A key element in realizing the benefit of this technology will be the ability of management and technicians to understand its capabilities and apply it intelligently in supporting applications systems.

The same system development and maintenance tools that will benefit professional technicians will also help end-users interact directly with computer and communication systems without the need for intermediation by members of technical staffs. The support functions will complement the generalized, user-oriented application systems that will be available; and, together, they will provide the end-user with a powerful package of tools for applying the technologies that will be at his disposal.