Talk-Back TV: Two Way Cable Television

By Richard Veith

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Richard H. Veith

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Introduction

This book is about a subject known loosely as two-way TV (television). To date, the medium is still pretty much in the research and development stage, having yet to be introduced to the public on any significant scale. So it might be best to begin by defining the term—just what is meant by "two-way TV?"

What comes to mind for many people is some sort of marriage between a TV and a telephone, a kind of videophone arrangement where the TV can watch you as you watch it. Other people see rather a marriage between a TV and a computer terminal or keyboard, where codes and messages can be punched out. The more imaginative might visualize a console full of switches and a wall-size TV screen. Even the menacing eye of a *Big Brother* watching us scamper about like rats in a maze can be associated with the term two-way TV.

Generally speaking, though, two-way TV is used in reference to bidirectional cable TV. In the last several years, cable TV owners began to test ways of using extra channel space for carrying return signals from the home; thus began interactive or two-way TV.

Therefore, two-way TV refers first of all to bidirectional cable TV. But a lot can be done with the idea of two-way TV; so much, in fact, that the term has been applied to a whole list of services that may or may not need a cable TV system to exist. For the purposes of this book then, two-way TV will be used to designate the total concept, the sum of services and capabilities that a two-way TV communications system can offer.

In line with that, the book begins with a listing and discussion of the so-called two-way TV services. The second chapter looks at how some of these services were tested in early pilot projects on cable TV systems. Other services from the list are described in Chapter 3 as they appear outside of cable TV; a prime example is Picturephone, which may eventually be used for standard TV pictures. The following chapter continues a chronological treatment of cable TV two-way pilot projects and leads into the subject of pay TV, which is both a one-way and a two-way TV service. The next two chapters deal with some of the broader realities of two-way TV, including teleconferencing and computer utilities. In the final chapter, some current plans for two-way TV projects are presented along with estimations and predictions for the future.

A great deal of what two-way TV is, or will be, remains yet to be detailed by designers, planners, legislators, and concerned consumers. Nevertheless, some steps have already been taken: pilot programs have been in existence for nearly a half-decade and experimental designs for some aspects go back much farther than that. Consequently, this book has a two-fold purpose: to bring together the details of existing two-way TV development and to explore the territory of the concept itself. In the process, the problems as well as the promises of two-way TV communications will hopefully come to the fore.

A few words now should probably be said about the undeniable financial woes of the cable TV industry, since this book is about expensive technology related to cable. There is no ignoring the fact that during the latter part of 1973 the average per-share value of cable TV stocks dropped to less than half previous levels. And halfway through 1974, the majority of the publicly held cable TV companies saw their stocks slip even lower than the January figures. The Teleprompter Corporation, the largest cable TV firm and twice the size of its nearest competitor, lost almost $30 million in 1973 and was investigated by the Securities and Exchange Commission for violation of security laws and lack of corporate financial candor. The corporation finally agreed to a permanent injunction barring future violations and was then faced with a stockholder's suit for $8.6 million on a related matter.

In brief, there has not been much room within the cable industry in the recent past for investment in two-way TV. And there may not be much room for a few years to come. But this does not alter the fact that two-way TV services will ultimately be developed. There is too much involved in too many places for them not to be. Money for development has continued to steadily appear, not only from within the cable industry, but also from other industries and from government agencies and departments in the form of grants.

The current slowdown in development may even be beneficial. It may afford more opportunity for discussion and thought, leading to less startling but more solid achievements. There are still a number of problems that need to be worked out. Which services, for example, would be most useful and acceptable? Even more, who will provide the services? Independent companies, and other common carriers all have interests in the development of two-way TV that rival those of the cable industry. And not the least of the problems is the selection of the hardware, the home terminal. A variety of designs offering strikingly different features and capacities have been produced, and each ought to be weighed against the others before binding decisions are made. These questions and others lie behind the information and commentary provided on the following pages.

This book is an outgrowth of my master's thesis on two-way cable TV. The thesis, completed in December 1972, is on file in the main library of San Francisco State University.

Chapter 1

Concepts and Capabilities

Strictly speaking, two-way TV is a bit of a misnomer. It tends to be misleading. The name two-way TV, in fact, includes more than simple two-way communication and much more than TV.

Actually, two-way TV is the term both for the physical systems capable of two-way TV and for the collection of services that such systems can perform. As such, two-way TV is the product of a variety of wire and cable systems and the aggregation of their accomplishments. In other words, it is the name for a broad collection of new ways to communicate electronically.

In a minor way, the name two-way TV can also apply to the terminal machine itself. This application is not common for the simple reason that most two-way TV systems use attachments for standard TV sets rather than complete, specially designed "two-way" components. In any event, a two-way TV is usually a combination of a standard TV receiver and some response device for sending signals back to a central point.

This response device may vary a great deal in design and capability, reflecting the wide range of uses for two-way TV systems.

For example, the response unit may be a relatively simple automatic sensing device or meter monitor, which returns signals from a home or elsewhere without any action by an individual. A little farther up the ladder of sophistication, the response unit can be a keyboard or button panel for typing messages or codes to be returned to a control center. At the upper end of the sophistication scale is the response unit that incorporates a microphone and video camera, allowing the home user to send complete TV pictures back to a collection point.

All of these things are possible under the aegis of two-way TV. Even more may be possible, including things not yet envisioned, since the creature known appropriately as two-way TV is still in its infancy. The ultimate appearance of the adult animal is still a matter of conjecture. On the other hand, quite a bit of work in two-way TV has already been done.

Two-way TV is intimately connected with computer advances. Without computers two-way TV growth would be stunted at best. In most cases computers (or minicomputers) are the heart of the two-way TV system, sending out and receiving in continuous streams the electrical signals that make two-way TV possible. As computers are improved and refined, the capabilities of two-way TV will continue to grow. Eventually, each will benefit the other—two-way TV systems will help computer systems and services to grow almost as much as computers will help two-way TV to grow.

This is not as farfetched as it sounds. The computer industry, a giant in its own right, has become closely associated with the electronic communications industry during the past decade. Business reports generally conclude that almost all forms of communications are being computerized[1]. Computer manufacturers are increasing their emphasis on communications applications. In the years ahead, one of the major areas of growth for the computer industry is expected to be products for communications uses. Consequently, distribution facilities—cable TV systems and specialized common carriers—will play a vital role in bringing computer capabilities to new markets and customers, thus reinforcing and fostering more computer growth. In their book *Data Banks in a Free Society*, Alan Westin and Michael Baker state that communication networks not originally developed for computer systems may nonetheless profoundly affect the computer industry. They go on to specifically mention the great potential of cable TV as a distribution medium.[2]

Two-way TV is therefore intimately tied to the computer in two general areas. First, computers control the flow of communications to and from customer terminals. And second, computers will use two-way TV systems as distribution facilities, as extensions of themselves, permitting two-way TV customers to engage in countless activities with and through computer complexes.

Besides the relationship with computers, two-way TV is obviously closely associated with cable TV as has already been hinted. The broadband coaxial cables of cable TV systems provide an as yet unexploited facility for two-way TV unmatched by any other existing telecomunications facility or mode. (See Appendix A for an explanation of the details of broadband transmission and coaxial cable.) However, cable TV systems are not absolutely necessary for all varieties of two-way TV. Some two-way TV system functions can be accomplished by (1) routing the return signals through telephone lines or electric power lines, (2) transmitting the return signals over the air, or (3) by designing the system in

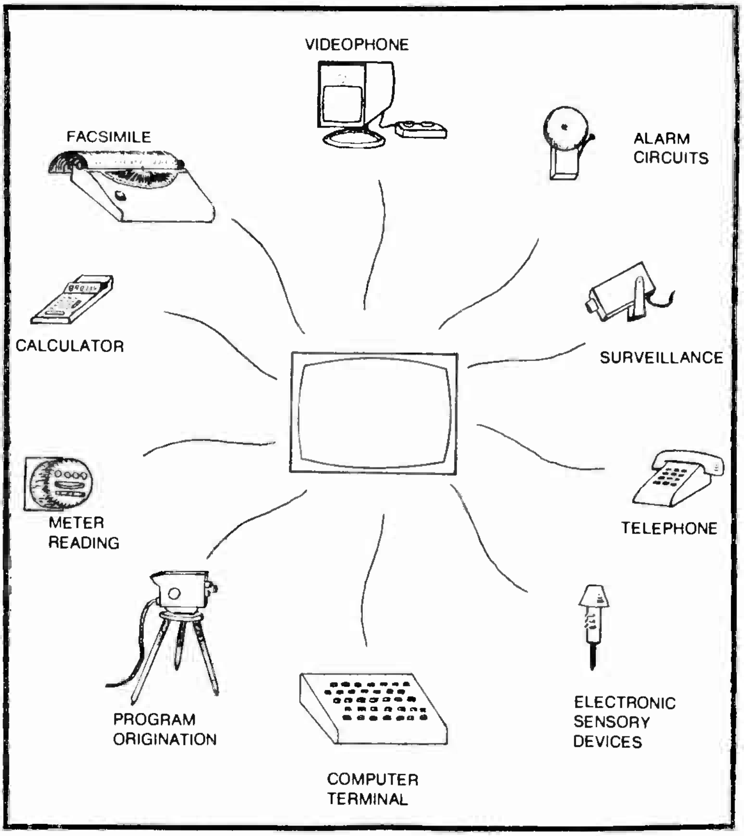

Fig. 1-1. Some of the elements of two-way TV.

such a way that apparent interaction does not require return signals.

By way of explanation, there is probably no better way of delineating two-way TV as a concept and collection of capabilities than by going through a list of all the things that two-way TV systems can do—this means all the things that have been designated as two-way TV services. It should be noted that these are more properly the services of any broadband communications system. Because the only broadband links to homes at this point are TV cables, the services have become known as two-way TV services rather than broadband network services, since service to the home is what two-way TV is primarily about.

By giving the emphasis in a description of two-way TV to the *services* rather than to the *cables* or *consoles*, the broad meaning of two-way TV more easily unfolds. Moreover, the resulting concepts can then transcend the limitations and imperfections of this or that cable system, broadband network, or computer center.

SERVICES

Some two-way TV services have nothing at all to do with the TV aspect of the home terminal. The meter monitor services and variations thereof are typical examples. Other services, offshoots of the broadband capacity of two-way cable TV systems, have little or nothing to do with terminals in the home or indeed in any building. There are the municipal uses of sensing and monitoring devices incorporated into cable systems for vehicle location and traffic control that also fall under the umbrella of two-way TV for no obvious reasons.

Therefore, in order to talk about two-way TV services, arbitrary categories have been employed. The categories used here have been chosen to facilitate understanding of the general concept of two-way TV, although in other situations different ordering methods may be used. Economists might want to see the services divided along lines of economic viability. Engineers may tend to use breakdowns based upon the degree of engineering sophistication required. Computer specialists speak of computer services and noncomputer services.

From the public's point of view, two-way TV services can be discussed in terms of control and direction—that is, in terms of the individual's control over the communications involved and the individual's ability to direct the communications to specific points. The word *control* here refers to a user's options for creating messages and instructions. Of course, any person with a two-way TV in effect controls his or her own participation in two-way activity by virtue of being able to pull the plug!

On a very basic level then, two-way services and programing can be divided into two groups: those services initiated by the user (viewer or subscriber) and those services initiated by a central control point (most likely a computer). The services initiated by the subscriber can then be subdivided according to the subscriber's options for directing a communication to a central point, an single point within the system, or all points within the system. Using the criteria of control and direction, a list of services applicable to two-way TV has been categorized in Table 1-1. This list is a compilation of services suggested by nonprofit, commercial, and government agencies.[3]

The nonsubscriber initiated services are not necessarily the simplest to implement or operate. These services, in fact, represent a full range of design complexity. The bulk of the two-way services that do not require subscriber or user action includes monitoring, meter reading, and channel polling services, in which a device at the home or office automatically reports periodically to a computer. Electrical impulses traveling back and forth between a central point and the individual two-way TV terminals form the basis for such services. Hundreds of terminals can use the same channel because they are designed to accept only those impulses that are preceded by the proper coded address. Naturally the electrical impulses do not require the large amounts of channel space needed for high-speed data, voice, or video signals.

Surveillance services are also in this category and are relatively easier to establish because they need not be computer controlled. However, surveillance systems using video monitors for such things as watching traffic flow or public area activities may require a great deal of channel space, viewing consoles, electronic maps, and devices for alerting attendants to correct problems.

Vehicle identification services are a modification of the monitoring and polling services. Sensing devices are located not in homes or offices but at street corners and along throughways. The devices could be located above ground in what is known as the "signpost" method. Cables below ground

Table 1-1. Services of Two-Way TV

	NONSUBSCRIBER INITIATED	
	burglar alarm monitoring fire alarm monitoring utility meter reading channel polling marketing surveys patient monitoring production monitoring third-class mail electronic newspapers report distribution corporate news ticker	vacation surveillance public area surveillance traffic control vehicle identification pollution monitoring emergency callboxes control of lawn sprinklers, lights, etc. from the computer
	SUBSCRIBER INITIATED	
Data File	transportation schedules ticket sales and delivery reservation services travel maps entertainment listings and reviews welfare, social service information medical guides current events public documents restricted access files consumer reports catalog displays sports information weather information computer time-sharing personal data file budget preparation filing income tax records of tax deductible expenses voting opinion surveys	pay TV video, audio libraries computer-stored games travel maps recreational area information directories almanacs encyclopedias classified ad directory area codes zip codes computer dating credit checks signature, photo identification how-to-do-it guides recipes, menu planning bibliography preparation college information services
Point-to-Point	shopping banking services, transactions access to company files computer data exchange mental health center marriage counseling vocational counseling teacher consultation tutoring services local ombudsman	instructional programs games, quiz shows outpatient services remote diagnosis request special channels access to elected officials first-class mail videophone
All Points	original programing public access channels political channel debates	auctions, swap shops group conversations meetings

could be used as the triggering devices in the "electronic fence" method. Either way, electrical impulses are returned to a control center to indicate the presence or absence of the vehicles under observation. A police dispatcher could know exactly where all the squad cars are, even have the central computer figure out which squad car could reach an emergency area quickest. A transit authority could follow the progress of its buses and signal drivers to avoid backups. Obviously vehicle identification services are not exclusively the province of two-way TV systems, since transmitted radio signals would produce the same results. Sensors along cable TV routes may be less expensive in the long run and can be triggered by relatively weak radio devices much like the tiny gadgets in some buses used to register passage at toll booths.[4]

Emergency callbox services are similar to vehicle identification in that the locations of the terminals are street corners and over-the-air radio signals could do the same thing. For example, American District Telegraph Corporation manufactures a "Help Box" that generates its own radio pulse when a leverlike door is pulled down.[5] Arguing for cables though, some urban planners have suggested that emergency callboxes, especially fire alarm boxes, should have voice capability that could effectively utilize channel space on cable TV systems. Voice capability supposedly would not only aid in bringing the fire department to the right spot but would also reduce false alarms because of the identification features of voiceprints.

Rather complex two-way TV services that do use home terminals and are not initiated by the subscriber are electronic newspapers and mail. These services require much more than the simple electrical impulses of meter-monitoring systems and require some sort of printout apparatus at the home terminal. For both newspapers and mail, the terminal could receive information in the absence of anyone at home. In the case of third-class mail, subscribers may exert some choice over the categories of unsolicited mail they choose to receive. While some people would opt for complete control over every printout entering the home, it must be recognized that other people have no objection to, and sometimes welcome, various types of unsolicited communications.

The real realm of two-way TV is not so much the ability to receive data or to return simple impulses from meters, but rather the ability to create and control a communication that will produce an immediate effect—selecting a movie, ordering a dress, voting, playing games, or conversing with a counselor. These and many others are the subscriber-initiated services.

DATA FILES

The largest and most expandable subdivision of the subscriber-initiated services involves the directing of signals to a central computer or data file. Upon reception of commands or instructions from a two-way TV terminal, perhaps looking like the one shown in Fig. 1-2, a central control point may respond with information from its own files or activate return signals from elsewhere.

With access to computer files and computer functions, the knowledgeable subscriber can not only retrieve vast amounts of information but also use the computer for personal calculations, storage of personal data, and development of private computer programs. This will come as knowledge of computer use spreads throughout society. High schools as well as colleges, and even elementary schools, are teaching

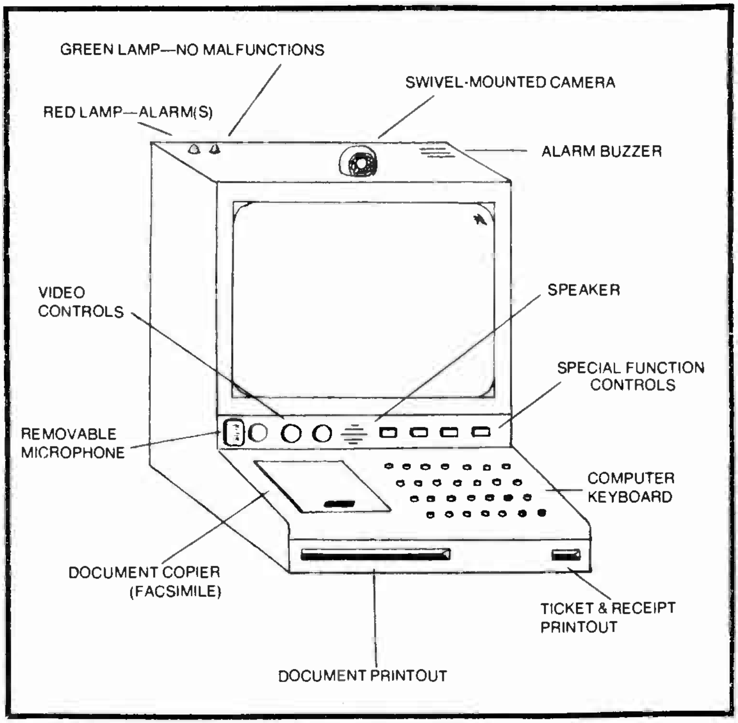

Fig. 1-2. Hypothetical version of a two-way TV designed for home use.

students to use computer terminals and to become familiar with computer languages. It may become quite a simple matter for homeowners to store their income tax data in centralized computers providing, certainly, that the proper measures are taken to prevent anyone else from calling up an individual's private file. Depending upon the complexity of the home terminal (ranging perhaps from an economy model to a super deluxe), computer responses could be viewed on the TV screen, printed on some sort of paper or tangible sheet, or merely listened to.

If cable systems were hooked into the data banks of national computer networks, duplication of files could be minimized. News, for example, might be fed into one computer complex by the Associated Press (AP) or the United Press International (UPI) and subsequently be instantly available, computer sorted into categories, to anyone across the country with a two-way TV console.

The basis for such a computerized news service is already in existence in a number of ways. United Press International, for example, began extending their all electronic computerized news service throughout the United States in early 1974. The hub of the system is a pair of large scale computer systems in New York. News items are filed and retrieved by over 100 offices across the nation, entering material directly into the computer. Editing and arranging is done on video screens using an electronic "cursor," a small light spot moved around the screen by control keys. Spokesmen for the UPI say that it creates a single "national newsroom."[6] Home users, naturally, would not have the ability to edit stories but they could certainly call up the data base available in a variety of indexed options.

A less dramatic and more feasible form of the data file set of services is the ordering not of static information but of moving pictures. This includes some forms of computer-assisted instruction and pay TV. In the former, the video programing may actually be stored digitally on computer discs or drums, or more conventionally on video tape recorders under computer control. In the latter, the video programing is more likely already available on a given channel but needs to be unlocked or unscrambled by two-way signaling. A simpler version of pay TV using two-way techniques merely has the computer take note in its own files when a subscriber turns on a special channel. (Pay TV, of course, does not necessarily mean that two-way techniques are being used or even that cable TV is involved. There are numerous ways of having viewers pay for special programing. These ways are dealt with at length in Chapter 5.)

POINT-TO-POINT

The possibilities for two-way TV begin to multiply rapidly as the subscriber is able to direct a communication not just to a central computer but to any single person or machine in the system. These possibilities vary greatly in complexity and are fraught with difficulties created by the need to switch signals, although probably most of the problems will not be insurmountable.

One possible set of services in this second subdivision of subscriber-initiated services is occasioned by the ability to interact with, or direct communications to, the computers of stores, banks, brokerage houses, and other businesses, perhaps using a modified home terminal such as the one shown in Fig. 1-3. A customer sitting at home could order a card table from Sears after viewing an electronically stored Sears catalog and have the Sears computer not only accept the order and make out a shipping statement, but also request the purchase price to be transferred from his bank account to Sears' bank account. Alternately, the Sears computer would simply put the purchase on a charge account and the customer woud take the action of calling the bank's computer to transfer the funds to pay the bill.

Even without interconnected computers, large computer industries could tie into a cable system to allow their employees to work from their homes. Such a development has been heralded as a return to the "cottage industries" before the industrial revolution, where craftsmen constructed products in their own homes rather than in factories or shops. With two-way TV computer terminals used in employment applications, the way would be open for drastic changes in working habits. Schedules and transportation patterns could be altered, the time devoted to work could be reduced, and the work force could be increased to include part-time participation by those who must stay at home or who have difficulty traveling.

Another set of two-way TV services is provided when a person can direct digital as well as audio and visual communications to selected points. On a point-to-point basis, this is identical to the telephone system. It can be done with video signals on cable TV systems, but most engineers agree

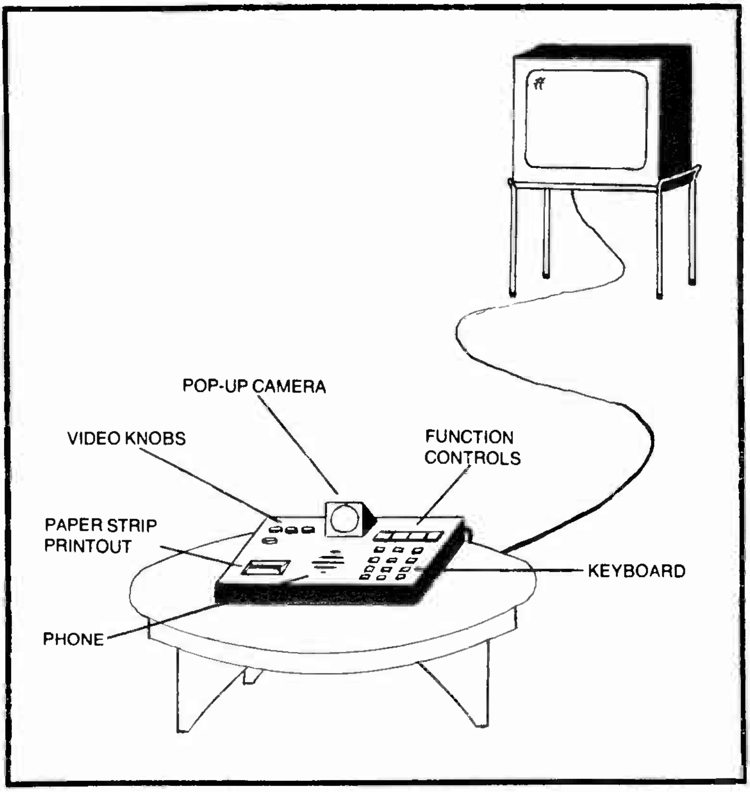

Fig. 1-3. This hypothetical version of a home two-way TV allows a standard TV set to be used with a console for ordering merchandise, purchasing tickets, showing documents, and so on.

that such a development would be highly impractical and inordinately expensive. Instead a limited point-to-point system is suggested for visual communications, in which only a few terminals would be capable of receiving calls from all other terminals. For example, students anywhere in a city could converse, by voice and visually, with teachers at the university extension center; or counselors in social and psychological welfare offices could dialogue with persons seeking aid from the confines of their homes. On a more restricted basis, one terminal could be called by only a small group of related terminals. For example, a doctor at a medical center could visually supervise paramedical personnel giving treatments at neighborhood health clinics.

If acceptable means of providing unlimited point-to-point visual communications can be established, whether by cable companies or telephone companies, then high-speed first-class mail (electronically delivered) and high-resolution videophone services could become a reality.

In the final group of subscriber-initiated services, the capability of point-to-point communication is forsaken for the simpler task of directing communications to all points. Depending upon the design, these services could be overwhelmingly easier to establish than those of the previous category. It is a relatively uncomplicated matter to merely allow a terminal to direct a communication, including TV programing, to a central point and then permit the communication to be redirected outward to all system participants. The difficult part is extending this provision for creating programing to every terminal on the system.

Presuming such difficulties can be overcome (and they have been in limited applications), the home two-way TV then becomes a production center. A homeowner could hold a garage sale in her living room. An armchair politician could harangue anyone who tunes in and not miss the opportunity for Hyde Park debates. The local philatelic society could hold their weekly meetings without leaving the warmth of their individual fireplaces and still exhibit their latest acquisition of stamps.

Whether or not the decreased social contacts, if indeed social contacts would be diminished and not just altered or substituted, would be an adverse side effect of two-way TV is a worthy question. It cannot be answered now, but it does nonetheless affect the planning, introduction, and ultimate acceptance of two-way TV services.

The whole question of the social effects of two-way TV is intriguing and preoccupying, both because of the stakes that are involved and because of the fact that no truly accurate answer can be found before the fact. One of the supposed developments of the increased ability to conduct affairs from home terminals is the ever so gradual dismantling of heavily populated urban areas. Along the same lines, transportation needs would diminish since fewer people would need to commute to work or engage in any travel where physical presence was not necessary or desirable. Expressed differently, two-way TV as a total comunications complex could bring about a return to tribal structure society, a theme Marshall McLuhan began to popularize nearly a decade ago. Other authors have suggested that present day communes and communal living arrangements are indications that we are already on the way to retribalization. On the other hand, there are equally believable arguments in favor of future hybrid social structures unlike the general forms of past societies. Whatever the social theory, the fact remains that two-way TV almost surely has a role to play.

The rest of this book is intended to explore that role as fully as possible, concentrating not so much on dreams and speculation as on what has actually happened in the development of two-way TV. Throughout, it must be remembered that any of a number of telecommunications facilities, singly or in combination, can provide the services of two-way TV. Cable TV systems are not the only means for offering advanced two-way services. Alternate transmission lines are available, and even telephone company wires look increasingly promising due to improvements in the digital coding of voice and visual communications.

In fact, digital technology, which has had a lot to do with the development of two-way TV, shows every sign of changing our traditional separate means of handling voice, visual, and data communications. Because of this, and because digital coding is a key element in two-way TV systems, it might be best to look at the fundamentals of digital communications and the work that is being done in that area.

DIGITAL CODING

If we were to start all over, engineers say, we would digital code virtually all forms of electronic communication. Digital signals are relatively cheaper to handle, easier to accommodate, and freer from distortion. They are also more versatile. Among other things, digital communications can occupy adjacent channels and not be subject to the crosstalk that bothers analog channels; digital signals can also be compressed to save time and channel space, and they can be analyzed instantly and transmitted on the basis of predicted changes, further saving time and space.[7]

In the recent past, the Bell Telephone System began installing switching devices which handle digital signals directly, eliminating the need for changing the signals to analog form before switching. Concurrently, American Telephone and Telegraph (AT&T) began offering for the first time in 1974 completely digital transmission facilities, placing the data streams on unused portions of microwave analog circuits in a process called "Data under Voice." Within 2 years the digital network is expected to attract annual revenues of some $116 million.[8] Communications satellites have likewise prepared for increased use of digital coding and transmission methods. Within the last year, the Communications Satellite Corporation developed a special digital channel which could carry the same amount of information handled by 12 terrestrial channels.

The use of digital logic and transmission methods has been adopted by our society to such an extent that the Vietnam conflict has been called the first digital war.

In general, there seems to be little doubt that eventually all electronic communications will be affected by the principles of binary digits, the basis of digital conversion. Essentially, any communication can be expressed in bits, a bit being the amount of information needed to make a yes or no decision.[9] A single page of type, according to one estimate, is equal to 18,000 bits of information.[10] In computers and data transmission, the bit (shortened from binary digit) is an *on-off* condition representing either a *zero* or a *one* in the binary number system. (The binary number system is the one most often used; but octal, decimal, and other number systems do have some applications in digital conversion.)

Any electronic signal in which a continuous range of frequencies is transmitted (such as telephone calls, radio programs, or TV shows) can be converted into a stream of bits and vice versa using various conversion methods. The most common method is pulse-code modulation (PCM). With PCM, the amplitude of an incoming signal is sampled very rapidly on an extremely minute scale; at each sampling the amplitude can be assigned a numerical value. The resulting numerical values, stated as binary digits, are then transmitted as a stream of bits, completing the conversion process. Figure 1-4 illustrates this process; the amplitude of a voice signal is expressed on a scale in the binary number system and finally as *on-off* pulses.

Another type of coding being used more and more is differential pulse-code modulation (DPCM), which codes the differences between an amplitude and the predicted subsequent amplitude—predictions are based on an electronic analysis of the preceding amplitude values. Still other conversion methods do not even code the analog signal as such.[11] Vocoder methods, for example, analyze voice patterns and code such attending factors as pitch, resonance, and unvoiced acoustic energy of speech.

In the past, digital conversion has been largely used to put computer data on telephone lines, since local telephone lines

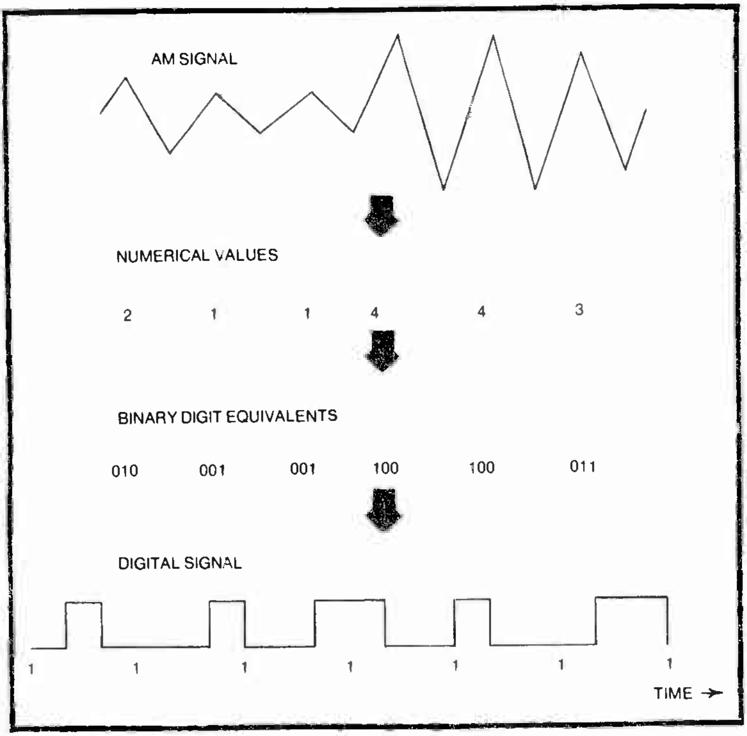

Fig. 1-4. Digital conversion. The amplitude of the analog signal is measured at successive instants in time. These measurements are expressed in the binary number system and transmitted as pulses and non-pulses.

are analog channels. But now, even analog communications are converted to digital form for long-distance links because of the savings involved. The Bell Telephone System's infant Picturephone network converts the analog video signals to digital form for all but local calls.

Digital conversion greatly affects two-way TV because of established notions about data, frequency space, and cables (or channels) needed. In order to explain, the notion of speed must be introduced. The speed of a digital stream is directly related to the size of the channel it is on. Certain speeds are necessary for different types of communication. A digitally coded telephone conversation, for example, would need to travel at some 64 kilobits per second (kilo = thousand) on a channel of the appropriate size. A similarly coded TV show must travel at nearly 64 million bits (megabits) per second and would need a substantially larger channel. Color TV, though, must travel at 92 megabits per second because of the increased need to minimize noise—random electrical impulses degrade transmissions.

Existing transmission lines can accommodate higher bit speeds than might be expected. The telephone wires to your home, properly prepared, might handle up to 1.5 megabits per second, which is over 20 times the speed necessary for a digitally coded telephone call. By comparison though, the coaxial cable of your cable TV system can handle some 300 megabits per second at least. Newer transmission lines will allow speeds even higher. An experimental laser system has achieved a speed of 5376 megabits per second, and more advanced laser designs are approaching a theoretical 10^{12} (tera) bits per second.[12] In terms of TV channels, the fiber-optic cables which are expected to be on the market at the end of this decade are said to be capable of 360 simultaneous TV programs.[13] Optical communications lines, incidentally, are reputed to be wiretap proof, since the glass-fiber thread would shatter if tapped into.

The fact that existing channels can handle faster speeds than those of the average digital stream is balanced by the fact that slow digital streams can then be added together to form one high-speed transmission on a high-speed channel. The process of interleaving bit streams, known as time-division multiplexing, involves the allotment of specific time segments to incoming data. The timing information is then incorporated into the data stream to permit untangling of the stream at the receiving end.

Two-way TV is a direct beneficiary of time-division techniques. It is the combination of time-division multiplexing and digital communications that makes many two-way TV services possible. A time-division data stream is the means by which a computer can talk to hundreds of two-way TV terminals using the same channel and not get mixed up.

In reality, in a computerized two-way TV system, the computer originates all signals. When the signals reach a terminal, they are then altered to digitally convey information back to the processing computer. There are a number of ways of designing two-way TV systems to do this. Some are described in later chapters as they operate in actual systems, but it might be useful to look at a generalized hypothetical method suggested by James Martin in his book on future telecommunications. In that case, the bit stream that flows in a loop is organized into blocks. Each block of bits takes care of eight two-way TV terminals. Bit by bit, a block would consist of a synchronization pattern, a group address, a space able to accept one character of information from each of the eight terminals, and several error-detecting bits. Martin estimates that by using this method, approximately 3968 groups of eight terminals could be handled by a single cable, and that each terminal could return to the computer 15.8 characters per second, about the speed of a fast typist.[14]

By using two channels for the bit streams, the computer could in effect dialog with an individual; replying with characters, still pictures, or ultimately TV. For this, the blocks of bits would have to be much larger, perhaps accommodating 120 characters of information in each block instead of 8. Using Martin's figures, it would take about ½ a second to receive a reply from the computer if only one or two of the eight terminals in a block were active at the same time. If all eight sets were trying to simultaneously dialog, the time delay would reach a maximum of 4 seconds for a system serving a total of 30,000 two-way TV terminals.

This should give a fair idea of the relationship between two-way TV services and digital techniques; the computer-processed data streams carry messages back and forth. But beyond the use of digital technology to control the responses from home terminals, digital conversion can be used to code TV programs themselves for storage and transmission. In England, the British Broadcasting Corporation (BBC) is developing a digital color TV recorder in which the analog signal is sampled at the fantastic rate of 13 million times a second. This information is expressed in 16,000 bits per inch on 1-inch-wide magnetic tape.

Another system, developed in the United States by Battelle-Seattle Pacific Northwest Laboratories, uses digital recording to store color TV programs on flat photographic plates. The bits of information are recorded as dots, each dot 1 micron in diameter. (A micron is 1/1000 of a millimeter.) According to Battelle spokesmen, a 30 minute TV program could be recorded on a 5- by 7-inch plate for as little as 25¢ apiece.[15]

Both of these examples presage the day when TV libraries digitally recorded and transmitted will be available at the touch of a button on a home terminal. Since digital signals can be more easily switched than analog signals, the distant future may bring the introduction of switched point-to-point full video services.

In sum, developments in digital technology (including computers) have come together with cable TV to pave the way for two-way TV. Cable TV, as was mentioned, is not the only suitable transmission facility but it is singled out because it has economic advantages, a largely unexploited potential, and a certain freedom from the sheer weight of years of operation exerienced by the older telecommuncations companies. The child is father of the man, wrote William Wordsworth nearly 200 years ago. In this case, cable TV, the child of TV, may have fathered a giant out of all proportion and resemblance.

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Chapter 2

Introduction to Cable

The birth of two-way TV, specifically two-way cable TV, occurred in late 1970 or early 1971, depending upon your definition of two-way TV and your notions of where beginnings actually begin. And naturally enough, more than one cable TV company was involved in implementing two-way TV during roughly the same time period.

Without trying to make a distinction between who was first, three cable companies can be mentioned together as the instigators of two-way projects. Rediffusion, Inc., Sterling Communications, Inc., and Telecable Corporation were all testing and fine tuning their particular versions of two-way TV during the first part of 1971. Each company held fairly individualistic views about the possible two-way services that would be successful with its respective customers. Each, out of necessity, tailored its two-way experiments to conform to its own quite different technical capabilities.

Rediffusion's cable TV system was uniquely suited for subscriber-originated programing; consequently, its test of two-way centered on that. Sterling's cable operation in New York City sought to capitalize on New Yorker's supposed desire for conducting affairs from the safety and security of their own apartments. Telecable embraced a broad view of two-way TV services and concluded that the services would have to be offered in such a way as to attract government funding. Therefore, Telecable used its considerable resources to fashon a fairly inclusive two-way pilot project designed for educational purposes.

Taken as a group, these three experimenting cable companies presented an admittedly premature, but surprisingly diverse, picture of what two-way cable was likely to be.

REDIFFUSION

London-based Rediffusion International, Ltd., had been developing a dialed-channel version of cable TV since about the mid-sixties. By the end of that decade, the British firm had chalked up enough TV cable installation to serve over 750,000 subscribers and had begun negotiations for planting a Rediffusion system in the United States.[1]

The decision to build in this country was prompted by discussions before the Federal Communications Commission (FCC) in 1968. At that time, the FCC had announced its intention of completely reexamining cable TV regulations. In order to insure a market in the United States free of before-the-fact regulation, Rediffusion brought its equipment to Washington for a series of demonstrations. Members of the FCC and industry representatives who attended the demonstrations were reportedly impressed with Rediffusion's dialed-channel approach to cable TV service. The London company was encouraged by the interest and decided to plan for a full-scale installation of its equipment in this country.

Arrangements were soon completed with Cape Cod Cablevision of Hyannis, Massachusetts, for a pilot installation in nearby Dennisport. Construction began in April 1970, and the Rediffusion brand of cable TV, promoted as the Dial-A-Program system (DAP) became available in September of that year.[2]

One of the major purposes of the Dennisport project was to bring to this country a working example of the parent company's research and development in subscriber-originated programing. In fact, one of the prominent assets of dialed-channel TV is the inherent provision for digital, voice, or picture communications to be sent by a subscriber to a central point or to other subscribers.

The most publicized two-way experiment in Dennisport was an early 1971 test of subscriber-originated video. A delicatessen was equipped with a camera to advertise daily specials by placing signs in front of the camera or by personal appeals. The signals were fed back to the head end over an ordinary subscriber link. Here they were converted from one set of frequencies (9.2–15.2 MHz) to another (3.2–9.2 MHz) and distributed to all subscribers as just one of 36 TV channels available. To complete the subscriber-to-subscriber interaction, customers at home could place orders by telephone. Later the cable company successfully tested the use of response terminals using the cable system itself. The Dennisport facility was also used to successfully test the feasibility of interconnecting DAP channels with the telephone network and of using the channels for data communications.

Although the Dennisport project was a limited one, it presented a glimpse of the wide range of applications for DAP methods. Computer-to-computer dialog, home-access-to-facsimile services, home-access-to-film libraries, banks, stores, and other businesses could be added to the system with relatively little extra cost above that for the initial installation. The Rediffusion management recognized, however, that a commercial market for the full two-way capability of their system did not yet exist, and they concentrated their attention instead on institutional uses of dialed-audio and video libraries in such places as universities and medical centers. The Dennisport project was brought to a conclusion within a year or so, and the Rediffusion Massachusetts office was transferred to Canada. Here a Canadian subsidiary of the British company has extensive research and engineering facilities.

What makes the DAP system unique is its similarity to the telephone network. Only one channel enters a home at any given time. As different channels are desired, the subscriber dials the channel number on a circular telephone-like dial shown in Fig. 2-1; however, outside the home the difference between the telephone system and DAP begins to show. The cable link to the head end is a special cable called Qwist cable that has a much greater capacity than ordinary telephone wires.

Qwist cable actually consists of four wires twisted together. One pair of wires carries TV signals, operating in the 1–15 MHz range (a TV channel is 6 MHz wide), and the other pair carries control signals that can only handle signals of 1.0 MHz or less.

When a viewer wishes to select a TV channel, he presses a reset button on the dial unit that sends an electrical pulse over one of the control wires to a set of switches forming the

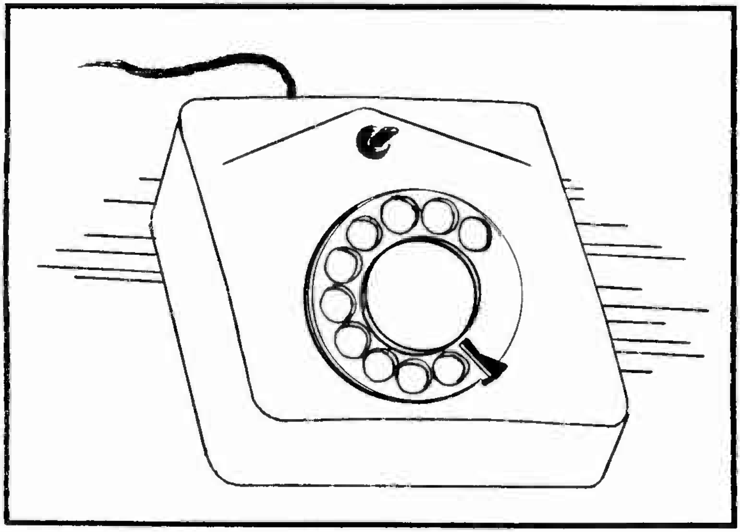

Fig. 2-1. Rediffusion's selector for dialing TV channels. The reset switch above the dial brings on Channel 00, the reference channel.

program exchange. Figure 2-2 shows a typical arrangement of the switches at the program exchange. There, the pulse automatically resets a 36-position reed switch to zero, which is the channel containing a directory of the programing available. The viewer would see a list such as that shown in Fig. 2-3. A channel number could then be dialed. As each number is dialed, that many electrical pulses are sent back along the second control wire to the program exchange to advance that subscriber's individual reed switch. For example, if channel 9 were dialed, 9 pulses would reach the program exchange and cause a switch to rotate 9 positions. Channel 11 would be dialed zero-one, and so on. Since each successive channel is one pulse more than the previous one, viewers can and do simply run through the channels by dialing a string of ones.

The reed switches in the program exchange have, as mentioned, 36 positions for that number of TV channels. But according to Rediffusion engineers, that number is not the upper limit since two or more switches could be easily provided for each customer, giving 72 or 108 or more channels to each user.

The program exchange, as designed for Dennisport, could only handle 336 TV sets (there were about 200 homes on the Dennisport cable system during most of the time the project ran), with the switches for that many sets occupying a cabinet approximately 2 by 8 by 6 feet. Consequently, in a full-fledged system more than one program-exchange cabinet would be needed for a single distribution center. In fact, 10 such exchanges per square mile is considered a good rule of thumb to go by. Physically locating the exchanges could be a difficult matter, though, because of their size and because there is a limitation on the distance any TV set can be from the exchange and still get good pictures. This distance limitation has decreased somewhat as the DAP system is perfected but generally speaking, TV sets must not be more than 2500 feet from a program exchange.

Technically, the Dennisport project demonstrated that dial-access TV was both possible and in many cases preferable.

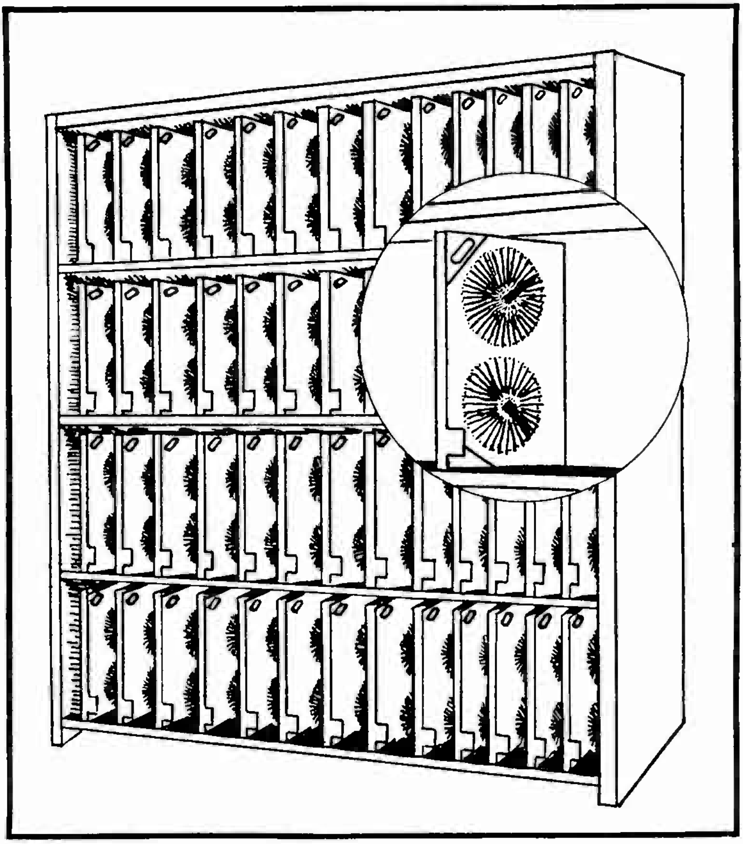

Fig. 2-2. The Rediffusion exchange contains rows of switch panels, each panel (inset) containing two 36-position reed switches.

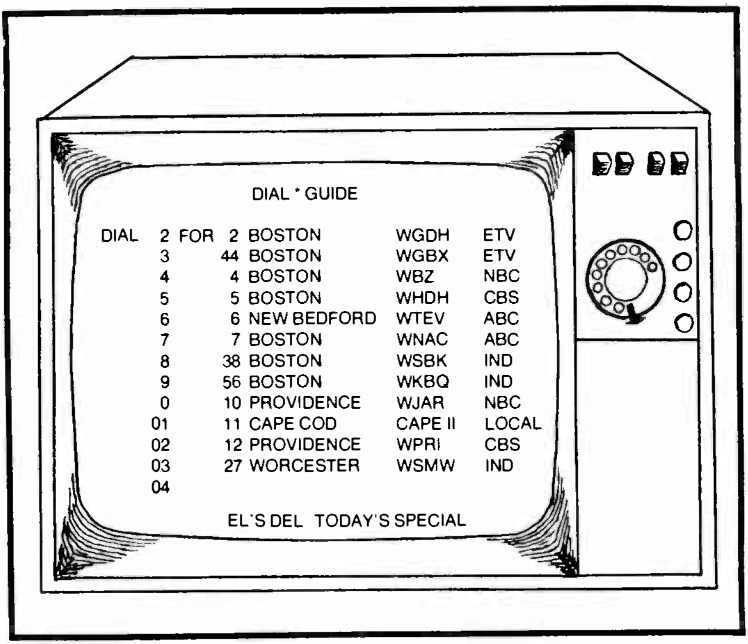

Fig. 2-3. For demonstration purposes, several TV sets were fitted with built-in dials. The directory for the Dennisport system is shown as it appeared on the reference channel.

The design of the DAP system, with dedicated lines and switching exchanges, proved versatile enough for some of the most distant two-way TV services, that is, services using fully switched TV-wide signals. The project was not intended to make any findings regarding the market success of DAP since the sample size was quite small.

Nevertheless, Rediffusion did manage to interest several institutional customers in DAP and subsequently began projects in this country, Europe, and Africa. One of the more ambitious institutional uses is for a hotel and convention center in Zurich, Switzerland. This system, described at length by John Pacey in a *Cable Television Engineering* article, was built into the Nova-Park Hotel and Business Center in 1972. In full operation, the center is to have 560 TV sets linked to a master control enabling individual rooms to dial conventional TV, pay TV movies, late minute stock market information, conferences not available to unauthorized viewers, and a special channel similar to a private line.[3]

The system is arranged into four broad categories representing the services that are available: education, entertainment, library, and training. The first two categories supply programs in a wide range of areas including commerce, economics, medical advances, town planning, law, psychology, future planning, and general entertainment. The library category represents the bank of 100 video cassette machines and telecine equipment for access to programs on film and tape. The training center combines a TV studio and nine classrooms for the production of material by convention delegates, business representatives, and so on.

To provide video services to conventioneers who chose to remain in their rooms, conferences are carried on the system in such a way that only registered delegates can see their organization's proceedings. This is done at the switching center where channels can be denied to any given number of TV sets. Alternately, a single channel can be opened up to several independent groups simultaneously. Although this is a convention center application, it is equally suitable for urban cable systems where doctors, lawyers, or other professionals might receive programing denied to the general public.

The pay TV feature uses low-frequency pulses that can be impressed on any channel for a varying charge. In other words, the pay TV programs can be individually priced and automatically recorded for any room.

In the United States, Rediffusion entered the educational market with a system at Case Western Reserve University in Cleveland, Ohio. Begun in late 1972, the system is part of the Health Sciences Communication Center linking classrooms, laboratories, and operating theaters by Qwist cable and extended to nearby hospitals by laser beams. The central control uses the same 36-position reed switches as the other installations and allows two sets of audio signals, one tied to the video program and one independent. Thus, there are in effect 72 channels available at each terminal with half of them for audio only. There are some 60 terminals altogether and any one of them can transmit video programing as well as receive it. Users at each terminal can also send signals along the control wires to operate distant video tape recorders. When a user is not in the act of dialing, the control wires can additionally be used as an intercom line. It should probably be pointed out that this establishment of point-to-point switched audio and video was based on the earlier experiments carried out in Dennisport.

Dr. Winfield Doyle, Director of Operations at the health center, reported that as of June 1974, the system was still undergoing evaluation but was functioning splendidly and was being expanded.[3]

A similar educational system for lecture halls and conference rooms is being installed at the University of Witwatersand in Johannesburg, South Africa. In Holland, a Dutch film is marketing the DAP system for commerical applications and is promoting it as the most economical and most versatile method of meeting current and future communications needs. In a booklet about the system, one of a series of *Kabelistiek* booklets, engineers for the Dutch company claim that DAP is only 10–20% more expensive to install than conventional coaxial cable and virtually eliminates the need for future massive capital outlay usually required for advanced two-way TV services. In addition, they put emphasis on the fact that the number of channels is not limited and can grow in multiples of 36 at will.[5] In Italy, the Societa Italiana per l'Esercizio Telefonico, the government authority for telecommunications, has also studied the Rediffusion system and produced a report favorable to DAP methods. The report found that the DAP system is suitable for videophone, meter monitoring, and data transmission as well as two-way TV. In general, DAP would seem to offer high reliability and flexibility and at the same time be cheaper to install and operate in the long run.[6] The Australian telecommunications authority, the Post Office, has likewise begun to study the Qwist cables and reed switches of DAP.

The Rediffusion method seems to be the ideal facility for all the glories of two-way TV; signals ranging from data pulses to full TV video can be originated by a subscriber and directed to a central point, to all points, or to any individual point. There are some drawbacks. For one thing, any computer-controlled service, such as meter monitoring and polling, would have to have access to an open channel and critics claim that the computer would not be able to know what channel the dial had been set for. Rediffusion counters that with the argument that the reed switch can be automatically reset to zero by the central office, thus opening a channel for meter-reading purposes; however, this does not answer the question of constantly open channels for alarm monitoring when a subscriber is not present to do the dialing.

The dials and reed switches have been criticized because they seem to be a technological step backwards, away from the step *up* to Touch-Tone methods. Rediffusion's defense is that the dials are cheaper than Touch-Tone keyboards, they consume less power, they are calculated to be more reliable, and they are about the same in size. The dials didn't seem to pose any problem for the users in Dennisport and were considered easy to become accustomed to. More important to DAP operation, the dials and reed switches allow one switch to handle a DC signal as well as an audio channel independent of the TV program; with Touch-Tone and solid-state switching, two switches would be needed for the TV program and the independent audio.

The actual space needed for the program exchanges and their associated cables is another area of contention. There is always the possibility that the space to locate would not be readily available except in limited installations. In highly populated urban areas, the space, when available, may be too costly.

Whether these problems are enough to keep DAP methods from being widely accepted is not known. Theoretically, DAP should be the logical choice for future telecommunications needs since it effectively unites existing telecommunications means—namely, telephone, TV, telegraph, and data transmission. Unfortunately, DAP is a late arrival to a situation where separate means are solidly established. In the United States, cable TV companies have strung enough coaxial cable to serve two or three times the eight million homes already subscribing; telephone companies have installed enough wire to connect over 145 million telephones, not to mention the even greater investment in switching exchanges and the investments of other telecommunications entities. The DAP system may be a very excellent design but it cannot be evaluated in a vacuum.

The DAP method is much more likely to be successful in the institutional market where terminals are in a relatively concentrated area and are limited in number, and where the space for the hardware can be incorporated into the original construction plans. In such situations, the particular demands of the institution can be allowed to influence the design of the DAP arrangement.

In the very distant future, it is conceivable that the DAP system may have more limitations than can be seen now. Speculating just for the moment, it seems possible that the very things that now seem an advantage, that is, the Qwist cables and the switching exchanges, may be restrictive in the future to the extent that conventional coaxial cable systems would be more flexible. In a time when wire cables may give way to optical cables, or when the need for three or more simultaneous TV channels is felt, or the desire for very wideband high-fidelity TV is common, DAP may suffer by comparison. With advances in digital coding and computer control, the conventional cable system may be able to do all the things DAP can do and more.

IN NEW YORK

While Rediffusion was working in Dennisport, another test of two-way TV services was taking place in New York City. The lower half of the island of Manhattan is the province of Sterling Manhattan Cable Television, a subsidiary of Sterling Communications now controlled by Time, Inc. In the middle of February 1971, Sterling conducted a rudimentary two-way TV poll and took pains to publicize the event as the beginning of two-way TV.[7]

The demonstration poll involved 10 response terminals situated in four building complexes. Each response terminal was connected to a TV set and contained a few buttons for viewers to push. At a prearranged time, an emcee on the cable system's local origination channel asked a series of questions that could be answered by pressing one or more of four response buttons. To begin with, viewers were asked to switch to any other channel and then indicate with the press of a finger, which channel they preferred. Next, those at home were requested to select one of two ladies present in the studio as "Miss Home Terminal of 1971." Following that, opinions were solicited for or against a recent proposal by the chancellor of the public school system. Finally, an Eastern Airlines commercial was shown and viewers were polled for their preferences for vacation spots. The "Miss Terminal" competition, incidentally, was a draw.

For a period of 7 months after the first public demonstration on February 16, Sterling Manhattan and Video Information Systems, Inc., the manufacturers of the response units, continued to conduct periodic tests of two-way features. The number of home terminals was increased slightly to an even dozen, and experiments in subscriber-initiated requests and off-track betting were included as well.

At the time of the public demonstrations, the home terminals were not computer controlled; impulses coming in were tabulated by hand and displayed on a simulated computer display panel. Later, a minicomputer was incorporated into the system which could sequentially accept data from each terminal, and Sterling announced plans for a full-scale computer-controlled test of two-way TV services involving 500 home terminals.

The advanced test never took place. During the months that followed the demonstration, Sterling came under the control of Time, Inc., while at the same time experiencing financial difficulties. According to Time's director for cable TV matters, Howard Dunn, Time felt that any significant test of two-way TV services would require at least 1000 home terminals and an investment of about $500,000. As a result, the plans were dropped. Instead, Time and Sterling elected to explore possibilities for putting commercial data taffic on the cable system and for engaging in pay TV. Later, in early 1973, Time and Sterling invested some $3 million in a pay TV network called Home Box Office, Inc. (HBO), beginning initially with 3000 subscribers in and around Allentown, Pennsylvania. (More about this in Chapter 5.)

The two-way TV system tested in Manhattan was, though, not unlike other systems that have subsequently been tried with more success. The response terminals provided by Video Information Systems looked very much like what is coming to be a sort of standard, a modified converter with four data buttons. The converter, shown in Fig. 2-4, in fact had six extra buttons. Four buttons were for the data entries and became illuminated when pressed; they would remain lit until the computer had accepted the information from that terminal. The fifth button, also capable of illumination, indicated *end of*

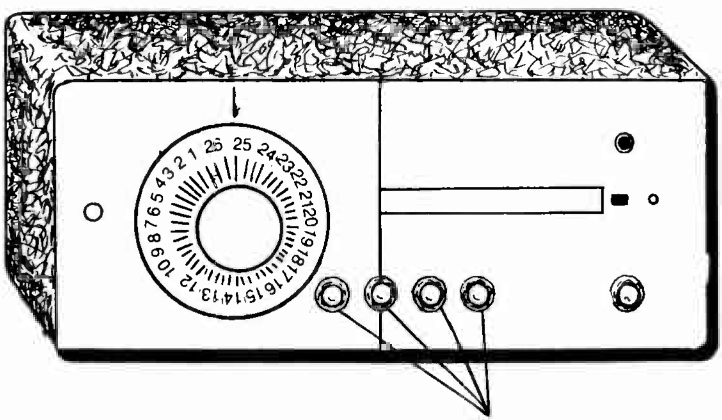

Fig. 2-4. The modified converter contains four response buttons, an end of message button, and a clear button.

message and was pressed when a viewer had finished pressing various combinations on the data buttons. The sixth button was *clear* and could erase any entry before *end of message* had been pressed.

The computer could poll each terminal because each response unit, called Video 12, contained a built-in unique electronic address code. In a normal poll, interrogation signals would be sent out in a stream from the control center at a frequency just above the FM band (frequency modulation, 88–108 MHz). The interrogation pulses would allow the home terminal to respond with coded information, using a frequency of 10 MHz. The response codes could identify the terminal, indicate whether or not the set was on, what channel was being shown, and whatever buttons might have been pressed. In a full-scale installation, 40,000 terminals theoretically could be polled once every second.

With the four data buttons, the upper limit for different initiated responses was 16 when using the buttons in combination. Video Information Systems later developed a Touch-Tone keyboard with 16 data keys which could be added to the original model of the response unit. With the addition of further plug-in circuitry, a full typewriter keyboard could also be used as a data-entry device.

The type of terminal demonstrated by Sterling, the four data button model, can almost be considered as typical of first-generation hardware for two-way TV. Such units can be used for pay TV billing, meter or alarm monitoring, and simple subscriber polling and response. The number of buttons, and even their location on the face of the converter, do limit the actions that a subscriber can take. Whether or not such units have enough appeal for the consumer of TV services when compared to more extensive (and more expensive) terminals is a question that cannot be answered before sufficient trials have been made. Several companies, though, completely skipped this first-generation level in home terminals in favor of more flexible and more capable models. Such companies as the Telecable Corporation, Teleprompter Corporation, and Mitre Corporation all inaugurated their own two-way TV systems with more advanced terminals replete with everything from keyboards to cameras and paper printouts.

KANSAS TELECABLE

Overland Park is an upper-income suburb of Kansas City that has the distinction of being the site for probably the first all-around test of two-way TV. Cable TV service there is provided by the Telecable Corporation, headquartered in Norfolk, Virginia. They began seriously planning for two-way TV during the latter part of 1970. By February 1971, as Sterling was polling TV viewers in New York City and Rediffusion was active in Dennisport, Telecable was ironing the wrinkles out of a pilot project that encompassed two-way digital, audio, and video transmissions.

The major emphasis of the pilot project was placed on educational applications; although retail uses, alarm monitoring and opinion polling were also tested. Certainly one of the reasons behind the decision to concentrate on educational use was the opportunity for generating additional monetary support. If the pilot project was successful, the local school district was prepared to apply for a grant to support additional two-way TV activity. The educational emphasis was also particularly suited to the type of short-term testing Telecable planned, matching the length of the experimental service to that of a concentrated course of study.[8]

Telecable began performance testing the two-way equipment during the first week of June 1971, and held the first public demonstration on the first of July. On that day, Jeff Hubert, a 17-year old suffering from a brain tumor and unable to attend regular classes for 3 years, began a 6-week course in American History. Installed in his home was a two-way TV that included a TV camera. (See Fig. 2-5.) Jeff's teacher, Mrs. Sheila Kocher, conducted the lesson from the Telecable studios although future lessons were to originate from the school. Jeff could type answers or messages on a 12-key alphanumeric keyboard, or press certain keys to open an audio channel to talk directly with Mrs. Kocher. Other keys would open the video channel so that Jeff could show his work or visually demonstrate a point. During the public demonstration, merchandising possibilities were also dramatized with a fashion show produced at a local branch of Sears and Roebuck using a camera-equipped terminal at the store. Jeff's mother made a purchase by digitally instructing the computer at Telecable headquarters.

At the end of 6 weeks, Jeff passed his exams in American History and received full academic credit; the two-way TV system was considered officially successful. School administrators and Telecable prepared a second course for two-way TV, this time to serve six home-bound students. The additional response units were installed and the course joined

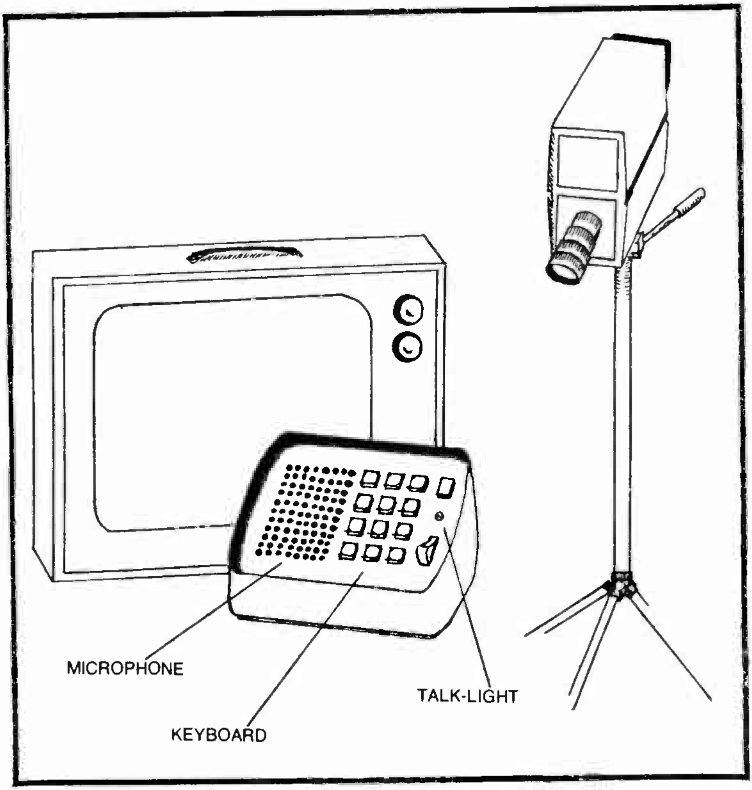

Fig. 2-5. The Telecable two-way TV system brought together a TV set, an intercom-like response unit, and a TV camera mounted on a tripod.

the list of two-way TV experiments. The Kansas system was also successfully tested for alarm monitoring, opinion polling, and data retrieval.

The terminals used by Telecable in Overland Park demonstrated a substantial improvement over the response unit tested by Sterling. The Telecable unit, manufactured by Vicom Manufacturing Company of Dexter, Michigan, was essentially composed of four different sections other than the TV camera. Figure 2-6 is a simplified block diagram of the four units involved. The first unit is the TV itself. A second unit is the channel converter common to many cable TV systems of more than a dozen channels. The two unusual units are the digital-circuitry unit and the "Queset" (an intercomlike box with 12 keys, a built-in microphone, and a *push-to-talk* button). The digital memory circuit serving the Queset could store data for a single line of 16 characters and each line could subsequently be displayed on the TV screen. The 12 keys on the Queset could be used in combinations to form a single character; thus, some 60 alphanumeric or editing characters were available for visual-print communication and up to 144 different message codes would be possible.

The entire system was computer controlled. The computer sequentially interrogated terminals for messages with a bit stream flowing at 1 megobit per second. The time required for a message to be accepted and acted upon was not constant, however, since interrogations become relatively slower as more and more terminals happen to want to relay messages at exactly the same time. This variant time delay is a factor in virtually all computer interrogated two-way TV systems but rarely is the delay slow enough to be noticeable, according to projections. In the Kansas system, the computer could address each Queset approximately five times a second. Each time, one character of information would be accepted. This may sound like a slow method for transmitting a lengthy message, but five characters a second proved to be acceptable in the applications that were tested.

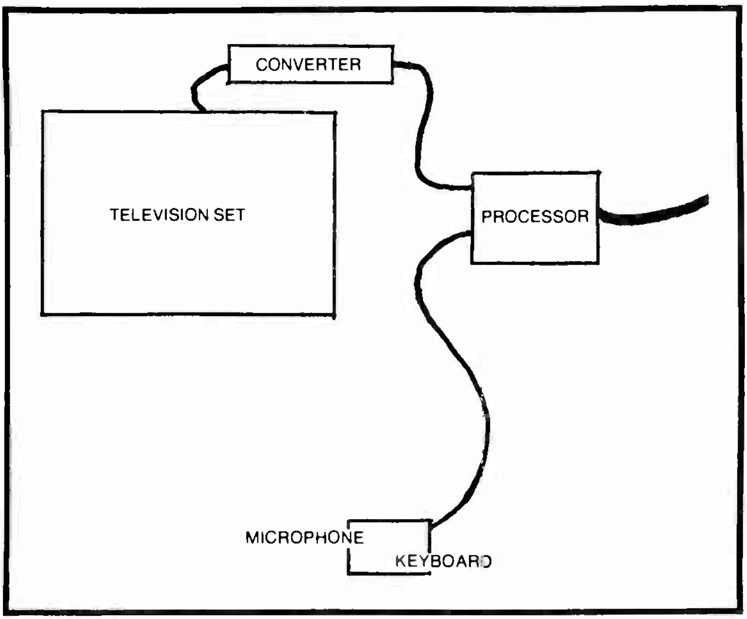

Fig. 2-6. The block diagram shows the TV, the Queset (microphone, keyboard), the converter (plus the digital unit that includes the logic processor), modulators, and an alpha generator.

To further analyze the communication possibilities of the Telecable two-way TV system and to have a point of reference for future comparisons, the digital stream can be broken down into bits, the units of information forming the digital codes. The interrogation to each terminal used 30 bits and the response from each terminal used 20 bits, but not all the bits could be used to relay messages. Some must be dedicated to keeping the bit stream aligned, some are error-detecting bits, and some are used as the address code so that each terminal will only accept its own interrogation. The bits, then, were apportioned as follows:

Bit	Interrogation	Response
Precursor	2	
Major address	8	
Precursor	2	2
Minor address	8	8
Precursor	2	2
Information	8	8
Total	30	20

The eight information bits are the ones used to form the one character of information that the computer will accept on each interrogation. Increasing the number of bits in each interrogation and response will naturally decrease either the number of terminals that can be served in a given amount of time or the speed itself.

The control center for the Telecable system handled the digital requests for audio and video channels as well as accepting the data communications. At the center was located the interrogation sequencer, an instruction computer, interface equipment, an operator's console, and computer programs stored on tape cassettes. The inventory of computer programs included the programs for the alphanumeric displays, control of the audio and video response channels, shopping services, alarm monitoring, and opinion polling.

The capability of the Overland Park project can also be examined in terms of the frequency allocations that were used, remembering that a coaxial cable of the type commonly used in cable TV has a bandwidth of roughly 300 MHz under ideal conditions. In two-way operation, however, portions of that bandwidth cannot be used without interfering with other portions. Much of the bandwidth was taken up by the 26 channels of TV programing at approximately 6 MHz per channel. In addition, two TV-wide channels were reserved for the digital signaling; the forward channel was set at 110–116 MHz and the return channel at 6–10 MHz. The digital signals were coded using frequency-shift keying, a coding process, whereby the signal is shifted between two set frequencies to indicate either zero or one in the binary number system.

The return-video channels were located low in the band at 12–30 MHz. Allowing 6 MHz per channel, it can readily be seen that only about three return-video signals can be handled at the same time. Thus, two-way video services for a large system are somewhat limited.

The forward-audio channels were, of course, part of the video allocations, but independent return-audio channels were set at 5.5 MHz, 5.55 MHz, and 5.6 MHz.

The two-way TV system in Overland Park was geared, therefore, to services of the polling and monitoring sort for the average subscriber and limited audio and visual communications for special institutional users, since the institutional users would be more apt to carefully schedule their usage to make maximum use of the few return-audio and return-video channels.

In full operation, the system and computer processing center were designed for a maximum of 65,000 subscribers. Additional two-way TV terminals would necessitate duplication of some of the processing equipment. The cost for each home unit, excluding the TV and camera, was set at slightly over $300, which was a substantial reduction from the original cost of $1000 per unit when testing first began. Nevertheless, the home terminal is still expensive, with the high cost being one of the major blocks to large-scale two-way experimentation. This expense is one of the major reasons why experimenters have turned to institutions and agencies or have sought subsidy funding of some sort.

At the time the two-way project was in operation in Overland Park, Telecable's research department under Gordon Herring used the system to explore services involving other public-oriented institutions such as hospitals and nursing homes. At one point, plans were considered for a two-way TV system to link doctors at Kansas University's medical center with school nurses in Overland Park. Herring's staff was also working with representatives of an audience-measurement firm as well as nursing homes. In the end, however, the Overland project remained basically a technical test and not an attempt to begin continuing two-way TV services. By the summer of 1973, Telecable had officially terminated the experimental two-way operation to study the results and improve the design. Soon after, Telecable applied for and received (in June 1974) a National Science Foundation (NSF) grant to further develop two-way services. The $100,000 grant is to enable Telecable in cooperation with the Rand Corporation, an equal partner in the grant application, to draw up a proposal for two-way social services in Spartanburg, South Carolina. Along with other grant recipients (mentioned later in this book), the proposal is to be submitted to the NSF in competition for more funds for the actual project.

For 1971 however, the Telecable, Sterling, and Rediffusion projects, despite all their problems and limitations, produced a remarkably varied introduction of two-way TV to the public. Their capabilities, compared in Table 2-1, covered a wide range of service possibilities. Sterling was testing services of a restricted sort that could presumably be economically installed on the basis of subscriber revenues. Telecable, though, conceived of two-way TV as an aid to education and health care and consequently designed a more elaborate system at greater cost. In a category apart, Rediffusion demonstrated in Dennisport that return audio and video could be added to a basic DAP system at little extra cost, but failed to convince commercial cable TV companies that the DAP system was preferable to conventional trunk and feeder installations.

Two other organizations also moved into the realm of two-way TV during 1971 but were of an even more experimental

Table 2-1. Two-Way Services Possibilities—1971

	Rediffusion	Sterling	Telecable
Return digital	no	yes	yes
Return audio	possible	no	yes
Return video	yes	no	yes

nature than the previous three. The Teleprompter Corporation conducted two-way experiments in Los Gatos, California, that were essentially equipment performance trials. The Mitre Corporation initiated a project in Reston, Virginia, that was a hybrid affair using telephones and telephone lines for the return communications. Both corporations, however, continued to advance their work in two-way TV and several years later both were prepared to launch substantial two-way TV systems.

LOS GATOS TESTS

The two-way tests in Los Gatos in 1971 marked the first step into two-way TV by the Teleprompter Corporation of New York, which is by far the largest owner of cable TV systems in the United States. Nationwide, the company was serving over 1,020,000 subscribers as of June 1974 in nearly 150 systems. In developing two-way cable TV, Teleprompter has worked in cooperation with Hughes Aircraft Company, a worldwide leader in space technology. (Teleprompter is owned 5.5% by Hughes Aircraft.)

At about the same time that Telecable was doing the planning in late 1970 for their two-way project, Teleprompter had finished their preliminary designing and was installing hardware on their cable TV system in Los Gatos, about 70 miles south of San Francisco. Included in the system were the necessary crossover filters and amplifiers.

Actual performance testing began in the second week of March 1971, and involved the sending of video and digital signals from selected homes back to the distribution center. For the video tests, instead of a camera, a video generator was used to create color TV signals that could be viewed on ordinary color sets at cable company headquarters. Three separate color channels were tested—low in the band and centered at 13.25 MHz, 19.25 MHz, and 25.25 MHz—the same general area as the return channels selected by Telecable in Overland Park. This is not surprising since technical considerations leave few alternatives. Digital communication was also tested using a prototype data terminal capable of a bit speed of 1 megabit per second.[9]

A prototype home terminal, such as that shown in Fig. 2-7, was developed for the tests but not for use in any actual services. The terminal consisted of two physically separate units other than the TV set. One unit, a small box with no controls or dials, was the "modem," which is a word borrowed

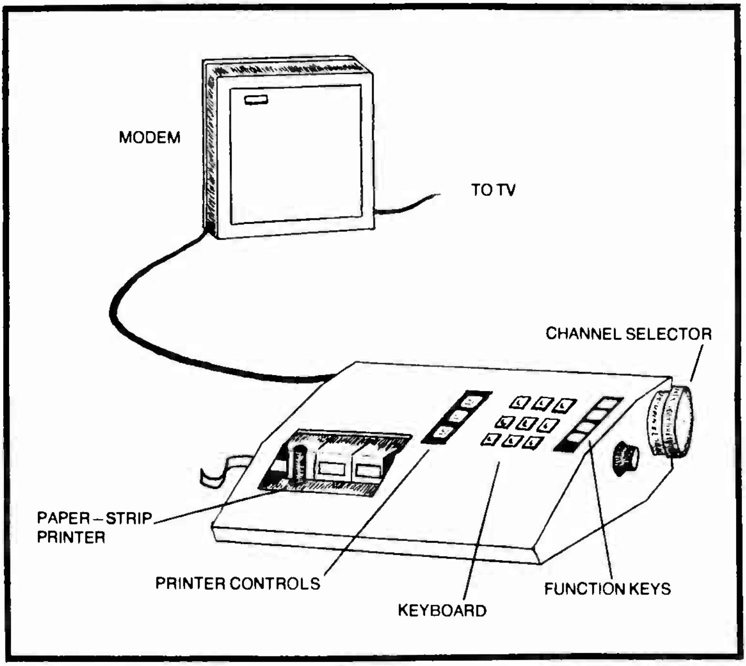

Fig. 2-7. This is a demonstration model of the type of home terminal Teleprompter had in mind. The "modem" houses the electronics which perform the functions controlled from the console.

from computer technology and is a contraction of modulator-demodulator. The modem housed the circuitry governing the digital signals and the circuitry for channel conversion. The second unit was the console with its small keyboard, channel selector, and a paper-strip printer. Unlike the Telecable terminal in Overland Park, no built-in microphone was included; but the Teleprompter terminal did have the advantage of being able to print out on paper all the characters entered on the keyboard. Similar to the Kansas system, characters typed out on the keyboard could be displayed in blocks on the TV screen, in this instance 20 characters at a time.

The digital signals sent out from the computer processor occupied 108–112 MHz using frequency-shift keying, but the return-data signals, at 21–25 MHz, used a coding technique known as phase-shift keying. That is, the phase of the signal is altered 180° to indicate either zero or one for binary digits.

Thomas H. Ritter, the director of the Teleprompter Development Laboratory in Lompoc, California, conducted the two-way testing and completed the project by October 1971. For a wide variety of reasons, two-way experimentation was shifted to a more flexible cable system then being constructed in El Segundo, California. This latter system has been prepared for advance two-way TV services by Theta-Com of California (a division of Hughes Aircraft), Hughes Aircraft Company, and Teleprompter. This is discussed further in Chapter 4.

MITRE IN RESTON

Unlike the preceding two-way tests and pilot programs, the project devised by the Mitre Corporation concentrated on a single service—computer-assisted instruction. In fact, Mitre firmly believes that the largest single use of two-way TV systems will be for instructional purposes. Also unlike the other experiments, Mitre relied on telephone lines to complete the return circuit, as outlined in Fig. 2-8.[10]

The Mitre Corporation itself is a nonprofit federal contract research center headquartered in McLean, Virginia. After some 4 years of research and development in computer-assisted instruction, Mitre decided to adapt computer instruction to cable TV and, as a result, set up a two-way TV project in September 1970 with the help of a grant from the NSF.[11] In the first phase of what has been a continually expanding project, Mitre chose the nearby Reston, Virginia cable TV system as the proving ground for technical tests and demonstrations.

The computer involved in the project was located on Mitre's premises; from there the signals were microwaved to the head end of the Reston Transmission Company, a subsidiary of Continental Telephone, for distribution over the city's cable TV system. Reston Transmission had installed a dual-cable design allowing 12 TV channels on each cable; but with the replacement of some components, the system could handle up to 40 channels. This would be crucial to any large-scale implementation of the Mitre techniques. In the initial experiments, the return signals were in analog form traveling on lines of the Chesapeake and Potomac Telephone Company and needed to be converted to digital form by modems at the computer for computer processing. Devices for creating return data ranged from a Touch-Tone telephone to a 16-button keyboard and an alphanumeric typewriter-style console. The latter two devices were developed for use when the telephone return link was replaced by putting the return communications on the cable system itself.

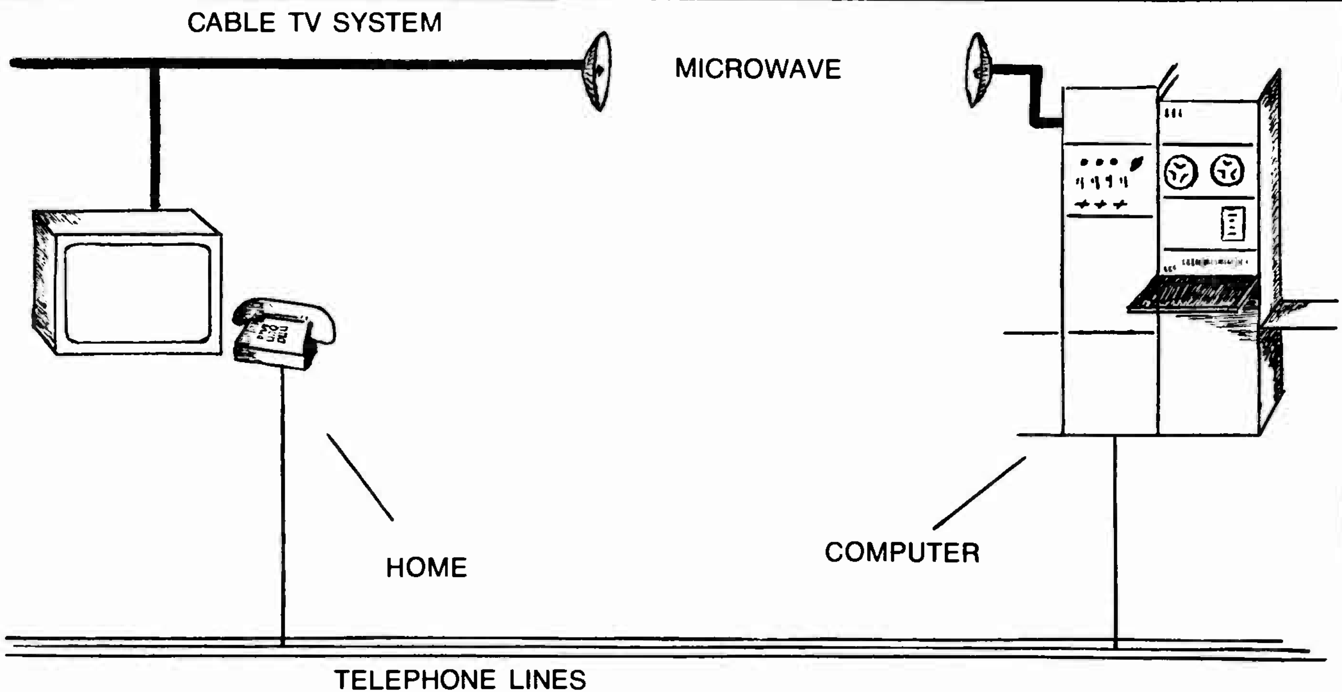

Fig. 2-8. Mitre's two-way TV system in Reston was really a marriage of a TV and a Touch-Tone telephone.

Mitre began performance testing their equipment and system design in April 1971. Six terminals were put into use in July of that year. The handful of terminals were located in both homes and classrooms.

At first, two educational programs and an information service were provided. One of the educational programs consisted of a set of lessons teaching children to add two digit numbers. The other program of computer-assisted instruction was a 5-day drill and practice course in fourth-grade arithmetic. The information service was rather singular as a form of two-way TV in that it broadcast large amounts of information to all TV sets at all times. The viewer, however, would select only one segment of the information file to be shown on the screen. This form of two-way TV, in which the viewer must make a choice but the choice is not transmitted back to the head end, is not restricted to cable or wire systems and can be adapted to conventional broadcast TV. The BBC has been developing a system dubbed "Ceefax" in which 30 categories of data can be incorporated into the unused gaps in a normal TV signal and broadcast right along with a TV program. A keyboard device in the home is then used to switch from the TV show to one of the information categories. The BBC does not expect the system to be ready for commercial use, though, for several years.

In the Mitre design, the broadcast information categories included a weater service, stock reports, racing forms from Pimlico and Shenandoah Downs, sports scores, a simulated ski report, and a fishing report. Viewers also had access to information channels which were not continuously distributed but could be called up by pressing buttons on the telephone or a keyboard. These selective information channels included a telephone directory, classified ads, a weekly TV program guide, and a weekly calendar of community events.

The Mitre experiments also included letting home terminal operators use the Mitre computer for personal calculations and the storage of personal data in the computer memory bank. And Mitre later initiated computer games and tested the technical aspects of shopping at home, electronic mail, voting, banking, and literally dozens of other proposed two-way TV services.

All of Mitre's two-way programs and services are based on the display of still pictures, a method that had previously not been tried in two-way TV pilot projects. The relatively unusual procedure has been called "Ticcit" (for time-shared, interactive, computer-controlled information television) and requires information to be sent only once every 10 seconds to each terminal. There the information is recorded and continuously replayed for effective TV viewing. In Reston, the picture-refreshing device was a video tape recorder at each terminal, which could also be used to record TV programs from the standard channels when it was not being used for viewing one of the computer-generated information channels. In future systems, either a group of terminals would share a centrally located video tape recorder for picture-refresh purposes or the recorder would be replaced by less expensive silicon storage tubes, single-field disc memories, or digital solid-state circuit boards.

Besides the video tape recorder and the TV, each two-way terminal additionally required a coupler-decoder unit. (See Fig. 2-9.) This unit housed the switches for channel selection, controlling the video tape recorder, electing a public or private mode, and selecting subchannels. The public-private mode switch refers to the option for the broadcast information categories or the selective information channels, respectively. Literally hundreds of information channels or categories (these are the subchannels) were offered by virtue of the fact

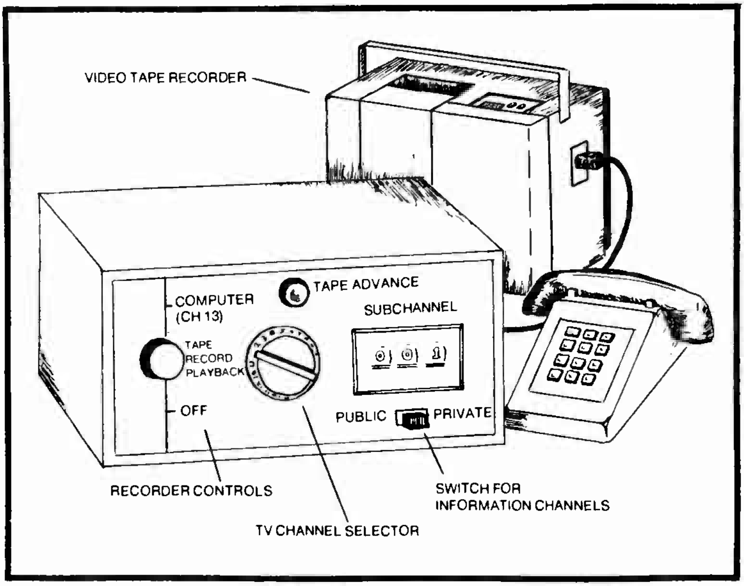

Fig. 2-9. The Mitre two-way TV project involved a video tape recorder, a telephone to contact the computer, and a control console in addition to the TV set itself.

that hundreds of different frames of a TV picture can be sent out during the 10-second cycle of the Ticcit system. And each frame can be addressed to a different terminal.

The computer interrogation of the home terminals developed by Mitre is not quite like anything that has been discussed earlier. While Mitre did, in fact, use a 16-bit address code that must match a preset code in each coupler-decoder, the address code was not transmitted in digital pulse form. Instead, the code was converted at the computer into black and white bars on the last line of each previously transmitted TV picture frame. Each TV frame (in normal TV there are 30 a second) can thus be addressed to an individual two-way TV, providing the basis for the selective information channels.

Combinations of the address elements will produce 32,000 unique addresses, but only 600 terminals could be served by a single channel in the Ticcit system because of the characteristics of a TV picture. A standard TV picture consists of 30 frames a second which is in reality 60 fields a second, since each frame is a composite of two interlaced fields. Ticcit, however, since it is oriented toward still pictures, uses only every other horizontal line in a TV frame which reduces the vertical resolution only slightly. Consequently, Ticcit can generate 60 frames a second and not 30. Multiply that by 10, since each terminal is contacted by the computer once every 10 seconds, and it can readily be seen that one channel serves 600 terminals.

For that reason, Ticcit designers suggest that 10 channels might be needed for two-way TV information services. In large urban areas, an unmodified Ticcit system might have problems, especially in view of the fact that many cable TV systems are only designed for 24–26 channels. Yet two-way TV techniques developed by other companies can give these systems 30,000–60,000 response terminals on merely one or two channels. On the other hand, Ticcit accomplishes the quite considerable feat of providing privately addressed video to all terminals. The importance of privately addressed video should not be underestimated; it is a key element in the complete utilization of two-way TV and a goal that is likely to be eventually sought by all two-way TV forces.

As the Reston demonstrations were concluded, Mitre continued to work on the educational applications for two-way TV and the Ticcit system. Reports of their study and analysis of the technical and economic aspects, the social impact and the ultimate implementation of two-way TV have been published in a 7 volume, 300 page series to acquaint the public with their work. This compilation also contains accounts of all their experiments in two-way TV; the results of surveys and questionnaires; and the discussions of panels of experts from the fields of education, sociology, TV and computer instruction.[12]

Along with the publications, studies, and public discussions, Mitre set about finding a suitable site for a large-scale test of their equipment and procedures. For a starting point, they drew up a list of specific criteria to govern their choice. The city to be selected must have a cable system serving a wide variety of subscriber groups, schools of different levels must be willing and able to participate, the cable TV operator also must be willing and able, and the cable system itself must be adequate for experimentation without expensive additions. Mitre then chose 31 cities across the country to focus on. After some investigation, seven cities were found suitable. Personal visits by the Mitre staff were then made to officials in each city, to the directors of the school systems, and to the cable TV operators. The list was finally narrowed to three sites: Akron, Ohio, Peoria, Illinois and Stockton, California.

Stockton was the ultimate choice because of the system design, its channel capacity, its expansion capability, and the diversity of subscribers. The Stockton system, Big Valley Cablevision, Inc. (owned by Continental Cablevision), had been constructed after Mitre had publicized some of their earlier work and, as a result, had adopted Mitre recommendations for a hub-type installation. This permits the refresh memories essential to the Ticcit system to be located at several hubs and shared by subscribers, instead of being located in each home. The hub design also permits different offerings to be on the same channel in different hubs. In this way the problem mentioned earlier of the limitation of 600 terminals per channel is evaded—for every 1000 customers the maximum number of simultaneous users is calculated to be about 100, and these would be scattered among the different hubs.

Although Akron and Peoria are both possessors of two-hub cable installations, Stockton has six hubs tied to a central control. The cables used by Big Valley were also in line with Mitre specifications, carrying a maximum of 60 channels while only 37 channels were carried in Akron and 30 in Peoria. Stockton also compared favorably in terms of eventual size.

The system expects to be serving half of all TV households in Stockton, bringing the subscriber total to 19,075–27,250. Both Akron and Peoria expect to be in the neighborhood of 20,000 subscribers.

Perhaps the most significant advantage that Mitre saw in Stockton was the population itself. According to Mitre's established criteria, a substantial diversity would be needed to insure valid results capable of being carried over to other areas. The California city was found to have a wide range of income levels, educational levels, and cultural heritages.

During the summer of 1974, Mitre began talking to leaders in Stockton communities to determine the needs of the populace. Later, a survey of 500–1000 citizens was undertaken to gain additional insights into the two-way TV services that might be welcome on the Big Valley cable system. Before the end of 1975, the to-way design was scheduled to be tested for technical problems. The programing for the computer services and computer-stored information was undertaken. Actual installation of equipment was slated for start in January 1975 with service to begin shortly after. Throughout most of 1975 Mitre and Stockton's Big Valley Cablevision waited for word from NSF that the additional grant of $4.5 million necessary to put the plans into operation would be approved. Because of the time elapsed, this figure was a substantial increase over the $3.2 million originally forecast.

The NSF was to complete their review of the project in October according to Ray Joslin, manager of the Stockton cable television company; but changes within the NSF itself resulted in the proposal being returned to Mitre for additions and resubmission. By the end of January 1976, Mitre, in cooperation with Big Valley, was once again preparing to submit a proposal for the multimillion dollar project.

Despite the delays in the high-cost computer controlled TV services, however, the cable TV system in Stockton continued to prepare for, and conduct, as much two-way TV activity as economically feasible. Big Valley's Joslin pointed out that thus far the Stockton system was one of the few, if not the only, fully active bidirectional dual-cable systems in this country. The entire plant, trunks and feeders, had been engineered for two-way operation, and a continuous schedule of two-way communication had been established by virtue of program feeds from Stockton's Lincoln High School. The daily programs are available to all subscribers on channel 11B, reserved exclusively for the high school origination.

Since it is an experimental project and the two-way services was only to be offered to 1000 homes, the participating homes were chosen impartially from the list of current subscribers. Those people chosen do not pay anything for the additional services, part of the tab being covered by a grant from the educational division of the NSF.

One of the more unusual aspects of the project is that it is to be evaluated by an outside investigator; namely, the Educational Testing Service of Princeton, New Jersey. The two-way services offered are all in the area of instruction and are evaluated for their educational effect. Aspects that are considered number many, ranging from the course work itself (easy to understand—conveys knowledge—is remembered) to the users (their motivation for choosing different sources—their backgrounds—their social and cultural classes) to the medium of instruction (computer characters—videotapes—audio lessons). Much of the course work is short noncredit programs from remedial to university level. Presumably, the evaluation report spells out how two-way TV courses are effective and how they are likely to be receied by people throughout the country.

Possibly, the Stockton experiment will involve some services that are not in the instruction category.For example, an *author* feature might be included, allowing subscribers to send in their own notes, announcements, or comments to be accessed by others.

The two-way terminals to be used in Stockton consist of 900 full typewriter-keyboard models and 200 16-key models. Although in Reston Mitre had produced its own hardware for the subscriber consoles, in Stockton terminals may be available from commercial manufacturers who have asked to be part of the project. Both the Jerrold Corporation and Electronic Industrial Engineering, Inc. (EIE), a subsidiary of RCA, have already developed two-way terminals and are willing to modify their designs to meet Mitre requirements for the Stockton project.

Electronic Industrial Engineering has been marketing their "polycom" concept for two-way TV for several years and has been involved in other test installations described in Chapter 4. Polycom includes the promotion of hub-style installation as the obvious choice for building massive systems in which a computer addresses individual terminals. A model of one of the EIE response units is shown in Fig. 2-10.

Jerrold Corporation, the leading manufacturer of cable TV equipment, has produced their own "Communicom" concept

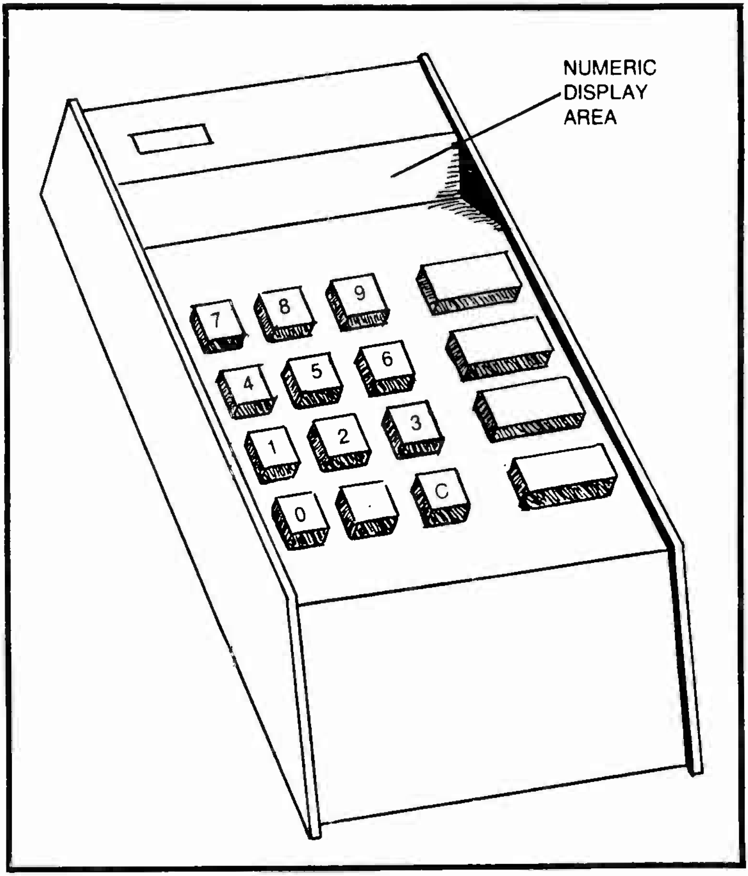

Fig. 2-10. This EIE "Data Entry" unit includes four special function keys alongside the 10-digit keyboard.

for two-way TV services. Communicom uses a central computer to process all signals and a response unit that can be either a simple converter, an address receptor, or a complete two-way terminal, depending upon the circuit modules that are plugged in. The basic unit of the home terminal handles channel conversion for up to 34 channels. A separate circuit module may be fitted inside for unscrambling pay TV programs. Another circuit module may be added to allow the terminal to accept digital address codes and commands. Figure 2-11 shows the basic unit with a remote unit that can be used with it. This requires additional circuit modules in the base. The remote keyboard is connected by wire to the base. It can rest on the basic unit or be removed for use at a distance.

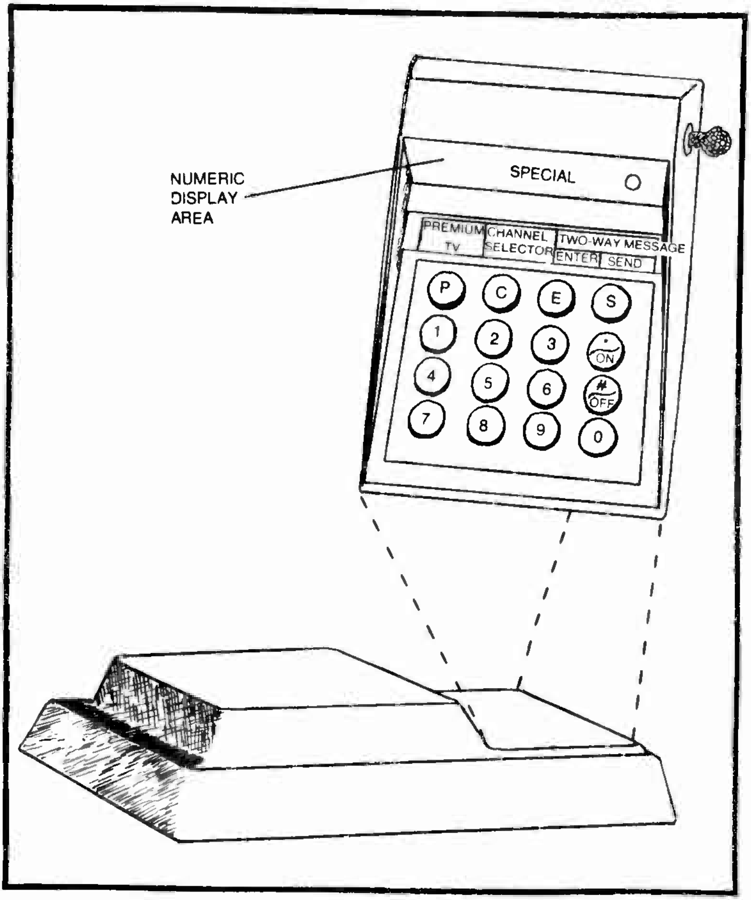

Fig. 2-11. The Jerrold home terminal consists of a remote unit for subscriber use and a base unit on which the remote may rest, containing the solid-state circuitry for channel conversion, picture descrambling, and two-way data.

The keyboard can order pay TV, change channels, send data messages and commands, and turn the TV set on and off. For shopping at home services, a special light comes on to indicate that advertisements of instantly purchasable items are being shown. More germane to Mitre's requirements, Jerrold has also worked with refresh devices to hold frames of information on TV screens for substantial periods of time.

Besides the home two-way terminals for use in Stockton, eight telephone "ports" are provided so that all cable subscribers, not just those participating, will occasionally have access to some of the services via a Touch-Tone telephone keyboard. This is yet another example of Mitre's employment of the telephone system to bring about services associated with two-way cable TV. It reflects a basic recognition that two-way TV encompasses various telecommunications facilities and that proper integration can be a very useful tool.

The Reston tests and demonstrations, unpretentious though they were, have therefore led to a very substantial involvement in two-way TV services in an urban setting. The Mitre Corporation believes that their publications, discussions, and demonstrations stemming from the Reston project in 1971 have had a major impact on many decision makers in government and industry in favor of sponsoring two-way TV development. Without much exaggeration, it can be said that the Mitre corporation has to date led all other experimenters in the extent and depth of continuing two-way TV implementation. As a computer-assisted instruction advocate, Mitre is perhaps even more anxious to make an impact on education and prove as much as possible that computer instruction can be both exciting and extremely beneficial. To this end, they are also engaged in bringing Ticcit to several community colleges in another project that will be discussed later.

In general, beginning essentially in 1971, two-way cable TV showed a varied if somewhat uneven start. A comparison of the response terminals of that year, shown in Table 2-2, shows that subscribers could press buttons, type codes, speak, and televise their own communications from their homes.

Table 2-2. Channels Available and Response Options—1971

	Total number of TV channels on system	Response options and response unit features
Rediffusion	36	10-digit dial
Sterling	24	4 buttons
Teleprompter	25	12 keys paper printout
Telecable	26	12 keys microphone optional camera
Mitre	24	12 buttons (Touch-Tone telephone)

Moreover, home terminals could flash indicator lights, print paper, and display individually addressed video in the form of still frames and as ordinary TV on unlocked channels. The fact that several of the pilot projects were not continued as such was probably due to insufficient preparation, the generally poor economic condition of the cable TV industry during the early seventies, and the overall scarcity of investment capital. Nonetheless, Rediffusion, Telecable, Teleprompter and Mitre continued to explore two-way TV services and to advance their particular concepts, refining the equipment, finding new markets, or obtaining grants for development. By the middle of the decade, all four hoped to be well into substantial market tests of two-way services that would clearly indicate the types of services and facilities successfully acceptable to the public.

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10. Using a telephone to request information over a cable TV channel has been tried in numerous instances. For example, in 1970 in Wyoming a camera was installed in the reference department of the Natoma County Public Library and telephoned requests for visual information were answered by cablecasts over a special cable channel. See Kenneth E. Dowlin. "CATV + NCPL = VRS." *Library Journal*. Sept. 1. 1970. pp. 2768–2770.
11. Mitre's two-way project for Reston is described in: "Computer CATV Link Offers CAI Promise." *Electronics*. July 19. 1971. p. 29; "Mitre Tests Computer Linked CATV Services." *Electronics*. April 12. 1971; Kenneth J. Stetten. *Toward a Market Success for CAI* (McLean. Va.: Mitre Corp.. 1972). pp. 55–56; John Volk. *The Reston, Virginia Test of the Mitre Corporation's Interactive Television System* (McLean. Va.: Mitre Corp.. 1971). pp. 1–18.
12. The seven volume series is summarized in *Interactive Televsion—Program Overview* (McLean. Va.: Mitre Corp.. 1974).

Chapter 3

Alternative Ways and Means

The English mathematician and philosopher Alfred North Whitehead once advised an audience that wisdom is the fruit of balanced development.[1] He was talking about an uncomfortable trend in our century for progress to be confined to more or less isolated grooves. His admonition is especially apt for two-way TV, since two-way TV, as a concept more than a reality, cuts across numerous grooves of technological and social development. If two-way TV is to share the wisdom of balanced development in a strictly technological sense, it will be a happy mixture of communications technologies beyond the confines of cable TV.

Theoretically, the ideal goal of communications planners is a fully integrated network providing the greatest number of compatible means for providing the widest variety of services and functions. Obviously, something short of ideal will result, but that should not deter the effort. There are many instances of the services of two-way TV showing their faces, sometimes a bit obscurely, in modes of electronic communication other than cable TV. This chapter presents a relative handful of such instances with the purpose of highlighting the possibilities for doing the same thing in different ways. Beyond that, some of the factors governing the interconnection and networking of two-way services will be discussed in view of the fact that interconnection is deemed indispensable to the full development of two-way TV.

SLOW-SCAN TV

To begin with, there is more than one way to send a picture electronically. An alternative to the real-time video transmission on broadband channels is the delayed-time video transmission on rather narrowband channels. This latter process is known as slow-scan TV. The process is somewhat analogous to sending a set volume of water through different size pipes: if you use a smaller diameter pipe, you will eventually get the water from one spot to another but it will take longer. In slow-scan TV, the signals are sent at a speed slower than that required for normal viewing so that they can occupy channels of smaller bandwidth.

As the signals accumulate at the receiving end, they are once again assembled together to form the complete picture. Figure 3-1 gives a rough approximation of what takes place. With slow scan, a moving image can be shown as a series of still pictures, or the entire transmission can be recorded and

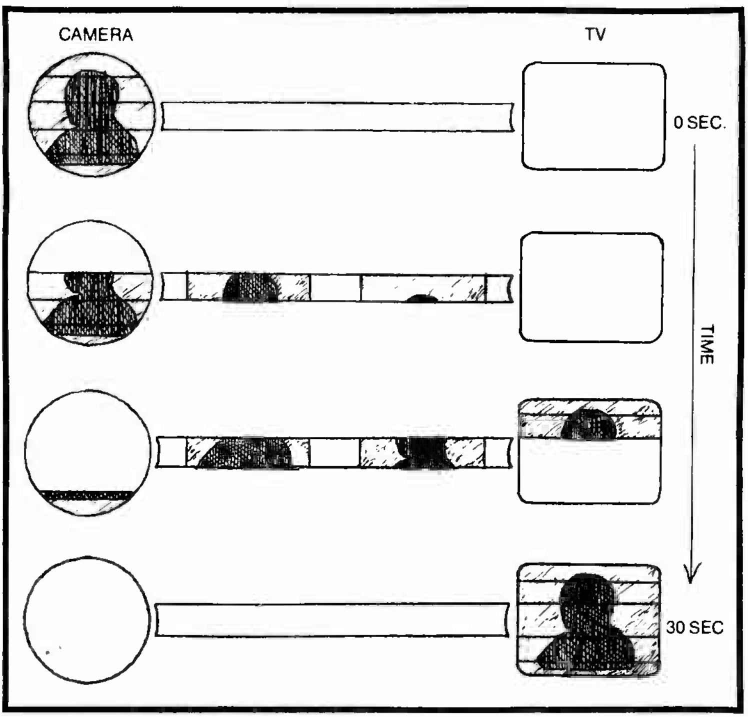


Fig. 3-1. Slow-scan TV takes time for a full picture to accumulate. In general the narrower the channel, the longer the time required for each complete picture to be ready for viewing.

later played back at the proper speed for live action. For example, according to some estimates a 2-hour movie could be transmitted to any home using the same lines as the Bell Telephone System uses for Picturephone over a period of about 12 hours. Later, the movie could be seen in real time with all the fidelity of the original.

Slow-scan TV uses the same type of channels that voice communications do, which is over a 1000 times smaller than the channels required for ordinary TV. Voice-band circuits have been used in many cases to transmit slow-scan TV across the country or around the world. Global Communications (RCA), for instance, has a slow-scan video-voice service which began international service several years ago. The videophone unit is a compact desktop model not much larger than 1 ft^3 in size. It is more commonly used as a means of conferring over documents than as a means of seeing people. Images on the unit's small screen cannot change much faster than once every 30 seconds. Another version of slow-scan TV, one developed by Robot Research of San Diego, allows the picture to change once every 8 seconds, but their picture has only 7 shades of gray and 128 lines of picture information. The video information can, though, travel over ordinary telephone lines since it is coded and converted to audio tones.

While slow-scan TV techniques are not suitable for live moving-picture communication between individuals, they have been found acceptable for security and surveillance services, where visual checks can be interrupted by periods of inability to see lasting several seconds. The use of slow-scan procedures could well be considered in the design of two-way TV systems for services that do not require instant video, and for decreasing channel space requirements or adapting services to telephone lines.

VIDEOPHONE

Real-time point-to-point video communication is probably best known in the form of Bell Telephone's Picturephone, but Bell is not the only developer in the field. Stromberg-Carlson of San Diego, for example, has produced a device called a Vistaphone that can be hooked into the telephone network. The Vistaphone uses a six-pair telephone connection, and has a maximum range of 50 miles without using the special lines that the Bell System uses or Picturephone service. While Bell Telephone leases their equipment to customers, the Vistaphone can be purchased for $2700.[2] The unit has been used to great advantage in Rochester, New York at the National Technical Institute for the Deaf for visual communication between people with little or no hearing.

Deaf persons, in fact, stand to gain greatly from videophone services, being able to use a means of communication previously denied to them. In Chicago, this realization prompted Montgomery Ward to install videophone service in their main catalog store. The video unit is not, though, an actual videophone as such but a combination of a telephone, a TV, and a typewriter keyboard. The keyboard sits in front of the TV monitor and, when a call is made, is the resting place for the telephone receiver. Requests and questions are typed and the answers appear on the TV screen, typed by one of Montgomery Ward's special services operators who take such calls.

Videophones are also manufactured outside the United States and have been most commonly used for the transmission of printed material and artwork. In Sweden, the L. M. Ericsson Company has a successful line of videophone units. In Japan, the Nippon Electric Company is completing work on similar devices. But the most prominent place in the field of videophones goes to Bell Telephone's Picturephone.[3]

Picturephone, the Bell System's trademark title for videophone units, has a fairly long history in this country. Bell Telephone Laboratories actually began tinkering with two-way video communications back in 1930, about 20 years before TV was a national institution. But the technology for a practical real-time system did not evolve until the sixties. A rudimentary Picturephone was shown at the New York World's Fair in 1960 and then remained a laboratory experiment for the rest of the decade. After several trial operations, commercial Picturephone service was finally inaugurated in Pittsburgh in June 1970. A typical Picturephone arrangement is shown in Fig. 3-2, with a camera-monitor, a unit for video controls, and a telephone.

Three pairs of telephone wires are used for Picturephone transmission which allows the video signal a bandwidth of 1 MHz. This is about $^1/_6$ the bandwidth of a color TV signal with a proportional degree of resolution quality. In operation, one of the three wire pairs is used for the voice communications, one pair is used for the video signal going forward, and the last pair is used for the video signal coming in. Outside of local areas, the video signals are digitally coded for efficiency and accuracy of transmission. This digital conversion is

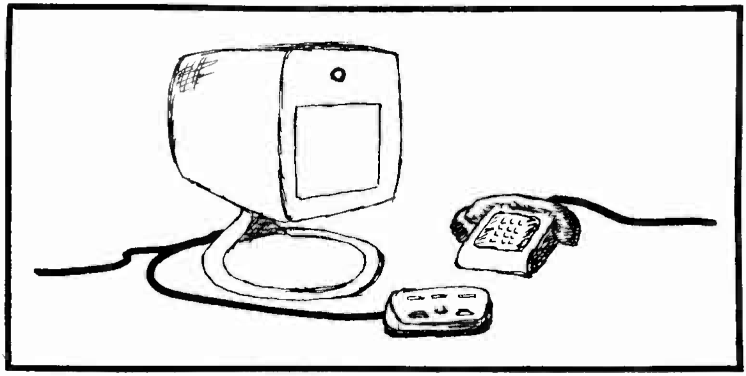


Fig. 3-2. Picturephone. The camera is located just above the viewing screen, and calls are dialed on a Touch-Tone telephone or its equivalent.

accomplished by using a three-bit code to express the numerical differences of successive readings of the amplitude of the analog signal. This is a form of DPCM. The resultant digital stream travels at 6.312 megabits per second.

Picturephone, for the present, is in black and white and the picture is transmitted 3 times a second. Technically, Picturephone has just begun to develop even though considerable work has already been done. Recent trials with CCD (charge-coupled device) crystals may greatly increase Picturephone potential (the CCD is a semiconductor storage element). With a picture stored in CCD crystals in the Picturephone itself, only that part of the picture which changes needs to be continually transmitted, since the part of the picture that does not change is kept refreshed by the CCD crystals. This amounts to a substantial reduction in the amount of video information that must be transmitted and allows for improved service in other respects. Bell Laboratories has also put together an experimental solid-state color TV camera which uses three arrays of CCD crystals. The developers predict that such a camera could be reduced to the size of a 35 mm still camera. Although this might prepare the way for color Picturephone service, Bell spokesmen maintain that there is no commitment to such an outcome.[4]

So far, Picturephone service has primarily been available in Chicago and to a limited extent in Washington, D.C. and in Pittsburgh, where it all got started. In Washington, marketing of Picturephone service was stopped in 1972 due to lack of demand. In Pittsburgh, only 38 units were ever installed and only 5 remained in 1974. Those remaining, moreover, were being used as an intercom system by one company which was beginning to find them too expensive to keep. The costs of $150 for installation and $60 a month for the first 30 minutes of use effectively discouraged applications for the videophones.

In Chicago, however, Picturephone managed to increase its list of subscribers. In the summer of 1972, an 8 sq mi area in the downtown section boasted 80 Picturephone customers with 320 units. Nearby Oakbrook, a Chicago suburb also fitted for Picturephone service, claimed slightly more than two dozen customers. However, since some of the customers were using the videophones only as on-the-premises intercoms, the actual number of exchange lines was 62 in Chicago and 14 in Oakbrook. A later check in 1973 showed that the number of customers had risen to 109 customers in Chicago using 473 sets.

Illinois Bell Telephone has tried to make Picturephone as attractive as possible by reducing rates. The installation charge was dropped completely. The monthly rate was $75 in 1972 and $86.50 in 1973. Illinois Bell has also promoted a number of public demonstrations of Picturephone service.

The Chicago police, for example, began to use Picturephone for connecting Bond Court with at least one district police station. Consequently, the judge setting the bail could see the defendant, and vice versa. In a project sponsored by the U.S Department of Health, Education and Welfare, Picturephone was used at the Bethany-Brethren Community Hospital complex to link two hospitals, three out-patient clinics, and a drug-abuse clinic. Doctors were able to remotely examine patients, examine EKG (electrocardiograph) charts and suggest treatment procedures to nurses at the clinics. Although the physicians accepted the videophones rather slowly, more and more reasons for using the units began to be found. Illinois Bell has also installed a handful of Picturephone booths for public use in several store systems by customers in a beauty parlor, for example, to shop by phone for items in other parts of the store. Despite such marketing endeavors, Picturephone's growth is undeniably slow and difficult. And one of the key reasons may not be the cost so much as the very design. In the few years since Picturephone went public, communications engineers have found that people do not really want to look at other people in the manner provided by Picturephone. For one thing, the impression of being stared at constantly was found to be unnerving. Some users developed the habit of not looking at the videophone while talking.

Another difficulty seemed to be the range of view of the camera. Since a person's face and shoulder tops fill the screen, an unwanted aura of intimacy sometimes developed.[5]

In fact, Picturephone customers would rather use the videophones for showing documents than for eye-to-eye contact. Unfortunately, the resolution of the picture on the video screen was not sharp enough to read a typewritten page. In response, Bell Laboratories produced a whole line of attachments for special uses of the videophones.[6] A wide-angle lens can be added to increase the field of view, or a narrow-angle lens can be used for close-ups, and a zoom lens can take the field of view from normal down to a ½ inch square. A few of the other attachments, including a slide holder that doubles as an EKG holder, are depicted in Fig. 3-3. The zoom lens can be put in backwards to magnify up to 500 times, the EKG reader can magnify 2½ times, and the Picturephone itself can be used as a closed-circuit camera with pan and tilt functions remotely controlled by a Touch-Tone keyboard.

In essence, the Bell System is trying to mold their videophone units to user demand, and not the other way around. In the process, the units will hopefully become more attractive as they become more versatile. Bell Laboratories has more recently been working on ways to use Picturephone as a computer terminal, a slow-scan TV receiver and a facsimile printer as well. Perhaps the most significant improvement on the drawing boards, though, is possible conversion to 525-line pictures. This is identical to the standard for TV in the United States, and means that Picturephone could receive normal TV programs as well as originate them. It would also mean that telephone lines to home Picturephones would have a bandwidth of 4–6 MHz and could possibly carry cable TV on a dial-access basis similar to Rediffusion's method. With cable TV lines and telephone lines both able to carry TV-wide signals, the opportunity would then exist for large-scale interconnecton to provide all manner of two-way TV services. An article in the November 1973 issue of *IEEE Spectrum* concludes that Bell's possible decision to go to 525-line resolution could bring about unheard of forms of communicating in various marriages of telephone and TV systems.[7] Naturally, the Bell System intends to conduct extensive evaluations before making the decision for or against 525 lines.

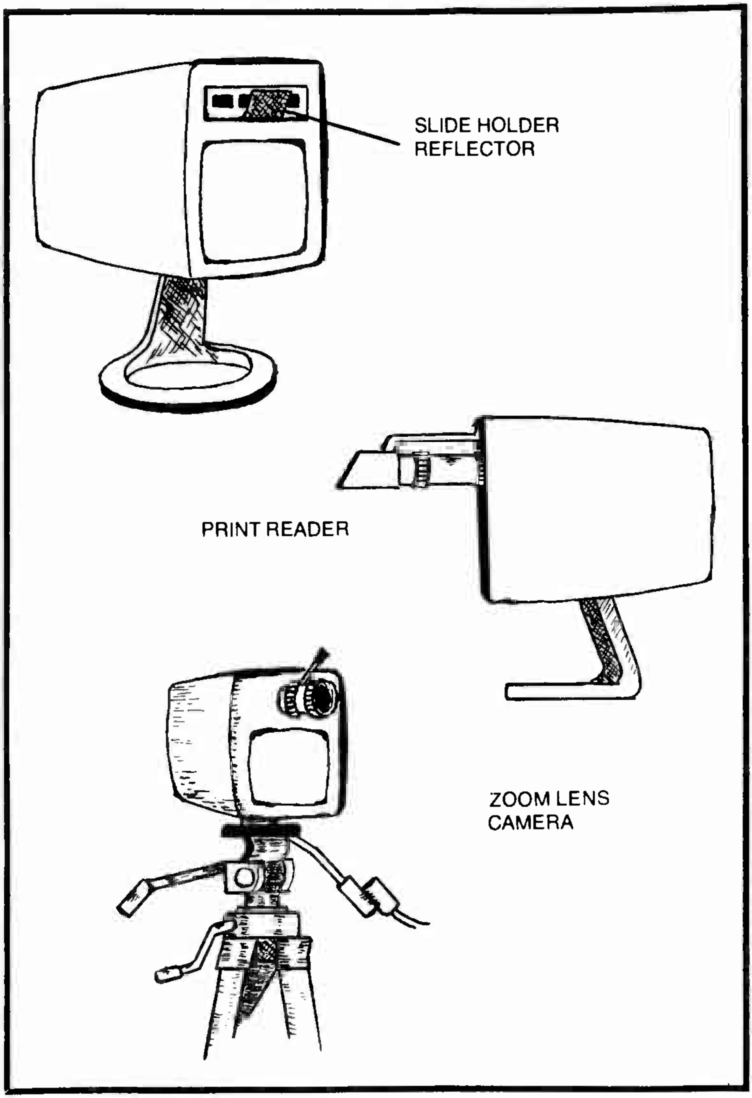


Fig. 3-3. The slide holder includes a reflector to use room light. The "print reader" is a narrow-angle lens on a c-mount which, in effect, magnifies text. A Picturephone on a tripod with a zoom lens can double as a camera.

HOTEL TV

In another type of video service, using two-way TV techniques but essentially a one-way service, telephone company broadband lines have been combined with closed-circuit TV to provide movies on demand. Computer

Cinema of New York, for example, provides movies to hotel guests with a system that employs a computer to control monitoring devices on each TV set. The computer, which could be miles away from the hotel, is automatically alerted by electronic pulses when a guest turns to one of the special movie channels on a room TV. If, for instance, two movie channels are being shown in addition to the standard TV channels, the guest would be able to watch 10 minutes of each movie. Then the computer would take note of the room number, the channel being watched, and the length of the viewing time. When the guest checks out, the desk clerk hands him a computer-prepared bill.

This form of two-way TV, involving minimal interaction, is available in a number of variations for both hotel and home pay TV use. Computer Cinema calls their product MAX (multiple access communications systems). It can additionally be used to awaken guests, alert the desk clerk if someone begins to tamper with or attempt to steal the TV, act as a fire and smoke alarm, and numerous other unspecified variations of metering and monitoring services. The MAX system is readily adaptable to cable TV installations with two-way capacity. Interestingly enough, Computer Cinema is affiliated with Time, Inc.,the prime force behind the pay TV service for cable TV systems known as Home Box Office, Inc.

At the end of 1973, MAX was being used to serve some 25,000 hotel rooms across the country. In the near future, the system was expected to be bringing movies, sports, plays, and nightclub acts to over 40,000 rooms.

Another hotel TV company uses a card and a card reader in conjunction with the TV set. Telebeam Corporation of New York markets a system in which a guest receives an identification card along with a room key when checking in. When the card activates a card reader tied into the TV circuit, not only can pay TV and message services be offered but also the detection of unauthorized entry and open doors or windows. Trouble alarms are relayed to a central console manned by hotel officials.

ELECTRONIC MAIL

One of the subscriber-originated point-to-point services that seems farthest from reality, as opposed to pay TV which is likely to soon adopt two-way techniques, is electronic first-class mail. However, even though it is not available in the home, electronic first-class mail is becoming well known as a service of Western Union. Western Union operates its Mailgram program in cooperation wth the U. S. Postal Service.

Mailgram is a modified point-to-point mail service since intermediary centralized locations must receive the electronic communications. In essence, any teleprinter that is linked to Western Union's computerized network can send a message to the teleprinter that is located in the post office nearest the destination address. There the electronic communication is converted to paper form, removed from the teleprinter, placed in a special envelope, and put immediately into mail pouches for delivery as preferential first-class mail. Since Western Union's philosophy is to supply more than just the transmission facility, its computers can also supply for business customers lists of previously stored addresses for volume mailings. The business customer who sends the same letter to many clients can store messages too, letting the Western Union computer take care of the details of selecting the right contents, addressing the letters, and transmitting them.

During 1974, Western Union expected to have a total of 70 teleprinters located at scattered post offices for the continually expanding Mailgram service. When the service was inaugurated recently in Santa Cruz, California, the U. S. Postal Service introduced it by advertising 3 days of free Mailgram service to the public. A teleprinter was located in the post office lobby. A steady stream of people came to write their letters on a Mailgram form and hand them to the teleprinter operator. The data from the teleprinter was routed to a west coast satellite ground station and transmitted via Western Union satellite Westar to points throughout the nation for next day delivery.

Facsimile is another type of electronic transmission which has been enlisted in the effort to speed the mails. The Postal Service has tried facsimile transmission between Washington D.C. and New York City in conjunction with Graphic Sciences, Inc., Danbury, Connecticut. Documents brought to a transmitting post office are electronically copied and transmitted to a receiving post office, where exact copies of the original can be picked up or delivered by special messenger. Some businesses, of course, have their own facsimile equipment that may be linked into facsimile networks; Xerox Corporation, for example, established such a network connecting company locations in the early 1970s.

Computer control of facsimile networks came in 1974 when Graphet Systems, Inc., began to establish a network in which the electronic signals would be processed by computer "packaging" units. The facsimile transmissions, in digital form, are arranged into packets to be stored, switched, and transmitted at high data speeds. Graphnet's packet-switched network is the first of its kind for commercial facsimile service.

In two-way TV, facsimile can be a competent substitute for teleprinters or for displays that need not be kept on the video screen. Facsimile can likewise be used for the transmission of graphic or print material that would be better and more usable in solid form, that is, on paper, than as a picture on the TV. At low transmission speeds, facsimile can and does travel on telephone lines, arriving at terminals much like the one shown in Fig. 3-4. For home service, a Picturephone line would be ideal for facsimile transmission. A Picturephone network would permit tremendous growth in the present facsimile market, probably primarily in business applications. Such a network combined with the facilities of two-way cable TV could provide many of the subscriber-originated services involving the transmission of reports, papers, news letters, and even electronic mail.[8]

METER READING

Returning to the near end of the plausibility scale, we find the monitoring and meter-reading services. Many of the first

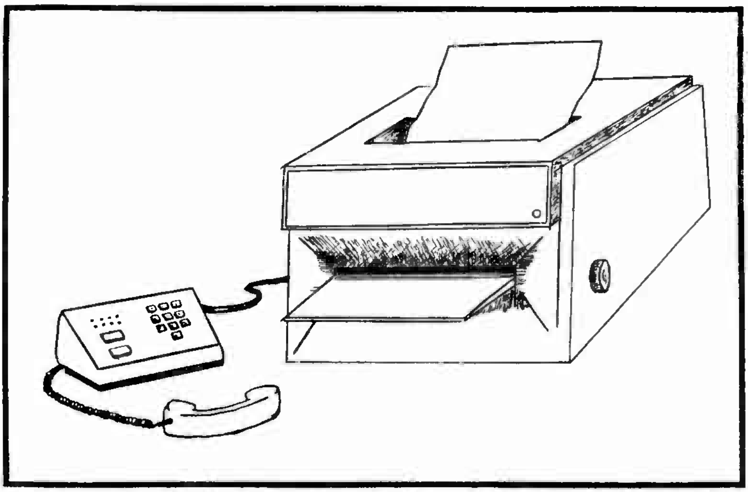


Fig. 3-4. Facsimile customers can place calls to associates and electronically transmit exact copies of print and graphic materials.

two-way cable TV services to be effectively established have been and continue to be in this category. Utility meter reading, while proposed for two-way cable systems, is not very practical unless virtually every home or dwelling is a cable TV subscriber. In view of that fact, various other means have been sought for electronically reading utility meters. One scheme uses the electric power lines to every home. Shintron in Cambridge, Massachusetts, has experimented with this by developing devices to code information at the home and impress it on the power lines without harming either the devices or the supply of electricity. The return signals would travel at the very slow rate of 0.05 bits per second and would be processed out at the power station and fed to a computer for billing.

Other schemes for remote meter reading call for the use of telephone lines. Experiments have been tried in a number of states. Typically, a computer calls each home once a month usually at night. The telephone does not ring. Instead a channel is opened for the computer to accept coded information from devices on utility meters. It would all happen too fast to interrupt telephone service. If the line was busy in the first place, the computer would simply call again later. Add this service to others for printouts in the home, and the homeowner may find his or her utility meters read, a charge computed, and the bill itself inching its way out of a two-way TV or videophone in a matter of seconds.

COMPUTER ACCESS

Access to computer files and functions from the home is another service in the two-way TV spectrum that could not only do without cable TV, but even Picturephone. Ordinary telephone lines would be used and the response from the computer would be spoken instead of being viewed on a screen. An example of a continually updated computer file that can be accessed in this way and is potentially available to a wide number of users is the parts information service provided by General Motors Truck and Coach Division in Pontiac, Michigan. Any authorized dealer seeking information on the availability of engine and body parts may use a Touch-Tone telephone to dial the computer. The dealer then enters the characters**#. The computer replies, "Enter your password number." In a series of such computer-person exchanges, in which the computer does the only talking, a request number and a part number are entered before an appropriate answer is given.

A somewhat similar arrangement, but more flexible and for the use of the general public, was offered in Seattle, Washington by Telephone Computing Service from mid-1973 to December 30 of that year. Anyone with a Touch-Tone telephone could access a computer for personal calculations, to pay bills, to store information, and to be called by the computer under preset instructions to be reminded of something. Subscribers were given a personal seven-digit number and a plastic overlay for their telephone containing such mathematical signs as +, −, ÷, ×, and computer-entry words. When using the system, a customer entered the identification code and then a one-digit code to specify one of six designated categories of services. The six categories were: checkless bill, calculations, home records, personal calendar, income tax, and budget. The checkless bill service covered only certain credit card bills, utility bills, and some department store accounts. It was also only available to people with a checking account at Seattle First National Bank. The income tax and budget services were essentially storage and calculation aids using computer programs to provide the proper organization. All responses from the computer were spoken.

While Telephone Computing Service was in business, they attracted approximately 300 steady customers. One of the reasons for that rather low number and for the early demise of the project was the small number of Touch-Tone telephones in Seattle. Many potential users of the computing service were unwilling to pay the telephone company for installation of Touch-Tone sets. Other problems stemmed from the fact that the procedures for access were too difficult for some, too few merchants were involved (bill paying was the most popular service), and there was a lack of weekend computer time.[9]

Much more extensive forms of computer access include library services that would probably require visual or print feedback instead of spoken responses. Computer-stored libraries have been in existence for well over a decade and have been linked together in networks via telephone company lines or leased lines from other common carriers. A prime example is Bell Telephone Laboratories own library network serving computerized libraries in New York City and in Holmdel, Murray Hill, and Whippany, New Jersey.[10] In addition, 20 or so other terminals are served on an off-line basis. The computer files contained in 1972 well over 120,000 books and 67,000 journals. For library services to be available in the home, ordinary telephone lines would be inadequate—the broader channels of a Picturephone cable or TV cable would be needed. There are, of course, broadband lines operated by several common carriers that can be leased for computer library service to local information centers, but under present rate structures they appear to be more expensive to use than channels on a cable TV system.[11]

NETWORKING

Stepping back from all this activity, and keeping in mind the many faces of so-called two-way TV, it becomes apparent that the services of two-way TV can, and most likely should, take advantage of the various communications channels ranging from narrowband to broadband. Communications needs can be tailored to fit the facilities as well as the other way around. In some areas of the world where communications channels are not abundant, needs can be satisfied by the most feasible of several theoretically possible means. For instance, a device called a "remote blackboard" which reproduces the writing of a sender at the receiving end as the writing is being done can provide many of the same features as facsimile but with the use of narrower channels. At the Bandung Institute of Technology in Indonesia, for example, researchers are quite pleased with the possibilities offered by remote blackboard techniques. In the United States, though, there has been little real enthusiasm for the devices in the past. Perhaps that will change as the devices are perfected. Bell Telephone Laboratories and others are currently working on remote blackboards in which an ultraviolet beam is caused to move over photosensitive film to reproduce writing or drawing.

It is not, of course, necessary to reach as far as Indonesia for an example of the possibilities for offering the elements of two-way TV services over what might be considered limited communications facilities. In rural and isolated areas of any country the principle applies. If the service can be accomplished without broadband transmission facilities, then certainly there is little reason for not doing so. As another example, home purchasing is rated as one two-way TV service definitely needing the broadband capability of cable TV. But Bell Laboratories has been devising and polishing a home purchasing system that will use telephone lines. Although the item to be bought will not be viewable as on two-way cable TV, the success of catalog sales renders that consideration doubtful. In the Bell plan, a card dialer which Bell introduced in 1963 is combined with a Touch-Tone telephone to produce a data terminal which reads holes punched in customer identification cards. To buy an item, a customer would call a store's special number, press a series of item numbers, insert the credit card, press another button to allow the phone to read the card, and hang up. The computer takes the call, adds the cost of the items to a monthly bill, and makes out a shipping order. Bell Laboratories is even working on a way to have the computer recognize each individual customer by voice alone, perhaps eliminating the need for the special credit card.

The key to merging these types of services into the overall design of two-way TV is the careful interconnecting of telecommunications channels or networking. Ideally, customers would want their two-way TV services to be interconnected enough to prevent wasteful duplication, to make the best use of total channel space, and yet to provide ackup means in the event of one segment's failure.

The interconnection of systems into networks and networks into larger complexes is a massive undertaking even when dealing with the same types of telecommunications channels. When talking about the interconnection of telephone, data, and TV networks, it must be realized that some of the problems may only be solved with greatest difficulty.

It is quite possible that some of the present problems and blocks to interconnection will fade into irrelevancy as advances are made in telecommunications methods. A cable TV system is entirely different from a telephone network and yet that does not mean that in the future a subscriber could not have the ability to direct a communication to a central point, to any other given point, or to all points. A cable TV subscriber could conceivably place an audio or visual call to another subscriber with all the ease of making a telephone call but using the cable TV system. With cable TV systems linked to national networks, that call could be made across the country.

In order to explore some of the factors involved, perhaps it would be best to take a figurative pause and look at the major distinctions between wire networks and cable systems before examining why the distinctions may not make much difference in the long run.

Local Level

On the local level, the telephone network is a fully switched facility; any subscriber can be connected to any other subscriber for private two-way communications by means of wires running from one to the other, passing through a switching center on the way. The message switching is accomplished by a vast array of electromechanical and, more recently, electronic switching devices. In a call from one telephone to another served by the same central switching office, one pair of wires is more or less simply joined to another pair of wires and the connection is complete. Outside the local level, many calls are multiplexed together to flow through one large channel and are routed to district and regional switching centers. The long-distance routes themselves are interconnected so that any call will have the option of taking a number of paths, depending upon which is less busy at the time.

Cable TV systems, on the other hand, are completely nonswitched configurations on the local level, with a few exceptions such as Rediffusion's DAP. On the average cable TV system, all signals emanate from one point and are available to all subscribers at all times. The coaxial cable of the cable TV system has been likened to a huge party line—anyone who taps into the line is privy to all the communications on it. Figure 3-5 compares the coaxial cable system to the telephone network. Even though both are composed of trunk and feeder cables, in the TV system the feeder merges with the trunk and in the telephone system the feeder remains independent within the trunk all the way to the switching center.

A handful of cable systems in the United States employ a limited amount of switching. One, called the Discade method and developed by Ameco, Inc., Phoenix, Arizona, uses a local switching unit called the area distribution center (ADC). The ADC units are small and can be spliced into trunk cables to serve subscribers in groups of 8, 16, or 24. The ADC only allows a subscriber to switch from one trunk cable to another, not to an individual subscriber cable for private communications. Each subscriber has a rotary channel selector which send pulses back to the ADC where connection can be made to any one of 10 trunk cables, each trunk carrying two to four channels. Discade's first commercial installations were in Daly City, California and Disneyworld, Florida.

Another partially switched cable TV system is that by Rediffusion already mentioned. The Rediffusion switching centers are much larger than the ADC and more complex. Each unit of Rediffusion switches serves over 300 subscribers, switching subscriber lines to one of 36 trunk channels.

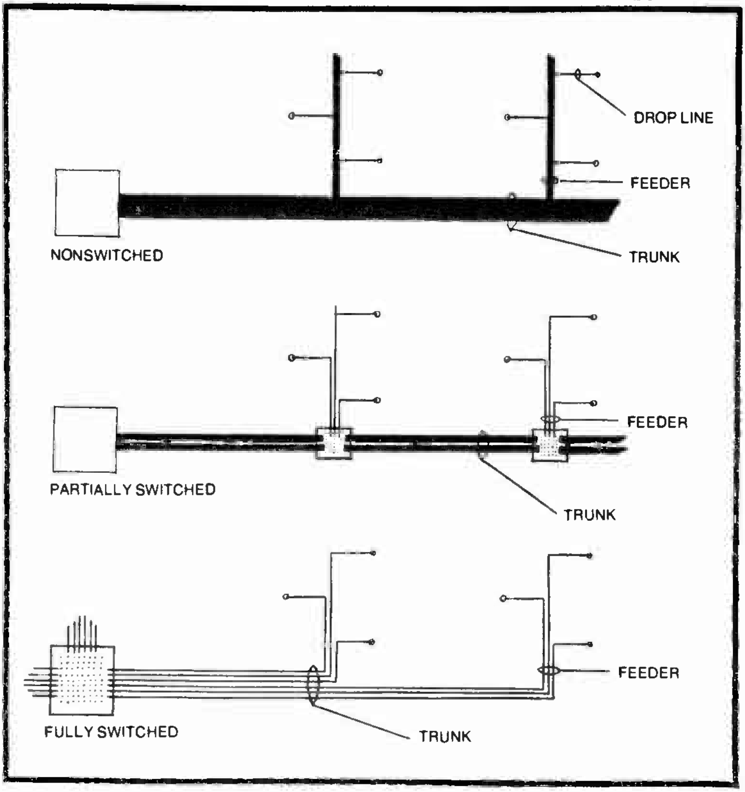


Fig. 3-5. Diagram comparison of local telecommunication distribution routes.

However, with the addition of some rather expensive devices and a little change in the design of the unit, the Rediffusion method could be used for point-to-point communications. The predicted cost, though, would be out of proportion to the benefits in light of the fact that the telephone network exists.

A partially switched cable TV design similar to Rediffusion's but having greater capacity and flexibility is that devised by GTE, which will be discussed in the following chapter.

Having sketched the use of switches for telephone service and the lack of a switched system for cable TV, it must now be admitted that in the future it may be possible to have switched point-to-point communications on the nonswitched cable TV systems. The trick is to use a multitude of unique digital address codes, time-division multiplexing, and a computer processor. At the present stage of development, two-way TV response units can direct digital requests and messages through a cable system to a computer using the interrogation-response methods described earlier. It is not difficult to program the computer to take a message from one terminal and redirect it outward to another terminal, after reading (in the incoming message) a digital address and using it to preface the outgoing message.

And not only digital communications, but TV programs as well can be privately addressed on a nonswitched cable TV system. The Mitre Corporation has produced a variation of its Ticcit design to do just that. Its address gating system, however, is intended for actual TV and not still frames. With the gating system, an address code is inserted into the picture information just before each sweep of the electron beam across the screen. If the address matches an address in a decoder located in the home, the picture passes through. The projected uses for the system include such selected audience attractions as pay TV, but the possibility remains that this could be a step toward computer-controlled point-to-point video communications on coaxial cable systems.[12]

An indication of what point-to-point TV communications might be like are medical systems such as that at Franklin Hospital in San Francisco. There, 22 TV-like terminals are connected in a computer-controlled network. The video matrix terminals (VMT) present only print and graphic information, not live action; information is called up on the VMT screen by pointing an electronic light pencil at coded entries appearing on the monitor. Messages can be entered on any VMT keyboard and directed to any other VTM.

For nationwide point-to-point video service, it has been said that we would need a fully switched 6 MHz system. But that would be an enormous project, both in extent and cost, if it were undertaken seriously with the view of replacing existing networks and systems. Instead, our total telecommunications capacity should continue to be a mixture of both integrated and nonintegrated telecommunications facilities. In an effort to categorize these facilities on a basic level, a National Academy of Engineering report to the Department of Housing and Urban Development (HUD) distinguished four types of networks: (1) a telephone network able to handle voice and facsimile communications, (2) cable TV networks for distributing video programing from central locations and offering limited polling and requesting services, (3) broadband networks for business uses, and (4) municipal sensory networks for such things as traffic control, vehicle location, pollution monitoring, and meter reading.[13]

From the standpoint of activity, these are useful breakdowns—four general ways of using telecommunications facilities. But these categories do not help in the attempt to create the optimum two-way broadband complex because they do not reflect definitive boundaries between actual types of telecommunications systems. The same transmission line can be used for services falling in all four categories; and one type of service can be structured to fit different categories of transmission lines. To fully appreciate two-way TV, the concept should not be restricted to one category of telecommunications or to one type of facility.

When two-way TV services begin to become widespread, there is little doubt that they will be found utilizing the network facilities of common carriers, specialized carriers, and categories of communications carriers that have not yet been designated. Consequently, a discussion of networking would not be complete if it did not go beyond the mere differences in regard to switching to look at the types of telecommunications networks already established. The increasing use of digital conversion continually diminishes the problems of interconnecting among them.

Common Carriers

First, in terms of visibility at least, is the network of the Bell System maintained by AT&T. Besides providing the hardware for some 145 million telephones, the Bell System has heavy investments in digital broadband lines. The most common data channel on the system, the T1 carrier, is designed for a digital speed of 1.5 megabits per second, accommodating 24 PCM voice communications. The next step up, the T2 carrier system, operates at 6.3 megabits per second and is the transmission line needed for the digitally coded signals of long-distance Picturephone calls.[14] If Picturephone service was to expand on schedule (and it looks like now it is behind schedule), a major T2 network would have had to have been installed in the United States by 1980. Other broadband channels, such as the T4 carrier capable of 281 megabits per second, are being perfected and installed. Perhaps the most significant step, for TV in general and two-way TV in particular, is a planned digital channel especially designed for digital (PCM) TV, operating at 92.5 megabits per second.

In order to perform switching operations on the digital signals in the best way possible, Bell Laboratories developed a solid-state electronic exchange known as the 4 S which eliminates the need to convert digital signals to analog form to perform switching functions. Initial installation of the 4-ESS is slated for Chicago in 1976. However, by the end of 1974, AT&T hoped to be completing its first private line digital network spanning the country. In Canada incidentally, a nationwide digital network called Dataroute was put into service in 1973.

Western Union, which is the world's largest communications company for such things as data and facsimile, has been establishing a broadband exchange network for data communications for nearly a decade. The broadband service primarily serves the business community for high-speed data traffic between business machines, including computers.

Western Union also offers an array of computer services, such as those mentioned in connection with Mailgram, using four large-scale computer centers. These centers are located in Atlanta, Chicago, New York, and San Francisco. The computer services include the ability of Telex customers (Western Union) to dial any TWX customer (Bell System), and the ability to join in industry networks, that is, special computerized networks using Western Union lines to link together banks, members of the securities industry, and so on. In addition, network customers can have messages stored and forwarded, files kept and Mailgrams generated. By the end of 1974, Western Union, like AT&T, hoped to have a completely switched broadband digital network serving major cities.

Specialized Carriers

Since 1969, this country has seen the birth and growth of what are termed specialized common carriers. These carriers specialize in high-speed data communications. The first of them to get started was Microwave Communications, Inc., (MCI) with data channels between St. Louis and Chicago. The projected MCI network will eventually serve about 81% of the population and a slightly greater percentage of the business community. The standard data channel (the network also carries analog signals) is 50 kilobits per second but the channels can be upgraded to 20 megabits per second. Microwave Communications is essentially a long-distance carrier and therefore did not plan to build, at least right away, their own local distribution facilities. Instead, local loops would be leased from telephone companies or MCI customers would construct their own local connections between their premises and MCI.

One of the MCI services, the Data Express, is an overnight transmission procedure that is proposed as an electronic means of physically shipping reels of magnetic tape filled with data, a practice that is common with some businesses. Data Express would transmit the reels at 250 kilobits per second over the MCI network, reprinting the data on reels at the receiving end. Hopefully, the service, which was initially available between New York, Washington D.C., Chicago, Houston, and Dallas, would be cost competitive with air freight.

The Data Transmission Company, or Datran, is another specialized common carrier which began by proposing an all-digital switched network to span the country. The completed network would interconnect 35 major cities using computer-controlled electronic switching devices. The intercity links were to have a total capacity of 20 megabits per second and be routed through 5 regional and 50 district exchanges. Unlike MCI, Datran planned to furnish the local distribution facilities as much as possible, using multipair cables, coaxial cables, microwave, or laser diodes in optical systems.[15]

In 1973, however, Datran was forced to delay indefinitely the plans for the switched digital network due to problems in securing adequate financing. Also, the plans for providing the local loops were curtailed because of heavy reliance on leased telephone company lines. Datran, which began service in 1973 with a link between Houston and Dallas, now hopes to have a limited switched digital service with long-distance data speeds of 1.34 megabits per second on wideband infrared channels.

Besides MCI and Datran, there are at least a dozen other companies with proposals for specialized networks awaiting FCC approval. Some, like Western Tele-Communications, Inc., have major interests in cable TV. Figure 3-6 shows the proposed Western Tele-Communications network along with those for MCI, Datran, and the network computer centers of Western Union.

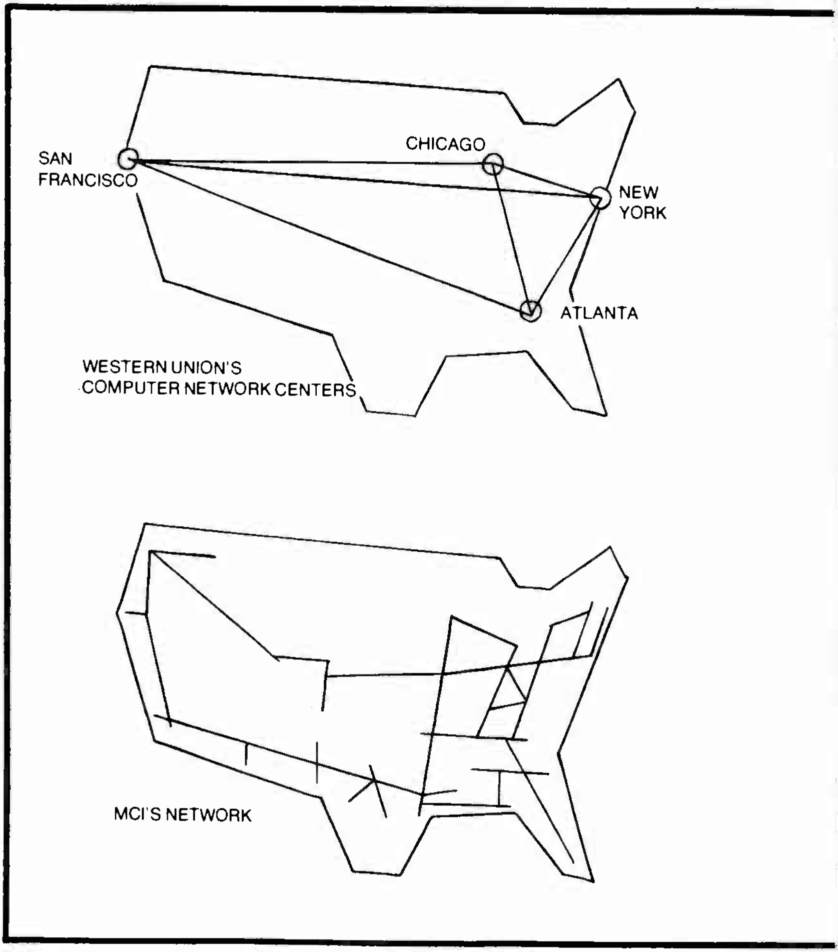
Multipoint Service

On the local level, another specialized carrier has been authorized by the FCC in the last several years which has hopes of capturing urban business markets before cable TV systems try to do the same thing. This new service, Multipoint Distribution Service (MDS), uses point-to-point microwave over short distances. The microwave channel is 10 MHz wide, allowing for a full color TV channel and a wideband data channel. To preserve privacy and make the microwave system a true point-to-point service, the signals can be scrambled and unscrambled by authorized parties. The maximum range of MDS is about 25 miles.

In an urban setting, complex MDS line-of-sight links could elbow out cable TV in the move for business markets such as data exchange, hotel pay TV, and medical TV systems. The development of MDS need not be in competition with cable TV, though. There is nothing to prevent cable TV operators from incorporating MDS into their systems. Several cable owners have, in fact, sought licenses. As an interesting sidelight, when the Microwave Corporation of America demonstrated their MDS system in New York City, they used the studios of the Home Box Office (subsidiary of Time, Inc.) to prepare the video transmission.

In the first months of operation in New York, Microwave Corporation MDS links were used by a brokerage house that wanted to bring personalized stock reports to several banks and insurance companies. Each morning an on-camera spokesman would present pertinent stock market information and then field questions from the remote audiences. One of the early proponents of MDS was Motorola, which used the service to bring first-run movies to Washington D.C. hotels. Other users have been the American Law Institute, for bringing extension courses to selected law firms; and the Black Vanguard Association, for bringing minority programing to certain apartment buildings.[16]

Since MDS is just beginning and many major cities have not been cabled for TV, it is impossible to describe the impact of one on the other when it comes to intracity business and educational broadband communications. Some authorities believe that there is enough potential business traffic to support both, while other commentators see cable TV as merely a residential medium and MDS as a business medium. A third possibility is that MDS will get the jump on cable in the large cities in regard to business and institutional uses, but will eventually give way to advanced cable systems in the long run. If the past history of telecommunications is considered, though, it is more likely that one medium will not cause the



downfall, or seriously hamper, the other; instead, if there is conflict, each will manage to stake out an area of interest.

An unknown variable in the future of MDS and cable TV alike is the domestic communications satellite, which cannot only provide long-distance links but also complex switching functions for points that may not be that far away from each other on the ground.

Domestic Satellites

Communications satellites are essentially relay stations floating high overhead. Signals beamed up can be beamed back over an area as wide as a third of the globe or as narrow as a few hundred miles. Consequently, the opportunities for

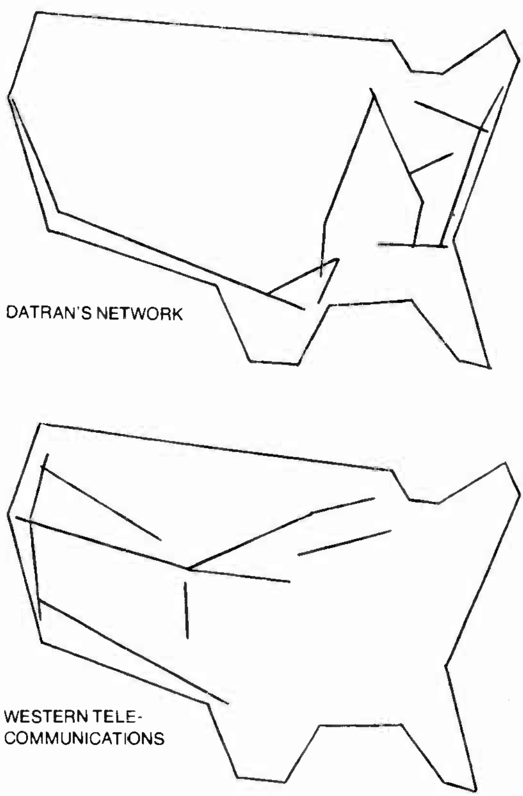


Fig. 3-6. A common carrier's special service network and several specialized common carrier networks as they have been proposed.

ground stations to join networks and for satellites to eventually engage in complex switching are nearly limitless. The comment has been made that satellites, unlike ground switching centers and exchanges, can be replaced every few years with better and better equipment as easily as launching a rocket.

For two-way communications, including slow-scan TV and digital TV, domestic satellites are likely to be most useful for linking isolated points such as islands, remote settlements and ships at sea. Experimental satellites launched by the National Aeronautics and Space Administration (NASA) have been used in the Pacific since 1971 for an educational and social network called Peacesat. Centered at the University of Hawaii, the network includes low-cost ground terminals at the University of the South Pacific on Fiji, the Polytechnic Institute of Wellington in New Zealand, and at other institutions on Saipan, Truk, Papua New Guinea, and other islands. Students and teachers have used the network to engage in two-way voice, facsimile, Teletype, and slow-scan TV experiments.

In Alaska, the same satellite has been used by paramedical personnel in remote villages to confer with physicians at hospitals in Fairbanks and Anchorage. In 1971 and 1972, another experimental satellite was used for two-way computer links to bring computer-assisted instruction to an American Indian pueblo near Albuquerque, New Mexico from Stanford University.

Commercially, a maritime network is being prepared by the Communications Satellite Corporation to provide a wide variety of two-way communications, including digital TV, to ships at sea. The use of a satellite permits communications free of the radio-frequency (RF) interference that plagues much of present maritime communications. For shipboard use and other remote applications, Comsat Laboratories has developed a digital satellite terminal that fits into a housing about the size of a refrigerator and uses a portable 15-foot antenna.

Generally, though, in populated countries domestic satellites will provide telecommunications links only to larger terminals or distribution centers. Canada, the first country in the world to have a domestic communications satellite in geostationary orbit (that is, at 22,300 miles high in the equatorial plane a satellite remains more or less fixed over one spot on the earth's circumference), uses its satellites to link both large and small distribution centers. In the populated lower part of Canada, the Anik I and Anik II satellites carry all forms of telecommunications between a small number of very large earth stations; in the far north, however, the satellites bring telephone and radio communications to a large number of rather small earth stations.

Domestic satellites for the United States were not a reality until April 1974 when Western Union's Westar I was launched into orbit. In June, Westar II was to be launched giving Western Union a total of 7200 two-way voice circuits or 12 TV channels. The satellites relay communications among five earth stations distributed across the country. Additionally though, Western Union allows customers to use its own earth stations to communicate with Westar. Another satellite service has been in operation since early 1973, but the channels have been leased from Telesat Canada, the Canadian system. The company who leased the channels, Globcom (RCA), expects to launch their own satellites within a year. The American Satellite Corporation, a subsidiary of Fairchild Industries, once also planned to orbit its own satellites but now leases channels on the Western Union satellites. A summary of these and other domestic communications satellite plans is given in Table 3-1.

With the proliferation of domestic satellites, the interconnection of telecommunications facilities becomes easier. Cable TV systems as well as MDS systems and specialized common carriers could form their own networks or share networks. Earth stations are on the commercial market for purchase by any interested company. Scientific-Atlanta, Inc., manufactures a line of small earth stations with 25-foot dish antennas that sell for $100,000.

In a dramatic gesture, Teleprompter Corporation provided the first instance of a cable TV and domestic satellite union for the 1973 convention of the National Cable Television Association (NCTA). The earth station used was the mobile model produced by Scientific-Atlanta; the entire station was mounted on a single tractor-trailor. Programs were relayed by Canada's Anik satellite from sources on the east coast to the convention site in Anaheim, California. Some of the programs were speeches by political figures in Washington D.C., a

Table 3-1. Domestic U.S. Satellite Networks

Company	Status
Western Union	Satellites launched April, 1974 and June, 1974
RCA Globcom	Lease channels on Canadian satellites since January, 1973; to launch own system soon
American Satellite Corporation	To lease channels on Western Union's satellites late 1974
GTE Satellite Corporation	To lease channels on satellites owned by Hughes Aircraft Co.
American Telephone and Telegraph	To launch own system with the Communications Satellite Corp.
IBM Corporation	To launch own system with Comsat General Corporation

sporting event from Madison Square Garden, and films and shows from the Canadian Broadcasting Corporation studios in Toronto. The programs were not only viewed by convention delegates but also by subscribers to cable TV systems in Long Beach and Newport Beach, California.

The demonstration of cable-TV-to-satellite linkage was impressive but, in retrospect, ahead of its time. The cable TV industry was simply ill prepared to bear the high costs of installing satellite networks in the face of little proven benefit. The major cable TV companies did not exactly abandon satellites, though, even if they could not seriously consider the idea as an imminent possibility. Together they formed a consortium to study the matter funded by relatively nominal contributions of $1000–5000 apiece. Earlier plans by Hughes Aircraft Company to bring over 100 cable TV systems into a satellite network by 1975 have been held in waiting, pending change or modification.

The biggest question facing satellite-cable networks is what they will accomplish. At first, proponents thought that satellite-linked cable systems could become new networks to rival ABC, CBS, and NBC. Certainly such a network or two linking most cable systems would have substantial appeal to national advertisers. But the creation of another ABC, CBS, or NBC seems to be counter to the supposed potential of cable systems for meeting local needs. The advantages of satellite use may perhaps be more in line with two-way TV services than with conventional TV network programing. Martin Seiden writes in *Cable Television U.S.A.* that the real benefit of satellites for cable TV will be in new possibilities for services.[17] Some two-way TV services that require large-scale computer facilities, like computer-assisted instruction and information files, could benefit greatly from satellite interconnection. Data bases and computer hardware would not need to be duplicated across the country. Furthermore, independent companies could concentrate on the development of a single service or group of related services and be able to lease channel space from cable operators in numerous cities. In effect, for some services cable TV subscribers nationwide could share the same advantages of the subscribers of a single, rather advanced system.

An upcoming experiment that might answer some of the questions about satellite-to-cable-TV links is planned for 1975 using the Applications Technology Satellite launched by NASA in June, 1974. The satellite will be used to bring health, education, and training programs to 23 states, largely in the Rocky Mountain and Appalachian Mountain areas and Alaska. Ground stations will be relatively small and placed at 68 scattered locations; ⅓ of the ground stations will have two-way capability. Cable TV systems will be carrying the programing both from ground stations at their own head ends and from ground stations of the Public Broadcasting System.

The trend toward more and more digital processing of telecommunications and the growth of overall channel capacity in networks both augur well for two-way TV services. Interconnecting and sharing of narrowband and broadband facilities will provide a variety of services in a variety of ways. Telephone, facsimile, data, and TV signals traveling the pathways of common carriers, specialty carriers, and cable TV can be interwoven to produce the best use of each. By rising above the confines of diverse communications systems and services, the full development of two-way TV is only a matter of time.

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Chapter 4

More Two-Way Cable

The time was not right for two-way cable TV in 1971, it seems, and indeed during most of the next 2 years. Problems with regulation changes, inadequate equipment, scant financial support, and industry-wide economic distress all helped dull the picture for two-way cable TV. After the first flurry of two-way activity in 1971, the action moved backstage for more rehearsal. The headline-catching public demonstrations were replaced by sobering searches for monetary support and technical perfection. Rediffusion moved to the institutional market—Sterling cast its lot with pay TV. Both Telecable and Mitre devoted several more years to planning before again designing pilot projects. Teleprompter, which did not actually conduct public demonstrations in 1971, ended the Los Gatos tests and joined with Theta-Cable to prepare a pilot project that has yet to begin.

During 1972, only two other major cable companies ventured into the ring of two-way TV and they did so with noticeably cautious steps. The Denver-based American Television and Communications Corporation (ATC) conducted a pilot project in Florida and LVO Cable of Tulsa, Oklahoma (now United Cable Television Corporation) did two-way testing in Illinois. Both projects were terminated within a year or so with indefinite renewal dates.

TWO-WAY IN ORLANDO

The 1972–1973 two-way TV project in Orlando, Florida did not attempt to test audio or video response services; instead, ATC concentrated on services that only required a small number of response buttons on a digital home terminal. The two-way experimentation, announced in March and begun in May, eventually involved 25 two-way terminals in homes, schools, and offices. No services were actually activated, but the tests and demonstrations showed that the system was technically able to handle shopping at home, opinion polling, channel monitoring, pay TV, security services, inventory control, cable system fault monitoring, and credit card verification. For example, in the latter case, a terminal was located at a service station to allow an attendant to digitally check a customer credit card using the cable TV system.[1]

According to Edward J. Callahan, ATC director of engineering and development, the initiating of two-way signaling was not easy. It was found that the entire Orlando system had to be refitted with additional filters and shields to prevent signal loss and interference. The size of a return area also had to be limited to prevent the accumulated electrical noise from the terminals from obliterating the digital information on a return channel. Based on the Orlando situation, Callahan estimated that a community of 300,000 two-way TV sets would require 17 separate return areas, each served by three return channels of digital information.

The problems encountered in Orlando with signal loss, interference, and electrical noise on the return channels are fairly representative of the technical difficulties facing any two-way cable TV installation. Most cable systems that have been constructed for any length of time were installed with hardware and procedures that are simply not compatible with computer-controlled two-way services without extensive modification. The installing and physical placing of cables, the cables themselves, connectors, taps, plugs, and other hardware can all contribute to the disruption of return-digital channels.

The technical problems can be overcome, as ATC demonstrated, but the time, trouble and cost of refitting inadequately constructed systems is substantial. The full impact of the technical difficulties involved in bringing two-way services to existing cable systems first began to make itself felt after the 1971 demonstrations and was a contributing factor to the delay of most two-way TV projects for the next several years.

After overcoming the engineering problems in Orlando, ATC did conduct tests of services that added to the emerging picture of two-way TV by suggesting methods and practices that had not been publicly tried before. Although the response unit was a familiar enough keyboard, the unit housing the digital circuitry was located outside the home or office and served up to four subscribers per unit. The digital units were connected by separate lines to any alarms, meters, or other sensory devices that might be providing feedback in addition to the keyboard. This physical removal of the circuitry for two-way services from the vicinity of the TV set suggested a complete division between two-way service and TV. Conceptually, two-way services, especially those merely involving monitors or sensors, then became a class of its own irrespective of the wire or cable that brings them to the home. Whether or not the Orlando arrangement was more a product of technical considerations than design philosophy, the idea of

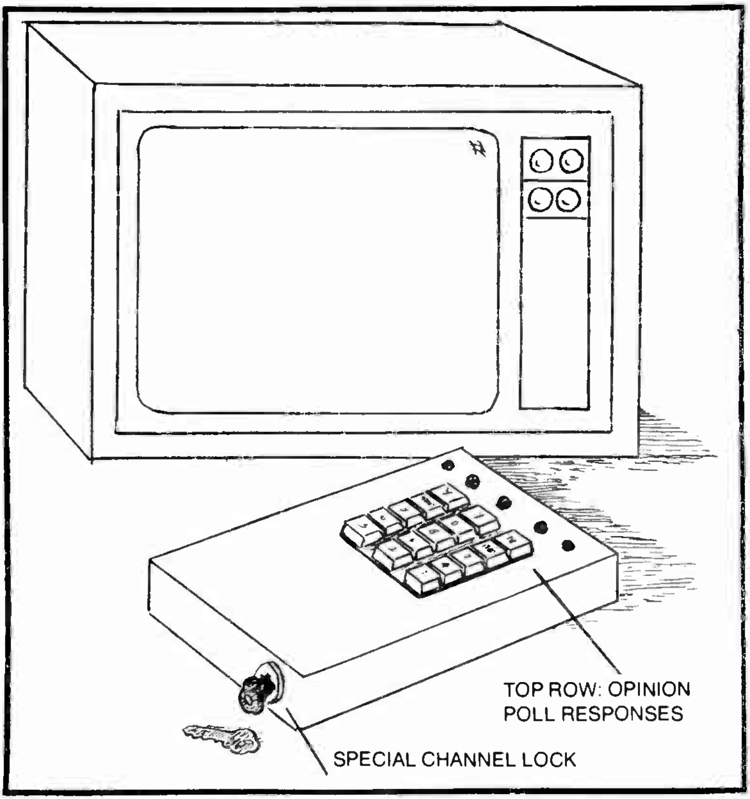

Fig. 4-1. American Television and Communications Corp. used a response unit developed by Electronic Industrial Engineering, Inc., which contained a key-lock for access to special channels.

divorcing two-way services from the TV set is a distince rival to the unitary concept of the two-way TV.

Even the relatively simple keyboard, shown in Fig. 4-1, which was developed by EIE contained a hint of alternative approaches to two-way services. Besides the 10 alpanumeric buttons, the keyboard contained a keyhole: to receive the pay TV channel, a subscriber must insert a key. Pay TV in that case is not then a two-way service. The two-way response unit simply becomes the housing for a mechanical device that did not happen to be included with the original TV set. In a similar way, the response unit of any system, especially if it is physically separate from the TV set, can be used to bring into the home any sort of switch or circuit that will influence nothing outside of the home.

As an experimental project, the Orlando demonstrations did not use a full-size computer to interrogate terminals at high data speeds. A minicomputer was used operating at the relatively slow rate of 42 kilobits per second for the forward signals and 675 kilobits for the response signals. (The use of a minicomputer does not of itself imply the slow operating speed of the system: minicomputers have been more than adequate for large two-way cable systems operating at 1 megabit per second when such use has been electronically simulated.) Eventually, the Orlando system was to operate at 1 megabit per second, which has become the apparent standard rate for digital signaling on two-way cable TV systems.

The organization of the bits in the digital signals showed an attempt for flexibility and a high return capacity. For example, the interrogation signal had an option for including the bits for a *command word* which could perhaps be used to activate or open up a limited access channel. A large number of bits in the response signals were likewise available for optional services or messages. Bits, of course, were also required for the digital address codes and to keep the data stream flowing properly. Consequently, the bits in each interrogation-response sequence were assigned as follows:

Bits	Interrogation	Response
Synchronization	5	
Address	15	15
Parity	1	1
Command (optional)	15	
Parity	1	
Information		112
Total	21–37	128

In the response signal of 128 bits, 15 were used for a command signal, 3 for opinion polling (*yes, no, no opinion*), 6 for alarm monitoring, 24 for channel monitoring (1 bit per channel), and 64 reserved for later use. Although the large number of reserve bits suggested a wide range of possibilities, the bit structure for the specific services mentioned indicates that the simplest structures possible were used, allowing only the minimum amount of information necessary to be returned.

Each remote unit tested in Orlando cost nearly $1500 but ATC predicted that mass production would reduce the cost to 1/10 of that. Since each unit was designed to serve more than one subscriber, it was not clear how users would be assessed charges for installation of the two-way units if a charge were to be made. It was also not clear what percentage of the Orlando population was expected to subscribe to two-way services since a single computer center would accommodate only abut 32,000 customers.

During the summer of 1973, ATC retained the engineering and consulting firm of Arthur D. Little, Inc., to design an active two-way TV system that could service 100,000 homes. The basis of the project was to be shopping at home services. One channel to each home would be reserved for advertising of products that could be bought instantly by subscriber-initiated responses from a keyboard. The shopping service was to get under way by the end of 1973 but instead was postponed indefinitely. One of the reasons given by American Television's Callahan involved the response units; the manufacturers of home terminals as a whole took the devices back under their "corporate wing," he explained. Also, ATC began seriously evaluating pay TV as a more likely way of attracting revenue at less cost. Although in mid-1974 the company had not made a final decision on either two-way services or pay TV, both continued to be given careful study.

The project that was postponed, the shopping service, would have been a singular accomplishment in that it would have culminated several years and $370,000 worth of research by the Arthur D. Little organization, Cambridge, Massachusetts. The interest of A. D. Little in two-way TV can be traced back to 1969 when a senior staff member, John Thompson, served as chairman of an Electronic Industries Association (EIA) Committee on two-way cable. He became intrigued by the subject and its potential.

Together with Bradford Underhill, another A. D. Little staff member, Thompson drew up a plan for a market test of two-way services based on a broad concept of two-way TV.[2] They offered the plan to the EIA but were told that the plan cut across so many spheres of influence that antitrust suits might be brought against it unless numerous companies acted as sponsors. Subsequently, A. D. Little began soliciting diverse companies and business concerns to join in the project. Eventually some 40 business organizations, including at one point Time, Inc., and the *New York Times*, decided to support the venture although not all continued to stay in the project.

The first part of what was a three-part plan to establish two-way TV service was begun in June 1970. This initial phase consisted of a market survey aimed at discovering the feasibility of and demand for various services. The investigations covered meter reading, home protection (alarm monitoring), shopping at home, real estate listings, reservation systems, computer-assisted instruction, electronic newspapers, pay TV, and several business and government services. During the survey several additional specific two-way TV services came to the attention of the researchers; namely, consumer shopping guides, personal use of a computer, instant news service, a classified ad service, and data storage.

After a year of studying and surveying, which had already cost the project sponsors $500,000, three individual two-way TV services were indentified as probably profitable in a beginning two-way TV system. The survey also named as second-generation services pay TV, educational programing, additional shopping services, audience participation activities, and business and government services. The exact nature of the first three services, however, was considered confidential information and the exclusive property of the participating members.

Several months later, the second phase of the project, the final business and engineering planning, commenced. During this time, it became clear that two or three different models of home response terminals would be desirable and that certain services should only be offered to selected groups in any location. The entire project was aimed at constructing a pilot project of 10,000 home terminals to convince the investing public that widespread development of two-way TV was economically sound. During this phase, the names of several likely spots for the demonstration system were to be determined.

In the final phase, an operating company known as Broadband Communications Network, Inc., (BCN) was to be established to select the project site and build and maintain the system of two-way services. In all, A. D. Little estimated that the consortium of companies supporting BCN would have to invest a total of $20 million to get the project going.

The final phase was never reached. In its place, A. D. Little presented a study of the findings, officially concluding the project in October 1972. The report concentrated on four types of services and presented detailed plans for their implementation. The four services were shopping at home, computer-stored information, pay TV, and an audio library of 1000 records. In the first category items could be ordered at home, programs by consumer advisors would be presented, and coupons would be given for discounts when shopping in stores. The second category included computer-assisted instruction as well as news, stock reports, and classified ads. The list of participating companies who shared the research produced by A. D. Little was never made public; consequently, the BCN study, even though it did not lead to an operating company, may have unrecognized effects on other two-way projects. According to John Thompson, two-way cable TV equipment manufactured by the Magnavox Company was based on A. D. Little's findings, and the Theta-Com project in El Segundo, California was related to the BCN studies.[3] Quite likely, the background material produced during the several years of research will surface in other public installations of two-way services and systems at a later date.

LVO IN CARPENTERSVILLE

A rather restricted test of two-way TV services was instigated in the summer of 1972 by United Cable Television Corporation, then called LVO. Announced in February, the testing actually got underway several months later in the Carpentersville-Crystal Lake area of Illinois northwest of Chicago. A total of six homes were equipped with digital terminals designed by Scientific-Atlanta, Inc. Essentially, the project was a test of monitoring services that could operate independent of any subscriber action. Homes were fitted with "black box" containers of digital circuitry, such as the one shown in Fig. 4-2, with no outside controls, dials, or buttons.[4]

The major emphasis was on security applications. A partner in the two-way project was Oak Security of Crystal Lake, who supplied the security devices which would trigger the digital signals. In effect, a computer continuously

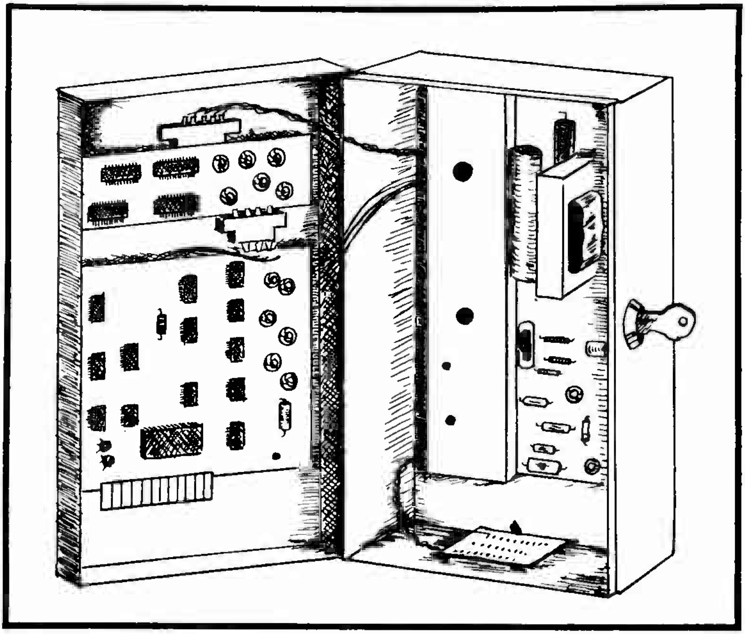

Fig. 4-2. The LVO experiment was based on "black box" monitor units for automatic emergency and security alarms.

interrogated all terminals. If an alarm device had been activated, the digital unit would return a positive pulse to the computer. The positive pulse would alert the computer and allow additional information to flow from the two-way unit to the processing center. The presence of smoke, fire, or an intruder would then be determined. In the first two cases, a printer located at the nearest fire station could automatically begin to type out location details. In the latter case, a printer at police headquarters could perform the same function.

Less emphasized was a test of channel-monitoring procedures. The computer processor could keep tabs on the total number of sets watching a certain channel at any given time. But the computer would not be able to determine exactly which homes were watching which channels, a feature that the LVO management considered essential for preserving the privacy rights of individuals.

The system was also tested in a minor way for opinion polling and subscriber control over limited-access channels but no services as such were offered. For opinion polling, Scientific-Atlanta developed a handheld response unit with three buttons (*yes, no, no opinion*) and a slightly more flexible converter model, shown in Fig. 4-3, with three buttons, a *clear*, and a key-lock switch.

The experiments were eventually phased out because of technical problems with the cable system and because, more importantly, it was determined that the services could not be economically maintained. Since the services were largely based on security needs, an increased demand for protection by cable subscribers had to have been present. Unfortunately for the experimental project, the Carpentersville crime rate was later discovered to be one of the lowest nationally. According to Kip Farmer, Coordinator of Subscriber Services for LVO, the low crime rate accounted for the fact that subscribers did not seem interested in the two-way security services.

After the project had been phased out, the management of LVO felt that pay TV would probably be the only profitable use of two-way capacity, but that pay TV by itself could not support two-way techniques. In fact, LVO concluded that a whole range of two-way TV services would have to be offered to make the system work. In the opinion of one official, the company was no longer prepared to be involved in two-way TV before 1976 or 1977.[5]

Even though the Carpentersville test was phased out, the equipment and system design developed by Scientific-Atlanta is commercially available. Therefore, it might be helpful to look at some of the system's features.

An examination of the digital construction of the computer-controlled signals shows a very simple design, which was chosen to allow for extremely rapid interrogation sequences. Relatively slow interrogation sequences would be

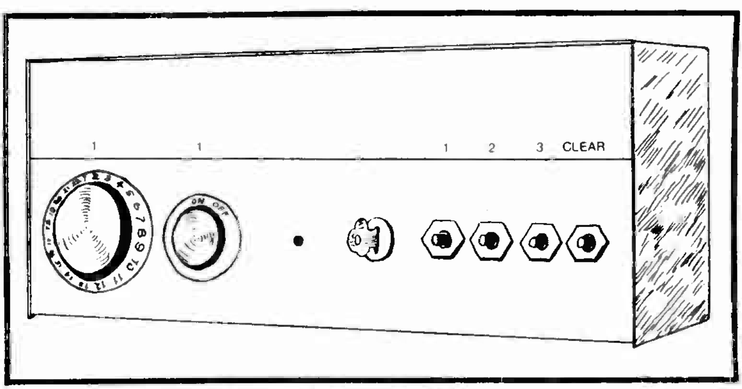

Fig. 4-3. The Scientific-Atlanta Series 6400 subscriber terminal incorporates a key-lock switch, three data buttons and a clear button.

of limited use in security services, especially in regard to fire detection. The organization of bits was as follows:

Ready	1
Address	13
Unused	2
Total:	16 bits

The ready bit, always sent out as a one from the computer, was used to instruct all two-way units to be ready for the next address in the digital stream. The unit would become ready by automatically resetting an address comparator. As the next coded address was transmitted, it was compared bit by bit to the address built into the two-way unit. Eventually, the address coming from the computer would match only one two-way unit; the others would then be reset to a blank condition prior to the arrival of the next addressed interrogation.

At the responding unit, a lamp would go on to let the homeowner know that the device was functioning properly. If no alarm condition existed, the unit returned a 275 kHz pulse to the computer; if one or more alarms had been activated, the unit would return a 225 kHz pulse. In the latter instance, the computer processor would immediately come back with five 12.5 μsec (microsecond) data strobe pulses, spaced every 100 μsec. The two-way unit would convert the five pulses to a five-bit code containing information on the type of alarm. This digital code is returned to the computer at 225–275 kHz using frequency-shift keying, that is, using one frequency to indicate a zero and the other to indicate a one. It would then take the computer about ½ second to print out subscriber address, alarm code, and time of reception.

Scientific-Atlanta has continued to develop the system and has incorporated into the design a measure to minimize the effect of interference or electrical noise. Each time the central control unit interrogates a response terminal and does not receive the normal response, the central unit commands the terminal to respond twice more. All three response codes are compared and if they are not identical, it is likely that the initial response was due to electrical noise and was not an alarm code. In such cases, the printout at the control center would indicate that a false message was received.

The five-bit structure of the responses from the home terminals is not as limited as it might seem. The five bits can be used in combination to indicate codes based on the octal number system, in which case 32 different levels of one input could be determined and indicated. With the addition of other circuitry, the system could be used to transmit 20 data bits, the data being accepted by the computer in four successive interrogations.

The two unused bits in the interrogation signal as it was designed for Carpentersville were included for later use, possibly in a pay TV operation. They could also be used to increase the total number of subscribers that can be served by a single computer center. For example, if the two bits were used for a service, such as sending a command to the home terminal, the system would serve slightly over 8000 subscribers; but if the extra bits are used to increase the capacity of the system, nearly 33,000 subscribers could be accommodated.

The time required for each interrogation sequence would vary according to the distances involved, the total number of two-way units, and the number of units reporting an alarm at the same time. Under average conditions, the terminals in Carpentersville were interrogated once every 5 seconds. This seemingly slow rate was due to the fact that the Carpentersville system operated at a bit speed of 160 kilobits per second, as compared to the 1 megabit rate employed by other systems.

Some of the technical problems found in Carpentersville were similar to those found in Orlando. Although the Carpentersville cable system offered very good standard TV service with 21 channels of regular programing and a weather channel, the move to two-way communication brought additional technical requirements. The housings for the amplifiers and signal controls throughout the system were found to be improperly shielded with respect to radiation, the design of cable connectors sometimes prevented adequate contact with the aluminum shield in the cable, and cable drop lines were sometimes found to have defective electrical termination. All of these difficulties had to be corrected to reduce the noise and spurious radiations affecting return-digital signals.

The return bandwidth itself, 5–30 MHz, was found to exhibit unwelcome characteristics at certain points in the bandwidth. For example, signal interference occurred from 5–15 MHz with minor interference up to 20 Hz, but 7 MHz and 8 MHz remained essentially clear. The interference varied, as radio waves do, with moon and sunspot cycles and with the progression from day to night.

It should not be surprising then that two-way TV hampered by technical problems and beset by tight money, retreated from the marketplace during 1972–73. The Orlando and Carpentersville tests were representative of the few new public two-way cable TV experiments in this period. A glance at Table 4-1 shows that these two projects were also limited in scope in that no attempt was made to test return-audio or return-video services with active subscribers.

Two-way TV was far from forgotten though. Research and development continued on projects that began to appear as public demonstrations in late 1973 and 1974. A hitherto unmentioned company, Tocom, Inc., brought its two-way TV system to a state of readiness during this time and subsequently won several contracts for installations in retirement communities. Teleprompter continued to assist Theta-Com in pursuing two-way experimentation in El Segundo. Mitre Corporation launched a community college two-way TV project independent of the Stockton plans. Several

Table 4-1. Two-Way TV Features—1972

	ATC	LVO
Return digital	yes	yes
Return audio	no	no
Return video	no	no
Response unit	10-button alphanumeric keyboard	3 buttons

other two-way TV programs were similarly making modest gains in experimental enviroments as the middle of the decade approached.

TOCOM

The Irving, Texas firm of Tocom, Inc., made the decision in 1971 to begin to develop two-way TV services after nearly 20 years of involvement with cable TV. The decision was based in part on the company's supposition that it simply had no way to expand in the conventional cable TV field. In order to save itself from stagnation, the company viewed the production of a two-way cable TV system as practically a survival necessity.[6]

The work on the two-way design began without delay. By April 1972, Tocom felt confident enough to enter into an agreement with the city of Irving for an extended test of two-way TV services. The contract, which included the construction of the basic cable system, set forth specifications for the two-way test. The contract stipulated, for instance, that the two-way pilot project was to last 2 years and that subscribers would not be required to pay fees for installation or for regular TV programing. The additional services, the two-way features, were to be the only source of subscriber revenue. The elimination of the usual fees was instituted to encourage the high percentage of subscribers deemed necessary to make the two-way services practicable.

After the Irving project began, Tocom, which owned and operated three other cable TV systems, found it expedient to step back from the role of owner to that of supplier. In order to raise funds for the two-way project, the Tocom subsidiary created for the Irving situation was sold to the Leavell Company in July 1972. The terms of the two-way project remained the same, with Leavell using the two-way units designed and built by Tocom.

But the two-way project became plagued by delays. Early in the construction phase, problems with the two-way design for the digital signals forced a delay of nearly 9 months. In May 1972, the design of the Tocom system had been considered almost complete when tests showed that interference and cross modulation on the digital stream would most likely be too serious to be acceptable. Eventually the designers changed their original plans and put the digital signals on one frequency using phase-shift keying to form the codes.

By the end of 1973, Irving was technically ready for two-way services but authorization from the FCC in the form of

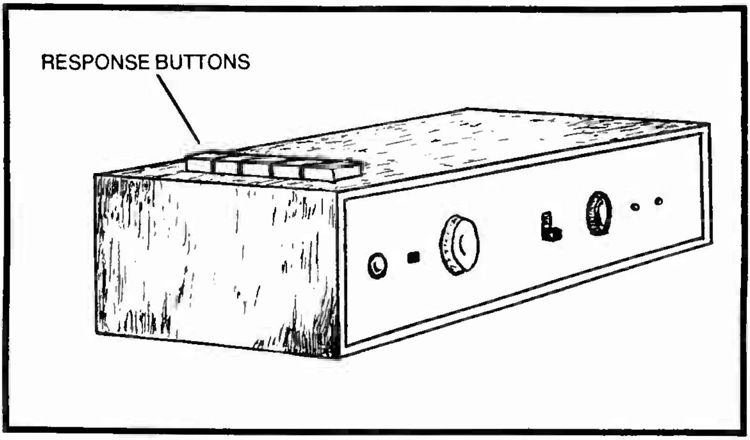

Fig. 4-4. An early model of the Tocom response unit was not much more than a modified channel converter with a few additional pushbottons.

a certificate of compliance took longer than expected. In the summer of 1974, Tocom's president, Michael R. Corboy, explained that no homes were yet connected in Irving because the company was seeking a marketing and financing partner. The portion of the Irving system that was constructed was technically ready, nonetheless, for two-way services and was being used for further engineering tests and for marketing demonstrations.

The response unit prepared for the Irving demonstrations is essentially a 26-channel converter with five pushbuttons, an internal fixed-frequency transmitter (5–25 MHz), a key-lock switch, and terminals for connecting meters and alarm monitors. (See Fig. 4-4). The pushbuttons, four numbers and a *clear*, can generate up to 15 different responses for certain two-way services. In comparison to other keyboards tested by other companies, for example the 12-key models, the Tocom unit seems rather scantily endowed. However, Tocom believes that in the overall design of their system the 15 response options will prove more than adequate. The key-lock switch is identical to the one on the response unit used by ATC in Orlando; it can be used to turn on a pay TV channel or a limited-access channel when the matching key is inserted.

The two-way TV services planned for Irving were shopping at home, opinion polling, and the automatic dialing of emergency assistance in response to alarm monitors registering fire, burglary, or a general emergency. Tocom had also advertised the use of the system for performing remote control functions for residents, including remotely feeding the cat.

In the operating design for the Irving system, the computer processor interrogated each terminal, called an RTR (remote transmitter-receiver), about once every 6 seconds, not much slower than the LVO system in Illinois. Like LVO, Tocom did not operate at a digital speed of 1 megabit but at the drastically slower speeds of 30 kilobits per second for the interrogation and 8 kilobits per second for the response. Each interrogation consisted of a reset pulse to insure that all information would be current, an address enable bit similar to the ready bit of the LVO system, and address code, a word code which signified the type of interrogation being conducted, and 16 data-shift bits. The organization of the bits was thus:

Reset	1
Address enable	1
Address	10
Word Code	1 (or more)
Data shift	16
Total	29 bits (or more)

In practice, when an RTR recognized its address code, it accepted the word code which would allow the information from the proper alarm, keyboard, or whatever to enter the RTR. Inside the RTR the 16 data-shift bits would then be converted to 16 bits of information; these could be used in a variety of ways, for example:

TV ON OFF indicator	1
Pay channel ON OFF	1
Fire alarm	1
Burglar alarm	1
Emergency assistance	1
Opinion poll	3
Channel being viewed	5
Unused	3
Total	16 bits

Since there is one bit alloted for the pay TV channel, pay TV becomes a two-way operation even though the channel is actually turned on by inserting a key in the lock. The two-way feature, however, allows the computer to know, every 6 seconds or so, whether or not individuals are watching a special channel.

In order to solve the problem of too many terminals contributing electrical noise to a single return channel, Tocom divided subscribers into groups of 1000. Each group would have their own set of frequencies, such as at 10 MHz, 10.8 MHz, 12 MHz, and son on; using frequency-division multiplexing. Since each group on one trunk cable would have its own operating frequency, address codes could be duplicated so that RTR-1 in group A is given the same address as RTR-1 in group B and following groups. The frequencies, of course, would differ. Not only does this procedure save on address codes but all RTR units with the same address can be interrogated at the same time. As a result, the time required for one cycle of interrogations remains the same regardless of the number of groups.

Each trunk cable in the Tocom system would serve up to 30 groups of RTR units, or 30,000 terminals. Since a single Tocom computer center was designed to serve four to six trunk cables, the maximum number of subscribers was tentatively set at 120,000–180,000.

Despite, and perhaps because of, Tocom's handicapped efforts to create an urban two-way TV system, a new market was found in retirement communities. Tocom does not intend to abandon urban markets in the long run but rather to use the limited markets of planned communities as a base for later expansion. The step into the retirement environment took place in early 1973 when Rossmoor Leisure World began looking for someone to install a conventional cable TV system for a new community being built near Mesa, Arizona. The possibilities offered by Tocom's two-way design for security purposes, especially, induced Rossmoor to award Tocom a $3 million contract. The agreement as reached in June and the system began operating in September 1973.

The idea seemed to catch on and in December Tocom agreed to provide the two-way equipment and design for a similar system to be operated by Computer Security Company of Hallandale, Florida. Computer Security would operate the system on a channel leased from a cable TV owner in Lauderdale Lakes. Within the next 6 months, Tocom had contracted to provide two-way services for three more new communities: Flower Mound near Dallas; Maumella near Little Rock, Arkansas; and Rossmoor Coconut Creek near Coconut Creek, Florida.

The two-way services provided at the Arizona Rossmoor community, lumped together under the title Monitor 6, are specifically geared toward older residents who might worry about quick emergency assistance and home security. For example, part of Monitor 6 is a switch for medical help, shown in Fig. 4-5. The switch is located in the bedroom and is activated by being pulled; a nurse is then automatically alerted at the community 24-hour health center. For residents who might not be able to reach the wall plug, a bedside button can be plugged in just as in any hospital.[7]

Another service potentially attractive to people who might engage in lengthy travels is the intrusion monitor. The device is disguised to look like an ordinary household item, perhaps a vase, plaque, or lamp; and will alert police authorities, via the cable system, if movement takes place within its range. The detectors are not, therefore, designed for use during occupancy of a dwelling but are loaned out by the Monitor 6 office to residents who plan to be away on extended trips or vacations. The Rossmoor installation also includes a fire alarm system of heat sensors tied into the cable network. An activated heat sensor not only calls the fire department but also warns everyone in the house of the danger.

The terminal used for subscriber-initiated responses is very much the same as that produced for the Irving project.

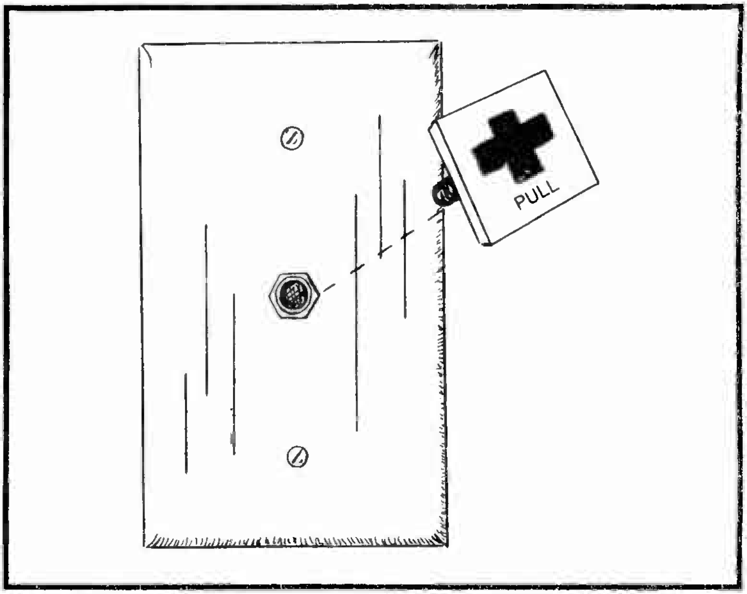

Fig. 4-5. The medical alert switch is a telephone plug/jack capable of being activated from a wall receptacle.

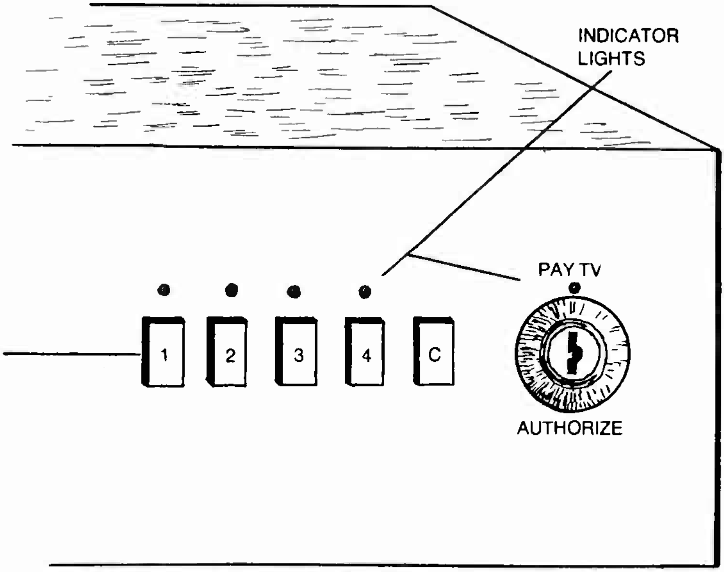

Fig. 4-6. This Tocom terminal is a channel converter with four pushbuttons, a clear button, and a key-lock for pay TV in addition to the channel selector. Indicator lights are located above the four response buttons and the key-lock.

(See Fig. 4-6.) Twelve channels are reserved for premium programing or pay TV and require a key to be inserted and turned in the lock. Anticipated services such as opinion polling, shopping, and games will use the five pushbuttons on the face of the terminal. Four of the buttons, numerically designated, are used to enter data and one button is a *clear*. As a button is pressed, an indicator light above it glows.

As before, Tocom advertises that the computerized system can remotely perform functions in the home such as turning lights off and on or heating the coffee at a preset time. To accomplish these things, switches can be plugged into the back of the terminal.

The Rossmoor system has had its share of problems in putting Monitor 6 into successful operation. Not all of the response units function all of the time, as they should. Moreover, new construction wreaked havoc with cables already underground, and underground amplifiers flooded when the lawns were watered. Presumaby, time will smooth things out. On the happy side, the initial operation of the system resulted in far fewer false alarms than anticipated.

When Monitor 6 became active on September 15, 1973, 30 terminals were tied in to the computer center, with a total of 80 residents in the community. The number of residents has continued to grow. By the end of July 1974, all occupied homes were to be on line. The computer processor serves a base unit of 2000 subscribers which can be expanded to 60,000 subscribers in increments of 2000. At Mesa, Arizona, the occupancy is expected to reach 6000 in a relatively short time and 11,000 eventually.

EL SEGUNDO TWO-WAY

In El Segundo, California another two-way TV system was shaping up in 1973–74. Theta-Com, a division of Hughes Aircraft Company, worked from the assumption that two-way TV can serve the business community as well as residential users and that the cable TV system should be arranged to meet the dissimilar demands of both.[8]

Consequently, in the El Segundo installation there are in effect two cable systems branching out from the control center; the A trunk system and the B trunk system. The A trunk is for service to homes and the B trunk is for service to businesses and schools. The frequency allocations for the two trunks reflect this division. On the A trunk, the forward signals (all the standard TV channels and more) may occupy frequencies from 54 MHz to 300 MHz. On the *B* trunk, though, forward signals will only occupy frequencies from 174 MHz to 300 MHz while return signals may use 5–108 MHz. The B trunk clearly has the enlarged return capabilities that businesses and schools would require, replacing the many forward channels that such users are not likely to want. At various points within the cable system, signals may be transferred from the A trunk to the B trunk and vice versa.

The Theta-Com two-way design, which was first tested in the field on the Los Gatos Teleprompter cable TV system and has been continually laboratory tested at Theta-Com's Los Angeles research facility, has been dubbed the subscriber response system, or SRS. It has been designed to handle initial two-way TV services economically and yet be able to add advanced two-way services without a major overhaul. In this respect, Theta-Com and its associates seem to have taken a longer range view of two-way TV than many of their contemporaries. Compared to Tocom, for example, the SRS design seems exceedingly flexible; a few of their respective features are contrasted in Table 4-2.

In line with the concept of providing for expandable services, Theta-Com produced more than one model of home

Table 4-2. Two-Way TV Features—1973

	Tocom	Theta-Com
Return digital	yes	yes
Return audio	no	yes
Return video	no	possibly later
Response unit	4-button keyboard	4-button model 17-key model, with 10 digits and 7 function keys, plus a paper printout

terminal even though a pilot project has not yet begun. The different terminals would meet an expected range of customer demands and would allow customers to upgrade their collection of services by ordering a new model. The SRS 101, an economy model shown in Fig. 4-7, contains essentially a channel selector and four pushbuttons. The next step up, the SRS 102 shown in Fig. 4-8, contain a 10-button numeric keyboard, 7 more function keys (including one marked PURCH and one marked PREM TV), a paper-strip printout, and optional accessories such as a 100 WPM (word per minute) paragraph printer and terminals for alarm and meter monitors. A projected SRS 103 may have a full alphanumeric keyboard; an integral paragraph printer; and optional features including a

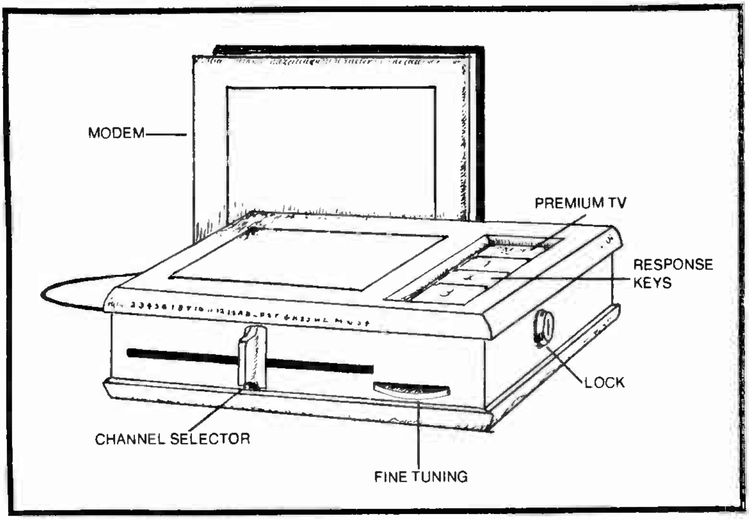

Fig. 4-7. The SRS 101 is only one of the models of two-way TV response units that have been developed by Theta-Com and Hughes Aircraft. The modem can be stored out of sight.

frame grabber (or picture-refresh device), a microphone, and the ability to plug in several TV sets to the same terminal. In all models, the console, the TV, and the digital-circuitry unit are physically separate. The digital circuitry and logic processors are housed with the channel converter in a small unit a little bigger than a lunchbox that contains no outside

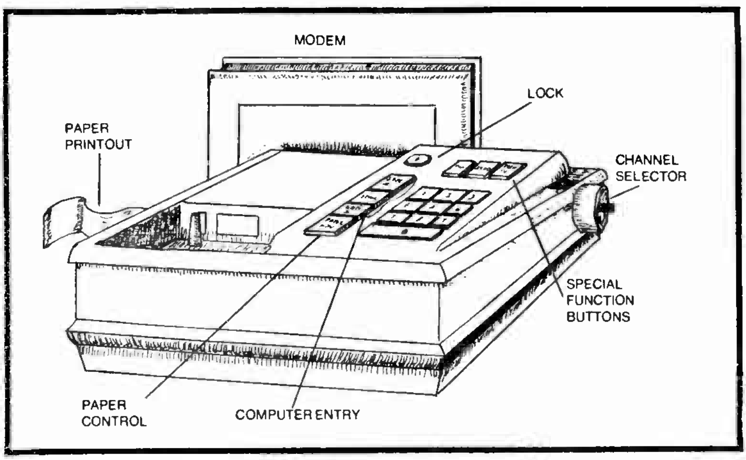

Fig.4-8. The SRS 102 is capable of more two-way TV services than the SRS 101. The different models are designed to meet varying consumer demands.

controls or switches. Thus, the unit can be stored in any out-of-the-way spot once it is connected to the TV cable system, perhaps behind the sofa or in a closet.

The response console, a similar-sized unit, can be placed anywhere in the room with the TV, perhaps right alongside the most comfortable armchair. By pressing keys, a subscriber can send messages to the computer center 20 characters at a time. If the message is longer than 20 characters, a tiny *busy* lamp on the console will light when the limit is reached and will remain lit for a few seconds until the computer has accepted the characters. The entering of the message can then continue. As messages pass through the response unit, whether coming from the keyboard or from the computer, the characters can be printed on a ½-inch paper tape for use as a receipt, a permanent record, a ticket, and so on (the SRS 101 does not have this feature).

Opinion polling, channel monitoring, meter and alarm monitoring, activating channels, and two-way digital communications are all possible in the SRS system. In addition, through prior arrangement with the computer center, SRS can, just like the Tocom system, remotely control such items as a video tape recorder, automatic sprinkler systems, or a contraption to feed the cat.

As usual, all the two-way TV services are based on a computer-controlled interrogation-response sequence. The sequence is not a simple cycle—the computer goes through a sort of doubling-back action. Terminals are interrogated in batches of 1000. The first time through the computer will only accept a simple status signal or a smple request signal. After the group of 1000 have been checked, the computer goes back to take care of any requests that might have been made, a request being any message originated by a terminal up to 20 characters in length. If the information in the request was an authorized code for a limited-access channel, for instance, the computer would then check in its memory bank to see that the request is legitimate and then act on it. After all requests for one batch of terminals has been taken care of, the computer can move to the next 1000 terminals.

Since the system operates at a digital stream speed of 1 megabit per second, the interrogation–response action takes place extremely rapidly. Even at peak periods of use, the time between interrogations is not expected to exceed 2 seconds.

It might be helpful to look at the frequency allocations for the A trunk system, the residential line, to get an idea of where all the frequency space goes and what amount of frequency space must remain empty to prevent cross interference. In the SRS design, TV channels are at 54–88 MHz plus 112–270 MHz. The radio band is at 88–108 MHz. The frequencies from 5 MHz to 21 MHz are reserved for two-way TV services which utilize return video—at 6 MHz per color TV channel, only a few simultaneous return-video signals are possible. The digital-interrogation signals occupy 108–112 MHz using frequency-shift keying and the return signals occupy 21–25 MHz employing phase-shift keying. The spaces in the total bandwidth not assigned, including the ends (0–5 MHz and 270–300 MHz), are best left empty for high-quality performance. Two-way cable TV has its limitations.

According to estimates, SRS can serve approximately 65,000 subscribers with a small computer. In more populated areas, SRS engineers say that several return areas could be linked to one large computer center by cable or microwave. In that case, the upper limit on the number of subscribers per computer center would be in the hundreds of thousands, about the same projected size as a full-capacity Tocom system.

Engineering tests of the El Segundo system began in late 1972 and demonstrations of two-way services continued from July 1973. The demonstrated services covered most of the more common ones such as polling, pay TV, shopping, and alarm monitoring. Beyond that, Theta-Com also tested interactive games, remote control of devices in the home, and frame grabbing. This last feature, in which a still picture is continually refreshed by a refresh device in or connected to the home terminal, is significant in that frame grabbing has been a key element in the educational two-way TV services developed by the Mitre Corporation. In fact, Mitre's John Volk has called the development of an inexpensive frame-grabbing process as the only major technological impediment to two-way TV and the key to future services.[9] Aside from Mitre and Theta-Com, very few if any other two-way TV builders have seriously tested frame-grabbing techniques even though their importance to computer-generated video is undeniable.

In testing alarm monitoring, Theta-Com had the alarm signals (received at the computer center) converted to visual representation and returned to the subscriber as a TV picture showing the data. Although this feature is not necessary for alarm-monitoring services, it is indicative of other uses of SRS for services in which digital pulses are converted to video form for viewing by subscribers.

The El Segundo tests also explored a form of point-to-point digital communications foreshadowing quite advanced two-way TV services. Using the SRS design, subscribers with digital keyboards could type messages to other subscribers. The digital codes were accepted by the computer, which could read a distinct address in the message; that address would then be used to direct the message to another subscriber terminal. There the two-way terminal would print the message on paper using the terminal strip printer. In such a process, the central computer becomes a switching center theoretically allowing any single subscriber to communicate with any other individual subscriber. The implications of such capability are enormous when extra-polated to the population as a whole served by interconnected computer centers.

The home terminals actually used in El Segundo increased in number and capability during the course of the trials. In the summer of 1973, only 13 terminals were in use representing the first models of home consoles produced. But by the time of the November and December 1973 and April 1974 tests, 19 terminals of a more advanced design were put on the line. Even newer terminals constructed on the basis of results obtained from the demonstrations were produced in the first half of 1974 and 15 of them were scheduled for installation later that summer. Besides the actual terminals, Theta-Com constructed a universal-terminal device which could simulate the returns of 10,000 different terminals to test the response time of the computer against the accumulated electrical noise.

In carrying out the tests, Theta-Com identified most of the engineering problems that other cable TV systems have met and will meet when installing two-way services. A report by Richard Callais of Hughes Aircraft Company details the measures that were adopted to locate and minimize interference and noise, including a patented technique developed for specifically locating sources of trouble. As elsewhere, the interference and noise could be traced to faulty connectors, improper shielding, grounding and termination, and occasional failures in amplifiers and power supplies. Consequently, the cable system was completely overhauled to meet rigid specifications. Some increases in noise were traced to local amateur radio operators; but with corrected shielding, the transmissions from amateur radio did not appear sufficient to disrupt digital signals on the cable.[10]

To guard against errors due to the noise and interference that is nevertheless always present to some degree, the computer was programed with the digital word lengths of all possible return codes so that unmatching codes would be rejected as false bursts. In a similar manner, terminal responses that appeared out of sequence or were missing entirely could be noted and appropriately handled as possible false or invalid data. Eventually, the computer was able to detect and ignore the great majority of spurious bursts of noise. The only drawback to the computer-error-checking process was the small delay in time while the correction functions were performed. The time delay would not be likely to be noticed by two-way customers, though, since it would be on the order of 2 seconds or less.

The patented technique for detecting interference sources developed by Hughes Aircraft engineers is for occasional situations where noise or interference is too much for the computer processor to analyze and ignore. The technique involves the installation of a switching device called a "bridge switching terminal" at points throughout the cable system. The computer can cause the switch to connect one set of distribution lines at a time to the return channel. Using the computer's ability to assess individual replies, the source of the trouble can then be narrowed to a limited area. The time delay caused by the action of the bridge switching terminal is less than 2 μsec.

The Callais report concluded that significant changes must come in the installation and maintenance procedures of cable TV if two-way TV is to become successful; however, the report noted that with proper care and with the use of the SRS design two-way TV services can be favorably introduced. Whether or not the El Segundo project is expanded to a full-scale market test in the immediate future is uncertain. At the conclusion of tests in 1974, it seemed doubtful that Hughes Aircraft would continue to fund installation of the hardware, at least not according to prior timetables.

MITRE'S COLLEGE SYSTEM

Before Mitre had begun its Reston, Virginia test of two-way TV, its researchers had already been studying computer-assisted instruction for use in schools. As the Reston experiments and Mitre's related research continued, it became increasingly desirable to design instructional computer systems that would be compatible with cable TV. This meant the use of standard TV sets as the remote terminals instead of CRT (cathode-ray tube) monitors or special terminals usually used in computer-assisted instruction. The result was Mitre's interest in frame grabbing already touched upon.[11]

Mitre began working on educational computer systems in 1971 with a grant from NSF to come up with a system and demonstrate its effectiveness. The project leaders decided to aim for the junior college (or community college) level because of its unique suitability for computerized instruction. Junior colleges are on the whole new institutions with diversified student populations amenable to individualized instruction. As a related consideration, junior colleges were chosen because of a visible trend toward statewide administration; this would make marketing of a successful system easier than when approaching numerous isolated institutions.

In late 1972, two community colleges were chosen for pilot projects testing computer-assisted instruction on standard TV sets. The two schools, the Alexandria campus of Northern Virginia Community College and Phoenix College in Phoenix, Arizona, were selected on the basis of their openness to innovation, the absence of restrictive state regulations, the representativeness of their student bodies, and their locations. The college in Alexandria, Virginia is relatively near the Mitre research center in McLean, Virginia and Phoenix College is not exceedingly far from Brigham Young University where much of the coursework was developed. When the pilot projects began, there were 128 student terminals at each school; the projects were scheduled to run from September 1974 to January 1976.

Although the Mitre community college undertakings are not in the category of cable TV, they are definitely in the realm of two-way TV. The college projects will not only affect the institutional use of two-way TV but general public uses as well. With standard TV sets as the response units, much of the design and measured effectiveness of the system can be carried over to commercial cable TV without modification. As with Mitre's two-way project scheduled for Stockton, the entire process and its results will be evaluated by the Educational Testing Service. The evaluation is to assess the quality of the computer courses, their teaching effectiveness, and the technical competency and relative costs of the projects; this will be done under a separate grant from the NSF to the testing service.

Mitre's Ticcit system, described in chapter 2, is the basis for the community college projects as well as the Stockton installation. The key to Ticcit is, of course, the use of frame-grabbing techniques to show still pictures on the TV screen. At the community colleges, the frame grabbing or picture refresh will be done by digital circuit boards at the central computer complex. Each student terminal has an associated picture refresher consisting of metal-oxide-silicon devices arranged in what amounts to a computer memory.

Since color pictures are digitally stored on discs in the computer complex, the digital signals can be sent to and held in the refresh devices as a series of bits. The luminance information is contained in bit-by-bit detail on a single circuit board 8 by 10 inches. The color information is held on another circuit board one-fourth that size in such a way that the color for half of each character is stored independently of the other half for flexibility in color use. The employment of digital-refresh memories is a substantial improvement over the video tape recorders used by Mitre in Reston, and contributed greatly to the feasibility of the community college projects. Digital devices were preferred over electronic storage tubes as well since the digital solid-state devices have greater reliability, better resolution at roughly the same cost, and are easier to use.

Hand-drawn pictures are converted to digital information for storage and processing by a graphic digitizer developed by Mitre. Color pens are used to draw on a special paper marked with a grid representing the character spaces on a video display. The paper is then scanned by a modified TV camera three times using red, green, and blue filters successively. Six colors are produced since the filters in combination give yellow, magenta, and black. The digital information is tested by a computer program for random errors and displayed on a video terminal for double checking by an attendant against the original. If acceptable, the bit stream representing the grid of 204 by 430 elements is then stored on a disc.

Besides the graphics, video displays are also available in the form of short color videotapes which can be called up by pressing a button on a student terminal. At the central station, 20 cassette recorders can be computer switched to play video material to any individual student terminal.

Audio programs or commentary are also provided, although it is estimated that students will be using audio help only 10% of the time. Like the digital graphics, audio material is stored in bit streams to facilitate random access to phrases and sentences, serving up to 20 students simultaneously. Each audio segment is no more than 20 seconds in length. The conversion process from the original analog signals produced by a microphone to a digital stream utilizes a form of PCM developed by Mitre in 1969. The analog signal is sampled 20,000 times a second, each sample generating a reference level for comparison with the next sample. As succeeding samples show an increase or a decrease from the reference level, a one or a zero is stored respectively and the reference level is adjusted accordingly. As the signals are being digitized, an equipment operator can play back the speech to correct any abnormalities with further computer input. Correct samples are stored on discs with the title and location of the information stored on a directory disc. Requests for audio material coming from a student terminal cause the computer to search the directory and then to find and retrieve the designated speech or sound.

Students communicate with the computer and control their learning speed by means of a keyboard with dozens of special command buttons, some of which are shown in Fig. 4-9.

Unlike a conventional cable TV installation, the Mitre college projects use separate wire pairs for the audio transmissions coming from the computer. The wire pairs are quite similar to the Qwist cable used by Rediffusion in that the audio wires are wrapped in the same jacket as the video cable forming one multiconductor cable. Also unlike conventional cable TV, the student terminals are located no more than 1000 feet from the computer control center. Although Mitre maintains that student terminals can be located in domitories or even off campus, the terminals at the two colleges are placed in clusters near the computers. (There are actually two computers working together in the system.) At Alexandria, for example, the entire system including student terminals is located in a learning laboratory area on the third floor of one of the newly constructed classroom buildings.

It has been said that perhaps Mitre's most valuable contribution to computer-assisted instruction and two-way TV will ultimately be the production of the course material itself.[12] The concept behind the Ticcit approach is that machines under the direction of specialists can do better what should not be done by individual teachers in the first place. Some learning does not require personal interaction; thus, the entire educational process would benefit if these areas can be identified and handled by computers under the direction of specialist teams. From the student's viewpoint, the computer erases the rigidity of classroom schedules, permits control

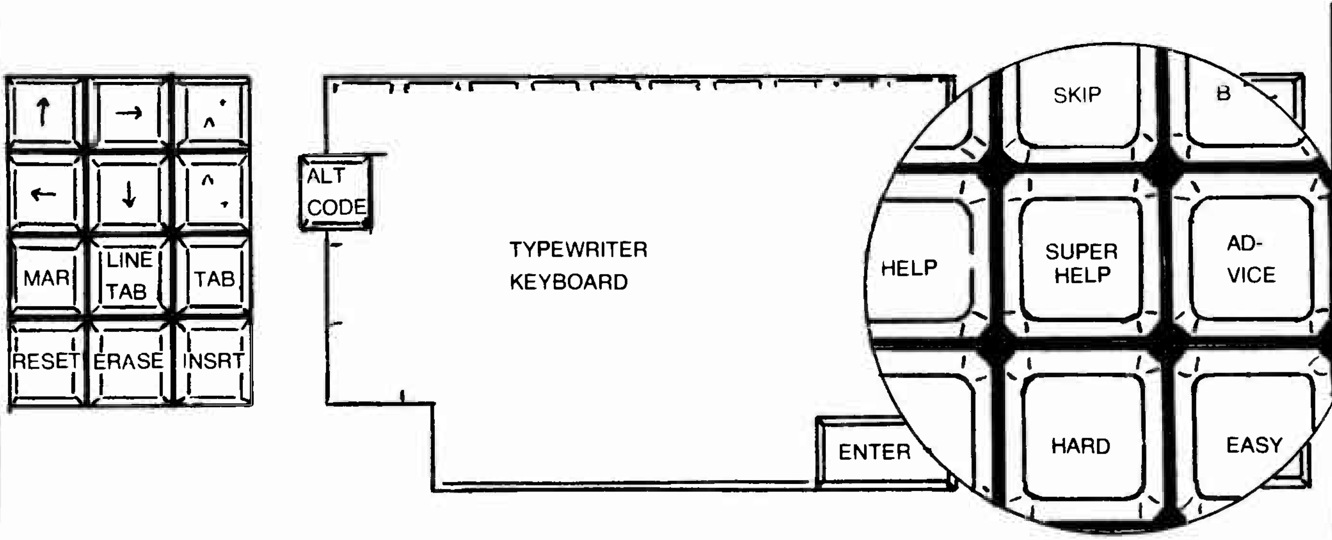

Fig. 4-9. The Mitre student console contains a full typewriter keyboard with 30 additional function keys to facilitate communications with the computer, reducing complex commands to one key. Inset shows some of the student option keys; other keys include GO, E.G., RULE, and PRACTICE.

over the material presented, and provides standards of mastery independent of an individual teacher's grading anomalies.

The procedure for developing the course material, described by Mitre in *An Overview of the Ticcit Program, January 1974*, began with an analysis of needs of junior college students and administrations. It was found that major problems existed concerning students' lack of competency in high school level mathematics and English composition. A full 20% of total teaching time was devoted to bringing students up to minimum levels in these areas. Four courses were singled out as the prime demands on teacher time and student time alike for the average junior college—two courses in developmental English and mathematics and two courses in freshman level English and mathematics. Consequently, for the college projects Mitre chose to produce a basic English course, an English composition course, algebra, and elementary mathematical functions.

The courses were put together by teams of psychologists, English and math teachers, media specialists, and computer programers at Brigham Young University under the direction of Dr. Victor Bunderson head of the university's Institute for Computer Uses in Education. Each course had its own team of several teachers, a design technician, and an instructional psychologist. These "author" teams developed the lesson objectives, prerequisites, outlines, individual items, and numerous rules or definitions—examples and practices in easy, medium, and hard varieties. After the lessons were formulated, they were reviewed by a quality control committee consisting of an authority in the field, a psychologist, a graphic artist, and an editor. After rechecking and improvements were completed, "packagers" translated the lessons into proper form for entry into the computer.

Ticcit also allows authors and packages of lesson material to work directly with the computer to set up lessons. For example, an author working on one segment can call up the displays that have been entered and review them before starting to work. Then, when ready to add a rule or an example, the author calls up a specification form and fills in the blanks. These specification forms contain blanks for directions on color, text, timing, arrangement on the screen, and answer processing. The computer can then act to add the material to the course. All of the specification forms are also available on paper and can be filled in away from a computer terminal; a keyboard operator would later enter the information on the identical forms stored in the computer system and viewable on terminal screens.

The team approach is designed to bring experts together to produce the best possible computer-assisted instruction. The results of the work of a small group can be transmitted to thousands of students who would still get the feeling of individual instruction. Moreover, the resulting courses can be marketed to many institutions. This possibility has caused some observers to complain that Mitre is trying to eliminate teachers and educate masses of students under the influence of a few panels of authorities and specialists. Mitre, however, contends that teachers are still needed for the computer courses to study and grade supplemental assignments, if there are any, and to personally teach students who have failed a lesson twice or who otherwise have difficulty. More importantly, the teachers that are replaced are freed for more creative teaching. Ultimately, broad use of programs such as Ticcit may require a redefinition or a fresh understanding of the role of teachers in society.

Students taking the Ticcit courses are the ones, naturally, for whom the courses are designed. One of the suppositions behind Ticcit is that students will receive better instruction in forms that will be appealing when they go to a student terminal. To that end, the use of audio, videotapes, grahics, color, procedures for previewing a course, converting lesons to games, getting incidental advice, and opting for a master test for an A or B grade were all instituted. Preliminary shakedowns of the Ticcit courses at Brigham Young University indicated that the goals of Ticcit can be met; namely, students could learn material they had failed before and come out of the experience feeling better about the subject matter.

When carried beyond the campus on cable TV systems or whatever, Ticcit-style courses could bring about unexpected results. For instance, if such courses can improve individual attitudes and impart knowledge to most students who try the computer instruction, a great impact might be made on people who have left school because of, or with, dissatisfaction with classroom learning. This in turn might conceivably lead to a desire for more education, and even a desire to return to a campus for studies that are not adaptable to computer-assisted instruction.

OTHER PROJECTS

It has been mentioned before that two-way cable TV development was relatively sparse during 1972–1974. As has been seen, a few experiments were begun and then terminated for various reasons and several others were aiming for final testing and marketing trials in late 1974. The experiments and pilot projects described, however, do not constitute an exhasutive catalogue and should not be taken to mean that nothing else was being done during this time in regard to two-way cable TV. Several other proposals and projects were being put together and were reaching various stages of implementation.

For example, in 1972 Community Information Systems received a $175,000 grant from HUD to help them establish a two-way cable TV system in Jonathan Village, a new community in Chaska, Minnesota.[13]

After conducting preference surveys and giving prototype equipment demonstrations in the summer of 1972, Community Information hoped to begin installation of the first two-way terminals by the middle of 1973. Further expansion to a system offering two-way TV services to all subscribers was not expected before 1975. In all, the system was estimated to cost approximately $4 million, rendering the grant helpful but not completely supportive. The response unit Community Information had initially planned to use was one developed by GE. The unit was hand-held and had 12 buttons, much like a Princess model Touch-Tone telephone. Digits pressed would appear on an electronic counter on the face of the unit like any small calculator, or, as the system developed, on the TV screen.

Subsequently, Community Information was awarded further research grants from HEW and the Minnesota State Department of Education. By the fall of 1974, a 16-mile cable system in Jonathan Village had been constructed for experiments primarily in health services and education. Two-way TV mobile carts (Fig. 4-10) have been used for person-to-person videophone conversations and person-to-group communications. Each cart contains a TV camera, microphone, video tape recorder, and two TV monitors so that the person using the equipment can see the picture being sent as well as the one being received. These carts have been used particularly in medical applications where video exchange is highly useful. Other carts designed for classroom and general school use do not incorporate a TV camera.

In Columbus, Ohio, plans were advanced as early as 1971 for a two-way TV system in which 11 channels of TV

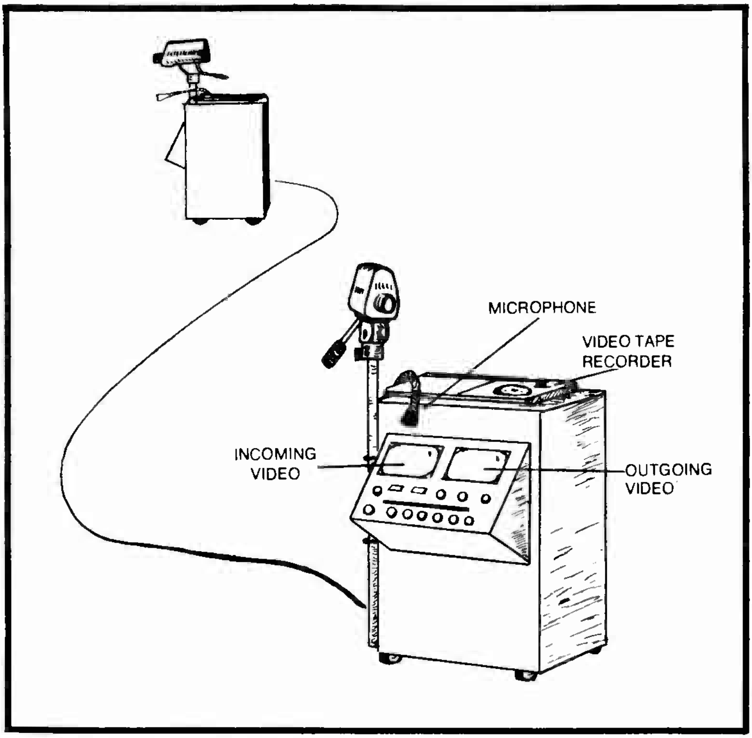

Fig. 4-10. Two-way TV cart used by Community Information Systems for educational and medical applications.

programing could be selectively ordered by subscribers with a digital response unit. Over a period of time, the idea changed to a simpler system in which a central computer could detect subscribers watching a pay TV channel. Coaxial Communications, Inc., subsequently began to test modified converters on their Columbus cable TV system which could report if a TV set was on, what channel was being watched, and if a key-lock switch for pay TV had been turned on. A computer would interrogate monitoring devices situated at amplifier locations so that groups of subscribers could be interrogated at a time. The groups could be as large as 200 subscribers and be interrogated approximately once every 3–5 minutes. During 1974, full-scale operation in regard to pay TV monitoring was expected.

A quite advanced version of two-way TV was put together in the early seventies by GTE, but the system has yet to get beyond the laboratory door. Originally, GTE had proposed to install the system in St. Charles Communities, Maryland, but the communities' developers eventually decided to forego providing the necessary financial support. After that, GTE continued to tinker with the system in an experimental installation at their Waltham, Massachusetts research center while hoping to find another location, perhaps in an educational, industrial, or scientific complex.

The GTE version of two-way TV is, not surprisingly, based on the conviction that the telephone network and broadband cable networks should be carefully interconnected (although remaining as a physically separate plant) for maximum public benefit. The GTE two-way TV network, which they call special services network (SSN), resembles Rediffusion's cable TV system in that channels are selected by dialing a 36-position reed switch situated in a local switching exchange. The SSN, however, would use ¼-inch coaxial cable instead of Qwist cable and would use Touch-Tone keyboards instead of circular dials. As a result, each local exchange could serve some 700 subscribers, which is about twice the number that Rediffusion could serve and only $^1/_{10}$–$^1/_{20}$ the number that can be served by a typical telephone exchange. Figure 4-11 depicts the local SSN

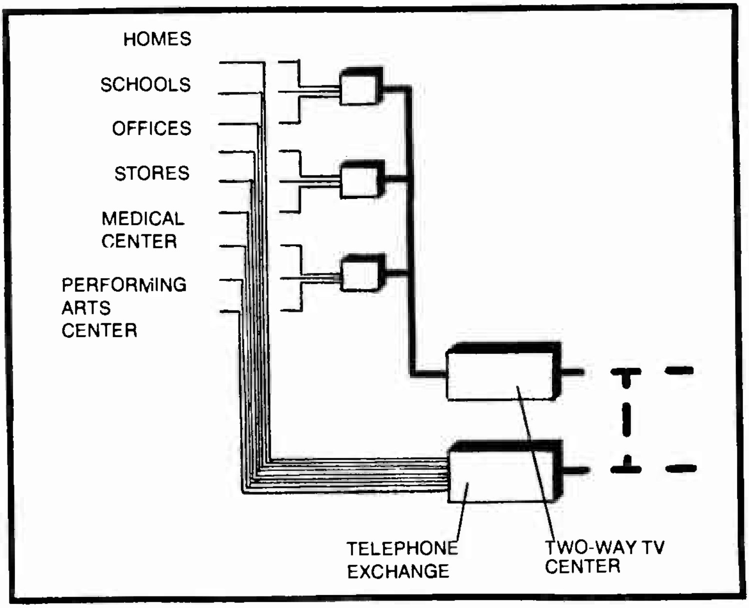

Fig. 4-11. Special Services Network (GTE) is designed to supplement the telephone network. Outside the local exchange areas, the two might share facilities. The TV exchange would handle broadband communications and the telephone exchange would handle narrowband communications.

exchanges leading back to a central control. Outside the central control, the SSN network could be interconnected with the telephone network.[14]

Virtually all forms of two-way TV would be possible using the GTE plan. Each two-way TV would be able to engage in two-way digital, audio, and video communication. Since the coaxial cable to each home would have a bandwidth of approximately 40 MHz, with possible extension up to 65 MHz, two TV channels could enter the home simultaneously. A full TV channel would be available for return communication as well as smaller channels for return-audio and return-digital signals. The system would be computer controlled, and could handle all the monitoring and polling services that are found on other two-way TV systems. For advanced services, the GTE broadband exchanges could route subscriber-originated communications to any other single point terminating at the exchange, to all other points or any combination of the two.

In order to grasp the full extent of the possibilities of the SSN, it might be advisable to look at the frequency allocations for the home link. The two incoming TV channels, A and B, were placed at 25–31 MHz and 37–43 MHz, respectively. This feature of two channels coming in on the same line even though all channels are dialed separately permits two TV sets in the same household to be connected to the same feeder cable and yet be able to dial different programs (the Rediffusion method cannot do this). The signals from the alarm and meter monitors do not have a frequency allocation because, unlike other computer-controlled systems, they are (direct current) pulses and not data bits. The band has been placed at 47–67 MHz with a return channel at approximately 2 MHz. If return-video communication is desired, a TV-wide channel is reserved at 3.19–9.19 MHz.

Their SSN is extremely expensive but, GTE says, its potential is vastly superior to anything else that has come up. They may be right, since the SSN seems to be an expanded form of DAP with most of the problems eliminated, but in the face of the high cost and lacking a market test it is hard to tell.

In yet another appoach to two-way TV, the site for the project was chosen before any plans were made for services to be provided. Akron, Ohio was chosen by both the major cable TV company that operates there and an independent nationwide survey as probably the best place to begin two-way TV. The Washington consulting firm of Malarkey, Taylor, and Associates recommended Akron in *Pilot Projects for the*

Broadband Communications Distribution System. The report, commissioned by the U. S. Office of Telecommunications, cited Akron for the high technical quality of the system, abundant channel capacity (46 TV channels, with 15–20 channels for return communications), high number of potential subscribers, and possibilities for interconnecting schools and universities.[15] Akron Cablevision, in turn, is building what is predicted to be one of the largest cable TV systems in the country, covering some 1200 miles, and is technically equipping it for two-way communication.

Alfred R. Stern, president of Television Communications Corporation which owns Akron Cablevision (Television Communications has since been purchased by Warner Communications), indicated at one point that the cable system in Akron was ready for two-way cable but the developers and suppliers of two-way services and response units were not. Stern added that much was yet to be done in regard to the software or specialized programing that constitutes two-way TV services, and that no suitable terminals had yet appeared on the market.[16]

This does not mean that Akron had assumed a wait-and-see attitude toward two-way TV. On the contrary, Akron Cablevision was exploring shopping services in 1970 but was forced to conclude that an unlikely volume of $4 million would be needed to make the service work. Later, the Akron system was considered by the U. S. Office of Education for an educational experiment using two-way techniques. In the 5-year project, in-service training would be provided to junior high school teachers. Dr. Leland Johnson of the Rand Corporation, also interested in educational applications, journeyed to Ohio to discuss with the University of Akron the possibility of offering courses for academic credit on the cable system using home terminals. And Akron was one of the top contenders for the Mitre project that was ultimately assigned to Stockton.

In general, two-way cable TV moved much more cautiously after the initial optimism was diluted by economic worries, nagging technical troubles, and the general realization of all that was involved. But the drive to perfect two-way TV and to explore the services and the needs that could be satisfied, continued. Approximately a half dozen major efforts moved forward in as many ways. As a whole, the experimentation of the early seventies seems remarkable for its inclusiveness; some of the seemingly most farfetched and most distant of the proposed services and capabilities were subjected to testing.

Even though the efforts differed substantially from each other, all seemed to hint to some degree that the ultimate goal, the very end product, was an all-purpose electronic communications network that would do everything for the home and office customer short of actually transporting solid matter.

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Chapter 5
Pay Cable Begins

Robert W. Peters, an economist and now head of the Stanford Research Institute's Communication Industries Research program, told an audience of cable TV owners in 1971 that local origination of programs would be the cable industry's chief source of new revenue for the seventies. He suggested that local origination would be a rapidly expanding source of new funds, rising from a predicted $90 million in 1973 to $350 million by 1976. Local origination was to be the "first fruit in the public cornucopia of services" of advanced cable systems.[1]

To be fair, Mr. Peters included pay TV via cable as the logical second step, but the fact remains that his calculations have not been justified by events. Even the best of predictions can fall victim, as this one did, to the caprices of fate and the influence of unknowns. Local origination has not only failed to attract audiences and monetary support but it has been curtailed in the years since that speech was delivered. The FCC noted in early 1974, as it reviewed the FCC rules requiring local origination in certain circumstances, that local origination had failed to win expected support from producer and consumer alike while at the same time being faced with sharp increases in production costs.

Instead, pay TV via cable is now being proposed and promoted as the chief source of new revenue and as the financial and even technological base for the wonders of two-way cable TV. A 1974 report from the Stanford Research authored by Kenneth Penchos describes pay TV as an upcoming multibillion dollar industry that can be expected to raise cable TV revenues some 40% in a decade.[2] Along the same lines, a paper released by Rand Corporation also outlined the expected growth of pay cable, placing pay TV revenue at $2 billion or more by 1980.[3] Ironically, that is the same approximate figure for a similar date (1981) mentioned by Robert Peters in connection with the supposed success of local origination. Other estimates for pay cable TV range from $200 million to $2.4 billion by 1980 and $4 billion by 1985.

Obviously, the possibility exists that pay cable will not lead the way to the advanced services of two-way TV despite a good number of sound forecasts. Nevertheless, pay cable deserves to be carefully studied and weighed in relation to two-way cable TV for several reasons.

First, as far as we can tell, pay TV is likely to be successful. As the Rand paper "Pay Television at the Crossroads" points out, audiences seem to be ready, costs have decreased, and a market has been demonstrated in hotel movies-in-your-room operations, thus lending credibility to the predictions. Secondly, and more importantly for the topic of two-way TV, pay cable of itself is likely to require two-way techniques for full development. Several return-signal devices have been produced specifically for pay cable purposes; these devices record selections by home viewers and return the data to the head end for billing purposes. Moreover, the bulk of pay cable ventures, which do not now utilize two-way techniques, consider their procedures as temporary, waiting for two-way cable systems to be established. And finally, many of the same companies preparing for two-way cable services are naturally enough the leaders in the pay cable industry.

PAY TV HISTORY

Pay TV—also known as subscription TV, premium TV, and toll TV—has been an idea that has been kicked around, literally, for over a half a century. Around 1932, Zenith Radio Corporation first began exploring the idea of paying for programs which would only be available to subscribers at a time when TV itself was still largely a laboratory phenomenon. (By 1923 a quasi-electronic TV system had been developed by Vladimir Zworykin, an American physicist. And an electronic TV system was demonstrated by Philo Farnsworth in 1927. An experimental TV program that same year was carried by cable between New York and Washington under the direction of the Bell Telephone Laboratories; the first TV drama was experimentally broadcast the following year. By 1937, 17 TV stations were broadcasting on an experimental basis.)

For years Zenith worked on a method of scrambling broadcast TV programs for reception only by subscribers with decoder units, finally announcing to the public on July 3, 1947 that such a system was ready. The procedure, called Phonevision, remained untried until 1951 when Zenith applied to the FCC for a license to operate a pay TV system. The FCC studied the matter for several years and issued on February 10, 1955 a proposed rule making on the subject and invited comments. By this time, Zenith was no longer alone; four other companies were Skiatron Television, Inc., International Television Corporation, Blonder-Tongue Laboratories, Inc., and Teleglobe Pay Television System, Inc.

The proposed rule making caused a storm of protests that has been described by Robert Horton of the Center for the Study of Democratic Institutions as a brush fire in broadcasting. He has stated that "no other issue before the FCC ever inspired such a volminous record" or involved so much conflict and confusion.[4] The storm increased in October 1957 when the FCC decided to authorize pay TV within certain limitations. Four months later, both the House and Senate Interstate and Foreign Commerce Committees, reportedly under heavy pressure from broadcasting lobbies, concluded that such FCC authorization would not be in the public interest. The FCC promptly suspended their authorization for the duration of the 85th Congress. In March 1959, the third report by the FCC on the matter finally allowed pay TV on a trial basis; a year later Zenith announced that in cooperation with RKO and WHCT—TV in Hartford, Connecticut, pay TV would at last be given a chance to prove itself.

The Hartford pay channel operated from 1962 to 1969 and was considered a financial failure. Subscribers paid installation and monthly rental charges for their Phonevision decoders plus an additional small fee for each program viewed; but enough revenue to support the system economically was not generated. Even so, the idea of pay TV itself was successful in that the Hartford experiment encouraged the FCC to issue its fourth report on December 12, 1968 establishing a subscription TV service. The following September, the FCC began to accept applications for commercial pay TV.

Throughout the experimental history of pay TV, the idea was never a money-maker. In *Talking Back: Citizen Feedback* *and Cable Technology*. Theodore Ledbetter and Susan Greene say flatly that all pay TV experiments failed, including a pay TV via cable attempt in Bartlesville, Oklahoma in the early fifties.[5] A report in *Business Week* estimates that over $200 million was lost in pay TV experimentation from 1950 to 1970 by firms such as Avco Corporation, CBS, Paramount Pictures Corporation, Zenith, and RKO.[6]

In the early seventies, however, pay TV paradoxically began to be presented as a tested and proven source of phenomenal new funds. The change in outlook was partly the result of a change in setting; pay TV moved from broadcast stations to cable TV systems. A few of the early pay TV developers did seek and obtain FCC approval of their systems after 1969 (Zenith Phonevision was approved in 1970, Blonder-Tongue Laboratory's design was approved in 1971, and Teleglobe's pay TV system was approved in 1973). At least one, Blonder-Tongue, planned to be on the air before the end of 1974. For all practical purposes pay TV abandoned the unlucky medium of broadcast TV. Instead, pay TV has found apparently willing acceptance on cable, where subscribers are already in the habit of paying monthly fees, renting converters, and receiving programs not on broadcast TV.

Another contributing factor to the relatively surprising success of pay TV on cable may also have been a mounting audience dissatisfaction with broadcast movies that have been cut, censored, interrupted repeatedly for commercial messages, and otherwise tampered with. In addition, pay cable came at a time when transortation costs, fears for personal safety, admission prices, and other similar pressures apparently encouraged movie and sports patrons to forsake the theater and stadium for the comfort and convenience of their own homes. For example, in one publicized case, the movie *Charlotte's Web* was offered on the Warner cable TV system in Olean, New York at about the same time it played a local theater. The result, according to theater owners, was that so many people elected to view it at home that there was a severe drop in attendance at the theater, causing the movie there to be an economic disaster even though it had successful runs elsewhere.[7]

PAY TV ON CABLE

Pay TV on cable systems went through experimental stages in several parts of the country during 1972 and early 1973. Generally, the conclusions reached supported the belief that audiences would be willing to pay another monthly fee for the opportunity of watching mostly movies and some sports without interruption. The cable experimenters decided that perhaps 30% of all cable subscribers would accept the new feature. In the year or so since those findings, pay cable has been a success in most cases. One company was forced to cease operations, at least temporarily, because of distribution problems. And none of the pay cable companies have yet come close to the 30% figure for pay customers on existing cable systems. By the middle of 1974, pay cable subscribers formed an average of only 12% of the total number of subscribers on the 46 cable systems where pay channels were offered.

Two-way cable TV techniques, advertised as the eventual basis for pay cable, began to be tested and used very soon after pay TV first appeared on cable. A two-way system in Columbus, Ohio was operating commercially as early as July 1973. Other systems and methods were likewise being tested at that time or soon after. In San Bernadino, California, a two-way TV system for pay programing was scheduled to be field tested in a joint project by Magnavox and Teleprompter. But before discussing these systems, it might be best to look at the much more prevalent pay cable ventures using one-way techniques.

Home Box Office

One of the first companies to offer pay TV on cable systems after the FCC 1969 authorization was Home Box Office, Inc. (HBO), owned in part by Time, Inc., and Sterling Manhattan Cable Company (Sterling is itself a subsidiary of Time). Home Box Office began its pay channel in Wilkes-Barre, Pennsylvania on November 8, 1972 using the cable TV system owned by Service Electric Cable TV, Inc., the owner of a dozen cable TV systems in Pennsylvania serving a little over 100,000 subscribers. By the middle of 1973, HBO had attracted some 11,000 customers on several systems in eastern Pennsylvania. Six months later, the company extended its service to nearly a dozen cable systems including four in New York. By the summer of 1974, the number of cable systems under contract with HBO had risen to 30 and the total number of subscribers reached 22,000.

Home Box Office is a program supplier, not an equipment manufacturer or a cable system owner. As such, HBO arranges for the movies, sports events, and other shows to be shown on the pay channels while the cable owner supplies the hardware and manages the sales, billing, and collection. They also provide technical and promotional support. The revenue then produced is split between the cable owner and the program supplier. In Wilkes-Barre and Allentown, for instance, Service Electric carries the pay channel to subscribers for an additional monthly fee of $6 and turns over 58% of the gross revenue to HBO. In effect, each subscriber to the pay TV service is paying $2.50 a month extra to Service Electric and $3.50 a month to the Time subsidiary.

For that extra monthly charge, viewers with an unscrambling device have the option of viewing six to eight feature films a month, a number of sports and cultural events, and some general interest shows. On any given night, the pay channel might be carrying two movies or one movie and a sporting event. They have presented selected games by teams of the National Basketball Association (NBA), the American Basketball Association (ABA), the National and World Hockey Leagues, the Professional Bowlers Association, and others including some unbroadcast games of the New York Yankees. During 1973, the pay channel also carried 175 events from Madison Square Garden and such cultural presentations as the Country Western Jamboree from Nashville and the Pennsylvania Polka Festival. Educational series, perhaps in pottery making or consumer economics, are likewise carried. In all, the pay channel is on each month for some 200 hours of otherwise unavailable TV programing.

In preparing to bring the pay channel to New York City, Sterling Manhattan, part owner of HBO and operator of a New York City cable system that is one of the largest single systems in this country, estimated that approximately 20% of the Manhattan subscribers could be expected to sign up for pay TV. Since the fee is $9 a month for HBO plus $10 a month for cable TV, this would mean an income of $1.2 million a year based on a subscriber total of 60,000 (that is, 12,000 could be expected to be pay TV customers). Of that income, 60% would go to HBO and 10% of Sterling's share would go to the city of New York under current law.[8] Service began in New York City on a limited basis in the fall of 1974.

In order to bring the live sports presentation and other fare to the scattered cable systems served by HBO, a network using cable and microwave has sprung up. Lines are leased from telephone companies, other common carriers, multipoint distribution microwave centers, and cable TV microwave relay stations. Essentially, then, the programing for the pay channel flows outward from central offices in New York City very similar to the major broadcast TV networks. If the company is successful and continues to expand its coverage and its programing, HBO could become a familiar fourth to ABC, CBS, and NBC.

Spokesmen for the HBO channel point out that their operation is readily adaptable to two-way techniques and national networking. At present, the two-way technology that would meet its specifications is not commercially available; however, even when it is, HBO is not so sure it will want to alter its currently successful formula. Gerald Levin, president of the company, argues that the "electronic magazine" approach (the repeated movies, live sports, music and educational programs shown at various times) is the best way of structuring pay TV at present and should not be discarded lightly when new technology arrives.[9]

Warner's Gridtronics

Warner Cable Corporation, the second largest cable owner in the United States, began experimenting with pay TV via cable in 1972 although it had the technology ready since 1969. For a year, Warner tested the operation and market appeal of its pay system in Akron, Ohio. On February 8, 1973, Warner's subsidiary, Gridtronics, Inc., officially began pay cable service in Olean, New York, Reston, Virginia (on the same cable plant that had been used by the Mitre Corporation for two-way testing), and several cities in Pennsylvania. After 6 months of operation, Gridtronics had expanded to seven Warner cable systems from Coos Bay, Oregon to Winter Haven, Florida. By the summer of 1974, a total of 10 systems were carrying the pay programing in what was still considered an experimental stage.

Gridtronics offers movies three or four times a day, repeating a base of two films a week, for a monthly fee of $5 on the average. Although the pay channels had attracted approximately 15% of the 10 system's total subscribers, Warner believed that there was an inherent problem in offering movies to the largely rural audiences of the Warner systems. One representative claimed that current movies were geared toward audiences in the 19–25 age bracket while cable customers in the areas served by Warner were on the average older than that.[10] Consequently, instead of attracting the over-30 population back to movies as some industry figures had predicted, pay cable merely highlighted the relatively limited appeal of the current movie product.

The converters used by Gridtronics for pay TV do not necessarily need the capacity to unscramble programs, since the pay channels are caused to use frequencies falling between regular channels. The PLUS 2 converter adds two channels in that way and the PLUS 4 adds four: PLUS 4 has the additional capability of unscrambling programs for even tighter security.

An automatic video cassette system for Gridtronic's pay TV service was developed by another Warner subsidiary, Goldmark Communications Corporation, under the direction of Dr. Peter C. Goldmark, an inventor and former head of research at the CBS laboratories. The cassette system, called Star-Pak, uses a solid-state unit to control presentations and to monitor transmissions with the purpose of eliminating distortion. The entire system uses four video cassette players under the control of automatic timing devices. The only part of Star-Pak that is not done electronically is the insertion of the video cassettes in the first place. The design of the system is such that it can be modified to serve as a prototype dial-access system in which viewers at home could dial the control center and order any one of the programs available.

Goldmark has also produced a tiny program scrambler about the size of a matchbox which can be used for either broadcast or cable pay TV. In mass production the scrambler is expected to be quite inexpensive.

TheatreVision

TheatreVision has been up and then down in the pay cable business. Starting in January 1973, TheatreVision offered a pay TV service to 750 subscribers on the Sarasota, Florida cable TV system owned by Storer Cable. The Sarasota system, with a total of 20,000 subscribers, is one of the few Storer cable TV holdings outside of California. In addition to the home viewers, TheatreVision was carried to a number of motels with some 250 rooms.

During the first year of operation, the TheatreVision decoder was found to be susceptible to random electrical noise and to unauthorized viewing by tinkering home users. The problem of users managing to see programs for free became so bad that finally, in February 1974, TheatreVision suspended operations pending the development and testing of a new decoder.

The system employed by TheatreVision involved the use of tickets bought ahead of time for $2 apiece. Tickets would then be inserted into the decoder and subsequently mangled by the device to prevent reuse. Figure 5-1 shows the type of ticket that was used. Besides the price of tickets, subscribers also paid $1 a month for the use of the decoder.

As for programing, TheatreVision offered six movies a month, three a day on alternating days. On weekends an additional cultural program might be added. According to Dore Schary, president of TheatreVision and a successful playwright and producer (he has won two Tonies and an Oscar for his works), the average home viewer bought three or four tickets a month during the winter and two tickets a month during the summer. As might be expected, cultural presentations attracted only half the number of viewers that the movies did; but surprisingly there seemed to be little difference, in terms of the number of viewers, between movies that had been box office hits and those that had been box office flops.

In March 1974, TheatreVision announced that it was ready to test a new decoder or converter that would not use tickets on a cable system in Irving, California. By summertime, the company was still, in the words of Mr. Schary, "retooling and reshaping" its venture.[11]

Optical Systems Corporation

Optical Systems was founded in 1971 by a man who had begun by reading about the possibilities and potential of two-way cable TV. Geoffrey Nathanson then hired an engineering company to investigate the process for scrambling pictures related to pay TV and proceeded to put together an industry leader.[12] In 1973, Optical Systems was

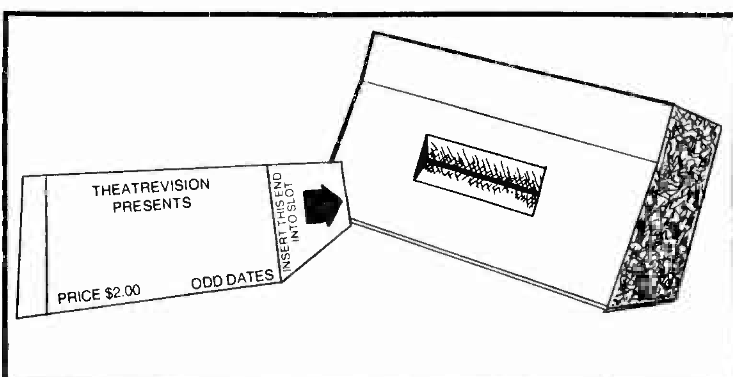

Fig. 5-1. Originally, TheatreVision used a ticket system for pay TV. The ticket idea was later to be dropped.

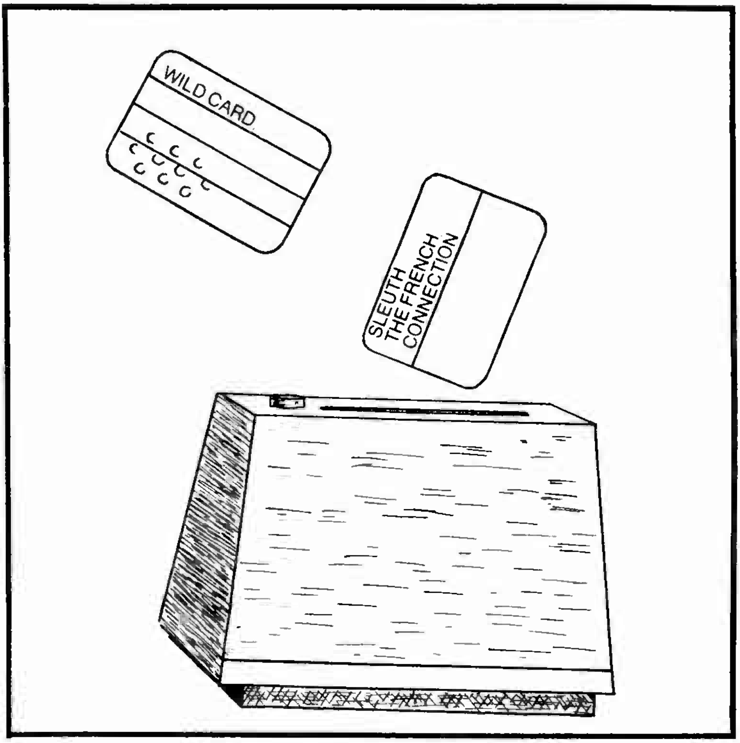

Fig. 5-2. Channel 100 also used a ticket system at first. Tickets resembling credit cards could be used for a variety of purchase options.

chosen by Cox Cable Communications to provide pay TV service for Cox's San Diego cable system, the largest single system in this country. Within a year, Optical Systems' pay channel, Channel 100, had been bought by over 25,000 subscribers in a half-dozen or so cable systems in California, Ohio, Pennsylvania, Iowa, Illinois, and New Jersey. This represented approximately 40% of the entire pay cable industry at that time.

Besides lining up new markets, Optical has moved beyond its first-generation unscrambler, which required tickets to be inserted, to a more sophisticated response unit enabling customers to order programs at any time and be billed on a per-program basis. Originally, the Channel 100 unscrambler or decoder looked more like a modernistic toaster than a TV accessory. (See Fig. 5-2.) Plastic credit cards purchased by customers would be inserted into the top; the prepunched cards allowed the converter to photo-optically translate a digital program code. Various plastic cards permitted a variety of viewing options. Cards might be good for a 13-week series of movies, a season of sports events, single events, particular weeks, or educational or cultural groups of programs. In addition, a "wild card" was included which contained unpunched holes; when a viewer desired to use it, he would call the Channel 100 office and receive instructions to punch out the proper holes for the program code in question.

By the end of 1973, Optical Systems had abandoned the multitude of cards because of hardware problems and simply charged a flat monthly fee of $6.50. This would be beyond the $1.50-per-month service charge for the unscrambler, an initial $25 security deposit, and an initial $10 installation fee. The installation fee could be dropped, though, during sales campaigns.

A new decoder was scheduled for introduction in early 1975 to again charge for programs on an individual basis if desired. The new device, shown in Fig. 5-3, would have a Touch-Tone keyboard to unscramble Channel 100 programs. Customers who wished to order a program at a moments notice could call the Channel 100 office and ask for the code to be entered. The set-top device, designated the PB 74, is not a two-way terminal as such, but can be judged a transition step to a full two-way operation.

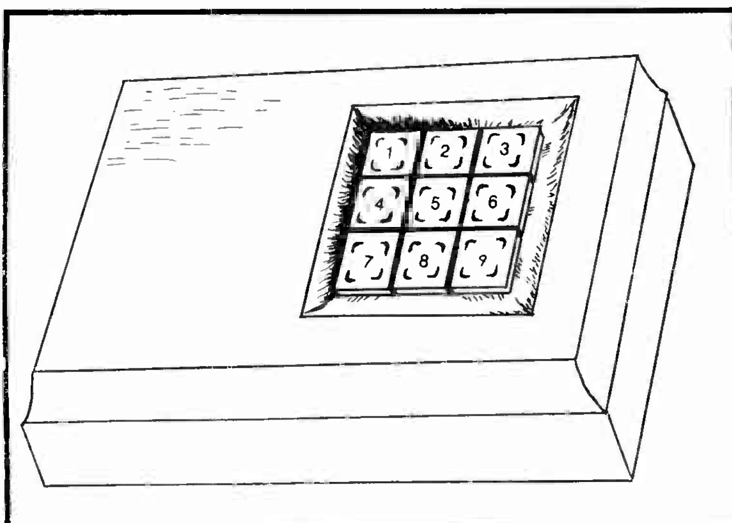

Fig. 5-3. Optical System's PB 74 can be situated beside or on top of the channel converter and is used for ordering scrambled pay TV programs.

The chief staple of Channel 100 is the current movie; however, professional and college sports (including Wimbledon matches), educational, and cultural shows are carried. In the latter category are programs of classical music concerts; light music and other similar shows; and descriptive programs on such item as sailplane flying, auto racing, Shakespeare, and the mysticism of medieval art. Of the 12–15 movies each month, 8–10 are being presented for the first time. The remainder are repeats of previous movies that have been popular. The new films each month are shown at the rate of two a week, one for the first time on a Wednesday night and the other for the first time on a Friday night.

Providing films for pay channels and predicting the audience sizes for various films has proven to have only a loose correlation with box office attendance records. Just as Dore Schary discovered in Sarasota, Optical Systems found that box office losers could attract relatively large audiences on a pay cable system. Similarly, the audiences at home and those who travel to theaters are not necessarily seeking the same sort of entertainment. Consequently, Optical has tried several approaches to identify customer preferences and select movies accordingly. As a start, they attempt to secure and show as many new movies as possible that have not been X rated. Estimating that 200 new movies appear every year, they select 104 which they consider the best. Secondly, in San Diego the Channel 100 office has established a Motion Picture Review Board composed of volunteer customers to assist in the choosing process. In the Davenport, Iowa area, where Channel 100 service began in May 1974 to five nearby cities, representatives emphasized that films would be scheduled and changed according to subscriber demands. Subscribers of all Channel 100 outlets early in the game made their wants known to the extent of getting a 5-minute intermission during most movies.

According to several newspaper reports, Channel 100 customers seem to be fairly satisfied with the pay channel and feel that it meets a need. The advantages and benefits of the service that have been enumerated include monetary savings when compared to the cost of bringing a family to a theater and the elimination of travel problems. In some cases, the channel solved problems that had been prohibitive in the past, as customers pointed out who could not or would not travel to a theater or stadium because of attendant difficulties. With the repetition of movies on different days and at different times, parents also have the ability to preview movies completely before letting their children watch at a later time.[13]

In regard to operating procedure, Channel 100 is a leased channel business. As such, Optical Systems assumes the responsibility for installing, marketing, and running the pay channel. The cable system owner receives a small percentage of the revenue as the access fee. In San Diego and Santa Barbara, California, Davenport, Iowa, and Moline, Illinois, Optical leases space on cable TV systems owned by Cox Cable Communications, Inc., one of the larger cable owners. Optical pays Cox 10% of the gross revenues; another 30–50% is paid by Optical to the major film suppliers. In Pennsylvania, Optical has similar arrangements with Sammons Communications, Inc., also one of the top 10 cable owners. The lease agreements do not necessarily mean that Optical will be able to expand to any other cable systems owned, for example, by Cox or Sammons. There are indications that Cox Cable, for one, has been sufficiently impressed with Optical Systems' success to consider establishing its own pay TV company for pay channels on its owned and operated systems.

The fact that the channel space is leased is significant for the development of two-way cable services. Two-way services will require major investments that few cable companies are able to make. However, special interest groups such as the pay TV companies or others in entertainment, business, or educational fiels may find it profitable to develop services that can be marketed by leasing channels on numerous systems regardless of system ownership. Up to the first quarter of 1974, Optical Systems had invested well over several million dollars and was still operating in the red; but all indications pointed to an eventual margin of profit by the end of the year.

Optical System's plans for expansion in San Diego are tied to the construction plans of the Cox Cable system, Mission Cable. As Mission Cable wires new sections of the city and county, Optical Systems will be able to bring pay TV to the entire city of San Diego. The pay TV company also plans to expand by introducing a second pay channel for special events such as rock concerts, classical movies, additional sports, and educational programs.

Outside the United States, Optical Systems has plans as yet unrealized for marketing the pay channels in Vancouver, British Columbia, where the largest cable TV system in North America is located. Premier Cablevision Limited, serving over 160,000 subscribers in 1973, formed Canadian Optical

Systems, Ltd., to take care of the pay TV programing. However, the Canadian Radio-Television Commission had yet to issue the necessary ruling permitting pay TV. As of July 1974, Canadian Optical remained a dormant company. If pay TV is finally allowed in Canada, it may find a great deal of room to grow in, since 56% of all Canadian TV households subscribe to a cable system.

Viacom Communications

Viacom, still another member of the top 10 cable owners, has been experimenting with pay TV using a procedure similar to hotel and motel operations. Beginning in the middle of 1973, a Viacom cable system in Smithtown, Long Island has been providing pay channels to several thousand customers.

The pay channel procedure, called Via Code, is one of the few to continue to charge on a per-program basis. Customers desiring to order a program must phone the Via Code order desk; there the clerk on duty enters an account number into a computer which unscrambles the picture for individual homes. For this service, subscribers pay $3 per movie and $2 for other events on top of a $1.50 service charge each month for the converter. Four special channels are provided in the pay TV system with one devoted to previewing shows, two devoted to movies from late morning to late night, and one channel for educational shows during the day and movies later.

The K'Son Corporation, which provides the converters for Via Code, has been developing a more automatic procedure for program ordering since 1973. With a device called an order concentrator, the telephone call from the customer is interpreted as a digital command and no clerk is necessary. The customer simply dials the order concentrator number, then dials a code identifying his account and another code to indicate the program. A computer handles the details of unscrambling the picture for that customer and billing accordingly. In this case, the pay channel has become a modified two-way TV service or dial-access service with the telephone line as the return link.

Besides the telephone link and the converter designed for hotel TV systems, the relationship of Via Code to hotel pay TV extends to the programing. Movies and other features are supplied by Trans World Communications, one of the leading suppliers in the hotel and motel TV entertainment industry. Trans World, in fact, uses Viacom cable systems in other cities to carry movies exclusively to certain hotels.

During the course of the New York experiment, Viacom officials noted that, contrary to TheatreVision's Florida experience, summertime use was high but tended to drop off in the fall when the major broadcast networks open their new schedule of movies.[14]

In general, pay TV via cable continued to grow steadily but not sharply in its first few years. Most pay cable operations became established in the three most cabled states—Pennsylvania, California, and New York. Besides the pay cable companies mentioned, several others were likewise testing the appeal of pay TV via cable. These companies included Cinca Communications using cable systems owned by TM Communications in Long Beach, Escondido, and San Clemente, California since March, 1973 (Cinca both leases channels and supplies pay TV programing); American Multi-Cinema using a cable system owned by Coaxial Communications in Columbus, Ohio; and Digital Communications Corporation using a Davis Communications cable system in Pensacola, Florida and one in Decatur, Georgia. Within a year, American Multi-Cinema withdrew its interest in pay cable.

It is worth noting that both Coaxial Communications in Columbus and Davis in Pensacola were involved in earlier studies of two-way TV services involving security systems and the ordering of original programing. The two-way investigations by Coaxial led to several years of testing a low-cost response method which culminated in a two-way pay TV system installed in Columbus in 1973.

TWO-WAY METHODS

Coaxial Scientific Corporation, a research division of Coaxial Communications, began studying two-way cable TV in the early seventies in an attempt to decide which services could be initiated with a minimum amount of cost. Pay TV and security services were ultimately chosen as the most likely candidates and work began on a response unit that would be inexpensive enough to allow for a successful large-scale operation.

By July 1973, a two-way pay TV system was ready for a commercial test and 1000 terminals were installed on the Columbus cable system. The company that operates the pay channels, Telecinema of Columbus, offers three channels of movies, showing approximately 15 films a month. The programs are repeated so that on any given day a half dozen movies might be shown at 14 starting times from early afternoon to late night. Subscribers pay $3 a month for the service and an individual charge for each show watched ranging from $2 to $2.50. Once a movie has been seen, however, there is no charge for watching it again.

Because Telecinema is a two-way operation under constant computer control, subscribers do not have to do any ordering for pay channels; as soon as a pay channel is turned on, the computer is aware of the fact. After 5 minutes of free preview watching, the computer will charge a subscriber for that particular movie. Also because of the computer control, Telecinema officials know exactly how many homes are watching which movies. Contrary to other indicated trends in pay cable, the Columbus results show that after the novelty wears off there is a very strong relationship between box office hits and home TV favorites. The general manager of Telecinema, James Wicht, has been quoted as saying that the success of pay TV films is tied directly to the success at the box office, the timing of the cable showing in relation to theater release, promotion for the film, and publicity regarding the film[15]

The two-way operation is based on both time-division and frequency-division multiplexing. Each home terminal is a modified converter, with its own specific frequency, constantly emitting signals. The signals, however, are blocked at key points and only allowed to return to the head end when the computer processor opens a path. Groups of 100–200 homes are thus sequentially polled when the signals from each group are allowed to pass to the head end.

Coaxial Scientific created the home terminals by taking standard Oak converters and adding a key-lock switch and a small circuit board with some 20 discrete components. The circuit board is, in effect, a transmitter, a frequency-shift-keying (FSK) modulator, and a data encoder. Each terminal can then constantly transmit a 16-bit word using its own specific frequency. The terminals can operate on any frequency in the 5–20 MHz range; in Columbus, they are restricted to 7.5–9.5 MHz with individual return channels every 20 kHz. The digital codes are created using the FSK modulator with shifts of 1.4 kHz. The 16-bit code can be used to indicate if the TV set is on, if the pay TV key-lock switch is on, and what channel has been selected. Three of the bits are necessary for effecting the return signal and 13 can be used for messages. In Columbus, the 13 bits were assigned as follows:

Channel monitoring	5
TV set *on/off*	1
Key-lock switch *on/off*	1
Installation status	1
Unused	5
Total	13

The unused bits can be later designated for security services, polling, or shopping.

The status reporting signals travel from the home terminal to a special device called a code operated switch (COS) where the signals from the groups of 100–200 homes are blocked unless the switch is closed. The COS units, generally located at bridger amplifiers, are addressed in turn by the computer processor at 113.4 MHz using FSK. When addressed, a single COS at a bridger amplifier (and an associated COS at the head of the trunk cable) will respond with an identification carrier in the 9.5–10.5 MHz range. Like the home terminals, the frequencies of the COS units are spaced every 20 kHz. The computer can then check to see if the right pair of COS units are on and that no other units are reporting. If so, the computer directs a receiver at the head end to tune in each frequency used by terminals in the group governed by that COS. As each frequency is monitored, data is accepted. Each code is received twice and compared in order to detect and prevent errors resulting from random noise or malfunctions. After a group has been monitored, another COS is addressed and the process begins again.

The use of the COS devices was considered a very favorable means of initiating two-way TV services without having the response signals overcome by noise and interference problems. The limited return area active at any one time insures that the effects of faulty equipment is confined to one group and that noise accumulation from amplifiers is kept to a minimum. The two-way system is kept under constant observation by the computer as it continually checks COS identification carriers and additional unique carrier signals from special end-of-the-line oscillators installed on each feeder line. The computer also monitors levels from the home terminals and prints out a daily system status report taking all these factors into consideration.

Besides monitoring the technical status of the system, the computer (in reality it is a minicomputer) monitors all channel use and subscriber viewing patterns. It also generates

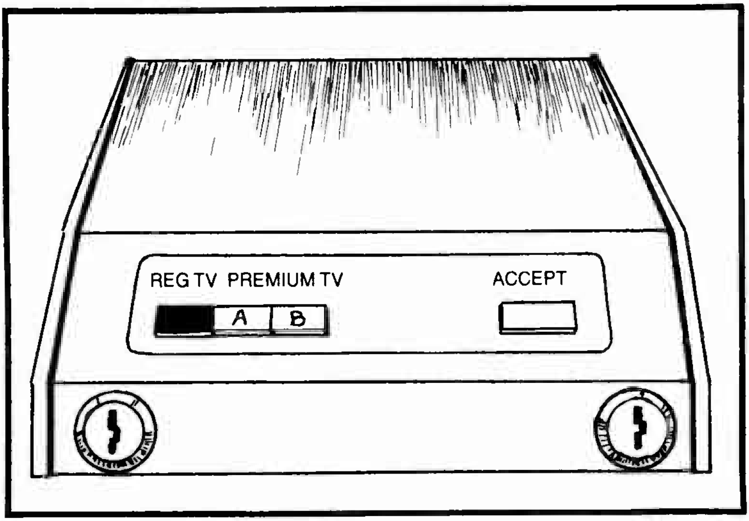

Fig. 5-4. With the Magnavox terminal, each of the two pay TV channels, A and B, must be activated by a separate key-lock switch. An ACCEPT button is provided for purchase of programs after the free preview period.

monthly bills listing each program watched, the date, and the fee. In Columbus, the minicomputer monitors the 1000 terminals about once every 4 seconds, but with additional units to be added at the head end the processor will be able to scan 10,000 home terminals in less than 2 seconds.

After a year of operation, Telecinema announced plans for 10,000 more terminals to accommodate an anticipated 11,000 pay TV subscribers by the end of 1975.

A different sort of two-way pay TV system has been tested by Magnavox and Teleprompter, in which viewers press an ACCEPT button to watch a pay channel causing a digital signal to leave the home terminal. On one-way cable systems, the return signal goes no further than a billing terminal every block or so; on two-way cable systems, the signals return to a central computer processor.

The home terminal, shown in Fig. 5-4, is used to unscramble two pay channels and to send the record of activity to the remote billing collection point. Each pay channel must first be turned on by key to prevent unauthorized access or accidental use by children. Viewers are allowed a period of free time, perhaps 10 minutes, to preview their selection. After previewing, the viewer may elect to press the ACCEPT button; if not, the program again becomes scrambled.

Digital responses travel from the home terminals to outside units named Idems, depicted in Fig. 5-5. An Idem is a switching and command unit using advanced semiconductor devices to accept signals from as many as 32 homes. The Idem contains the memory circuits for recording purchased programs and circuits for converting the information to audio tones. In order to retrieve the information on one-way cable TV systems, the Idems are connected to ground-level readout terminals; personnel from the cable company must act as meter readers, going to each readout terminal and plugging in an audio cassette recorder. The cassettes are later plugged into the computer at the central office for automatic processing of the data. The recorders do not erase the information at the Idems in case a recheck is needed, but as billing periods pass the memories are written over.

Using the Magnavox system in a two-way mode, the memories of the Idems are replaced by modems which would pass the digital information through the cable system to the head end computer. A slow data speed is used to minimize

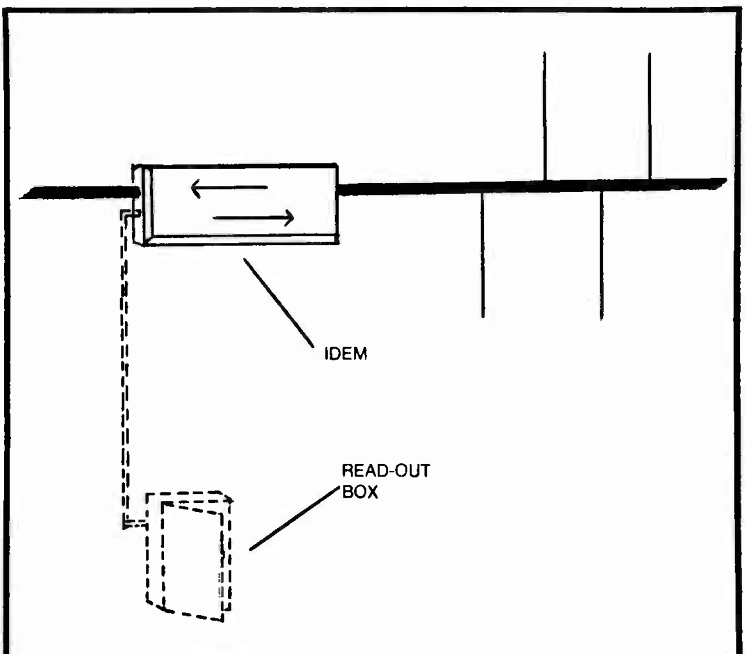

Fig. 5-5. The Idem (interactive data exchange module) collects data from up to 32 home terminals and either returns the data to the head end or holds it for collection via a readout box.

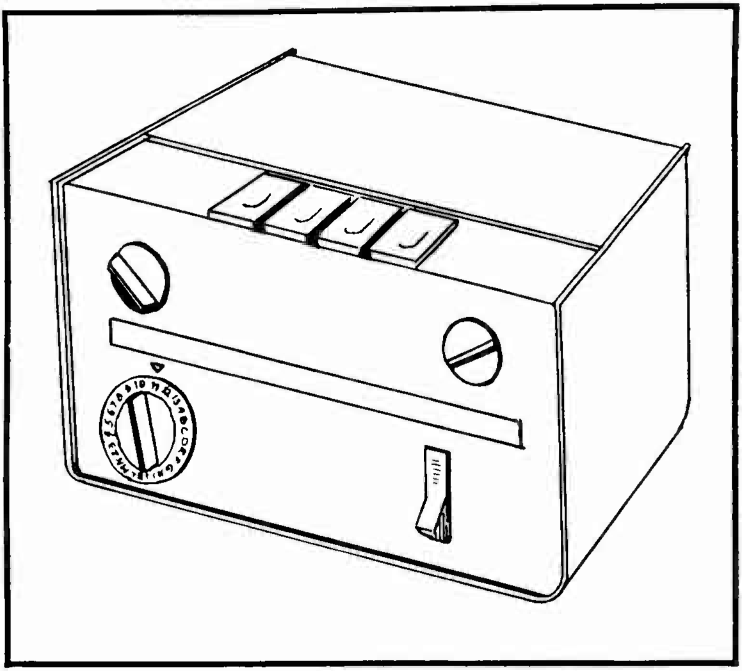

Fig. 5-6. The various types of Oak channel converters can be retrofitted with plug-in modules for individually addressed pay TV operation and two-way operation, including, as this model does, response keys.

frequency space required so as not to interfere with other return channels. Magnavox mentions that the pay-channel response unit can also be used for subscriber polling.

The flexible two-way design was developed at Magnavox in Torrance. California and field tested on a cable TV system in San Bernadino owned by Teleprompter. The system serves some 20,000 subscrbers, 60 of whom were to be invited to participate in a limited test of the pay channels in late 1973 or early 1974.

A modular approach to two-way pay cable has been pursued by Oak Industries, to bring one-way systems up to two-way operation for pay TV and other uses. The Oak converters can be steadily upgraded to one-way addressable pay channels, two-way addressable channels with a telephone interface, and full two-way channels with ordering keys on the converter. The home terminals, one of which is shown in Fig. 5-6, are modified with plug-in circuit modules. The first step up simply involves using the converter as a decoder. Programs can then be scrambled at the head end (without modifying the video information itself) and unscrambled at the home terminal. If the home terminal is given more circuitry to include a distinct address, the head end computer processor can control the unscrambling of pictures by individually addressing each terminal that is to receive the pay channel. For security purposes, the codes for the unscrambling can be changed frequently.

The complete Addresso-Code system includes the head end processing equipment and the computer programing to operate it. Subscribers can order pay TV programs by the hour, day, month, and so on depending upon the decision of the cable system operator. Orders can be placed by telephone and be automatically answered by the computer. Or, orders can be taken by an operator and manually entered into the computer. Both Touch-Tone and dial phones can be used to place orders automatically. If a request is made for a program at a later time and the call is being taken automatically, a special tone will indicate that the order has been accepted. The computer processor can accept 256 telephone calls simultaneously for a total of 100,000 subscribers.

The Oak line of converters can be set to receive two or four pay channels with provisions for adding more pay channels and response buttons. In that case, the telephone interface is replaced with return-data acceptance equipment. The converters also come with key-locks to prevent unauthorized or unintended uses.

Other entries in the two-way pay cable field have sought to produce other devices for similarly registering viewing times of pay TV customers. An Ohio firm, M1(2) Data Systems, Inc., announced in early 1973 that it had developed a device to interact with a telephone. After making a channel selection by pressing a button on the device, a customer would dial the computer processor and place the mouthpiece of the telephone next to the MI(2) device. The computer could then use the telephone lines to activate the program while keeping a record for billing purposes. The unit was produced for Home Theater Network of Los Angeles, but at the end of 1973 Home Theater had not yet been able to swing into actual operation.

The chief drawbacks to using two-way technology for pay cable TV have been the high costs for the home terminals and the scarcity of cable systems engineered and equipped for two-way traffic, with the former being probably the chief obstacle. The Coaxial Communications pay TV system, for example, was designed to specifically meet these two problems. The use of simplified digital circuits added to channel converters and the use of the COS devices permits a cable operator to add a return channel to a one-way system for the relatively low cost of a few hundred dollars per mile. And the home terminal costs only a little more than a channel converter.

By comparison, other two-way response methods and devices are expensive, beginning with a $150–200 cost for the home terminal alone. For pay TV applications, however, several companies have begun to produce less expensive units. The Magnavox terminal is estimated to cost about $100 per subscriber and the K'Son model used by Viacom is said to average $60 per home. Some manufacturers, like Oak, have sought to ease the high costs with the modular approach—advance circuitry being added only when necessary to an already purchased converter. As time passes, some of the costs might be expected to drop due to the increasing amount of research being done and the increasing number of units being produced. For example, the Coaxial Scientific pay TV unit is reported to cost approximately $15 in mass production (without converter).

Pay TV via cable in its first years of commercial existence has exhibited an ability to attract new revenue to the cable industry. It has not yet proven to be a runaway financial success nor has it shown itself to have the same appeal in markets across the country. Although some observers fear that pay cable may become so successful that it might be able to outbid both theater owners and broadcasters for popular movies there is no support for those worries in the trends of the first few years.

What pay cable has accomplished has been a demonstration of the means to achieve the full services of two-way cable TV. Pay cable has brought to the marketplace a service that apparently meets some needs or desires and which is already on the road toward becoming a two-way service. Presumably, the most beneficial and flexible form of pay TV would be one that did not charge for shows not watched and did allow a customer to pick his or her own time for watching. This will require some form of interaction. Consequently, both producers and consumers alike expect, happily or not, an almost inevitable progression over the years from present pay-channel procedures to eventual two-way cable techniques. If pay cable is successful to the extent that has been forecast, it will provide both the money and some of the hardware for other interactive consumer services.

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Chapter 6

Prototypes at Large

Within the telecommunications industry during the last several years, a number of two-way or interactive services have developed independently of cable TV but with the stated purpose of eventually utilizing two-way cable systems if and when they become ready. Other similar services have come about with a less direct intent to move to cable but would still consider the situation open and could become a part of the two-way cable industry if opportunities appeared.

These services and accomplishments, which are more or less waiting for the establishment of two-way cable facilities, are important considerations for proponents of two-way TV for their position as prototypes for subsequent services. These examples of two-way broadband and wideband communications have elicited customer reactions and user appraisals and have gone through design improvements in the process of ironing out their difficulties. When the time comes to market two-way cable services, a body of reference material already in existence can assist in innumerable ways. Moreover, some of the prototype services will need little or no alteration to switch from one transmission facility to another, perhaps to cable TV systems, or to be duplicated independently on different telecommunications systems. Just as Optical Systems leases channel space on various cable systems for its pay TV product, suppliers of the prototype services could, and in certain cases very likely will, lease cable space for their by-then-tested services and products.

Naturally it is not possible, nor particularly useful, to enumerate all two-way broadband services that might be considered as part of two-way TV, either now or at some later date. But it is certainly useful to explore a representative sampling, and that is what this chapter attempts to present. Some of the examples mentioned, like the two-way microwave TV system for government use, are already of themselves part of two-way TV, while other examples may become part of two-way TV if they are adapted to cable TV systems as a two-way service. In general, the examples mentioned may be taken as an indication of emerging sources of two-way services which are likely to merge with the mainstream of two-way TV in years to come.

TWO-WAY TV

A small number of institutions, primarily hospitals or medical complexes, have used TV cameras in conjunction with TV monitors and established limited two-way TV communication. In Britain, Canada, and Australia, the authorities who govern telecommunications have likewise established two-way TV in the form of TV conference facilities which can be rented by interested groups. In Britain, the service known as Confravision is available in five cities that have specially equipped rooms located in government buildings and interconnected for two-way TV.

However, perhaps the most ambitious project so far to have full two-way TV communication between more than a handful of locations has been a municipal government network in the Eastern United States. In New York, New Jersey, and Connecticut, members of the Metropolitan Regional Council, consisting of elected officials for county and local governments in those states, have the capability of communicating among their administration offices via TV. This communications system, described in detail in a Rand Corporation report by Rudy Bretz, *Two-Way TV Teleconferencing for Government*, uses microwave links between the buildings.[1] The idea of using cable TV systems occurred to the designers but such systems were simply not available and the idea was necessarily dropped for the immediate future.

The advantages of using cable TV lines, though, were inadvertently underscored by some of the difficulties the system encountered with microwave. For example, one of the greatest single causes of system failure in the beginning was antenna arrangement. The microwave antennas were subject to displacement by winds and storms to such a degree that at one point vandalism was suspected. Another advantage of using cable systems would have been the extra frequency space for control signals and audio communications. As it was, the system was designed to control all microwave transmitters from one central location. This necessitated the leasing and interconnection of signal-grade telephone lines (that is, lines below voice grade) for remotely turning the transmitters on and off with data pulses. Also, users of the system found that the operation would go smoother if audio channels were available beyond the one audio channel for the speaker being televised. In particular, an audio channel or phone line to camera operators or transmission controllers was deemed highly desirable. Yet it was not established in a number of cases because of the difficulty and cost of bringing in a telephone extension. All of these problems could have been greatly alleviated had an adequate broadband cable system been in existence.

The MRC–TV system, as it is known, was first proposed in 1969 and later studied and designed under a grant from HUD. In order to establish the needs that this system would meet and the use that it would have, the Rand Corporation was engaged to study and evaluate the existing lines of contact among the Metropolitan Council members. Since the regional council covers an area that includes 22 counties and over 500 smaller governments, the Rand researchers were able to draw up a long list of peer groups or common interest groups that exchanged information among themselves and would welcome a further opening of these contacts. The opportunities for sharing information in the form of special seminars and in-service training were also brought out by the Rand surveys and questionnaires. The various user groups that were identified ranged from boards of directors through mayors, judges, various technical committees, social service organizations, and coroners.

As the studies were completed, the council contracted with Genesys Systems, Inc. of Palo Alto, California for construction of the physical plant. The first experimental use began in July 1973. A year later the MRC–TV system linked seven county seats and two municipalities with a central studio at the World Trade Center in New York City.

The hub of the MRC–TV system is a pair of 180° microwave antennas on the roof of the World Trade Center. The antenna array beams a channel outward to directional-dish antennas approximately 10 feet in diameter located at the local administration buildings in White Plains, New York, Newark, New Jersey, Stamford, Connecticut, and elsewhere. Four return channels are used to prevent interference between adjacent locations.

The two-way unit itself is a TV monitor with a video camera mounted on it, shown in Fig. 6-1. The camera lens is relatively close to the TV screen so that users looking at the person on the screen appear to be looking directly at the camera. The units are usually placed at one end of a conference room and slightly elevated so that all seated persons can have eye-to-eye contact. The cameras are fitted with remotely controlled 10:1 zoom lenses for reaching people throughout the room.

The MRC-TV system uses special conference rooms with a control console included for a technician to monitor the communications if necessary. Figure 6-2 shows a typical arrangement with long tables facing a TV monitor, the two-way TV unit, and the control console. The conference rooms are altered to enhance the TV viewing and to deaden spurious

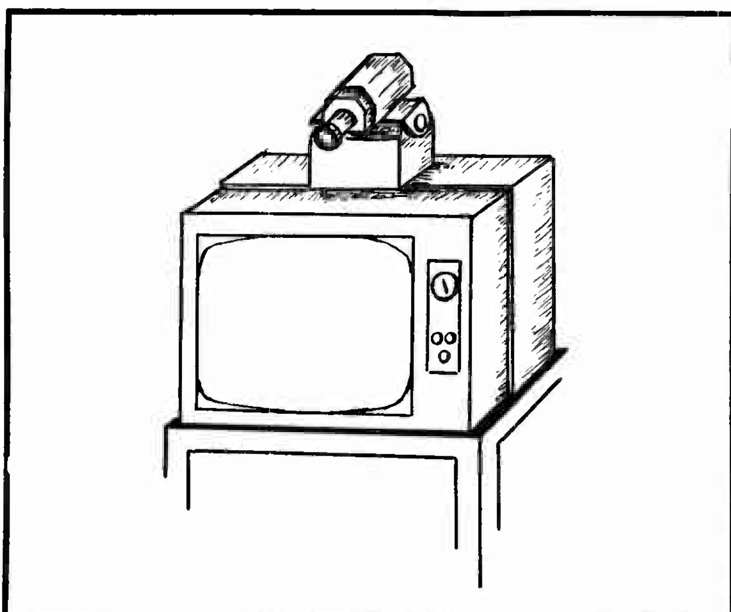


Fig. 6-1. The MRC two-way TV is composed of a camera mounted on a swivel post on top of a TV montior.

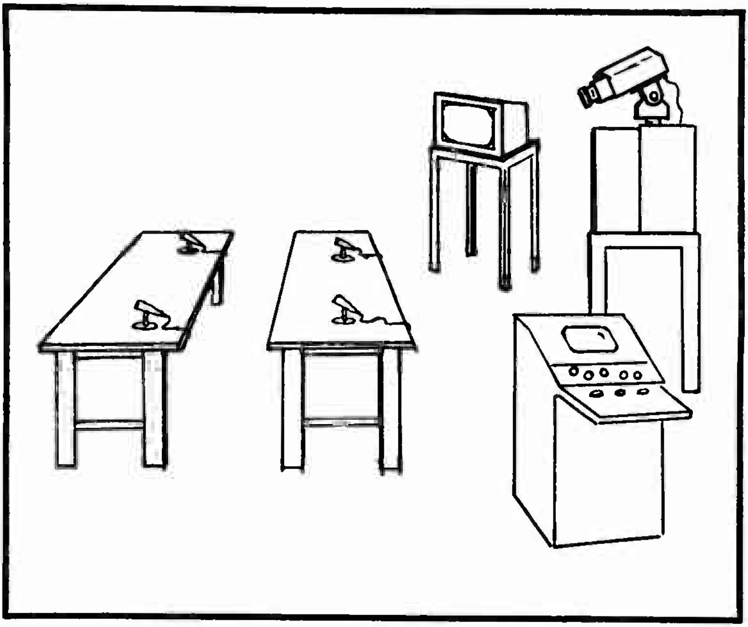


Fig. 6-2. A typical arrangement of several tables, table microphones, a TV monitor, a camera-TV unit, and a control console with its own monitor.

noises, disturbing echoes, and microphone feedback. The control console is included to allow an operator to correct drifting controls governing the picture quality. More often than not, though, the operators merely set up the room and equipment beforehand and are absent when the system is in use.

One of the early unforeseen problems with the system was one of concept, not technology. The MRC-TV users initially treated the two-way TV communicating as a kind of broadcast TV show and not as a kind of video telephone. The central facility at the World Trade Center would begin transmissions with show titles, background music, announcers, and so on. It took some time before the realization set in that MRC-TV was an extension of the group meeting and not a closed-circuit TV (CCTV) show with a gimmick. Although the system can incorporte films, slides, and other visual aids when necessary, its goal is to become as unobtrusive as possible when the users focus on the process of talking to one another.

The system is used on the average of 20–30 hours a week but not all of the locations are participating all the time. For government meetings, the average number of participating locations is six with an average of only two persons at each location; however, during seminars or in-service training meetings there might be 10–20 persons at a single two-way TV location.

Even though the system is still in the early stages of operation, some definite conclusions have been made by the people who use it. Many feel the two-way TV system increases rapport among government officials of different areas and adds needed contacts within governmental levels—contacts that are often desired but neglected because of the travel involved. Interestingly, two-way TV seems to enhance individual instruction during training sessions. Trainees lose the feeling of being lost in the crowd when the instructor and themselves appear as isolated individuals on the TV screen in direct communication.

And unlike either a telephone system or a radio system, users do not become uneasy when nobody is saying anything. In fact, especially during instructional sessions, there are long periods of silence as paper work is being done.

The system continues, of course, to modify itself as time goes on in order to work out the difficulties that it does have. For example, the chairman of a meeting now has the ability to preview the speaker or location next in line for the main channel to see if that location does indeed have something to say. The precedure itself for indicating this underwent considerable change as the system progressed. At first, a button at the various locations needed to be pressed when a location wished to be put on line; however, if the button was not pressed, the central control at the World Trade Center could not see that location. Consequently, users formed the habit of leaving the button pressed all the time. As a result, there was no way for them to indicate whether or not they wished to speak and whether or not they were being previewed by the chairman. Finally, a small unit with a button and a flashing light was devised. The flashing light would indicate that a location wished to speak and a steady light would indicate that that location was being previewed. It was also discovered that a free audio channel was needed independent of the video source so that communications other than the words of the speaker on the screen could take place.

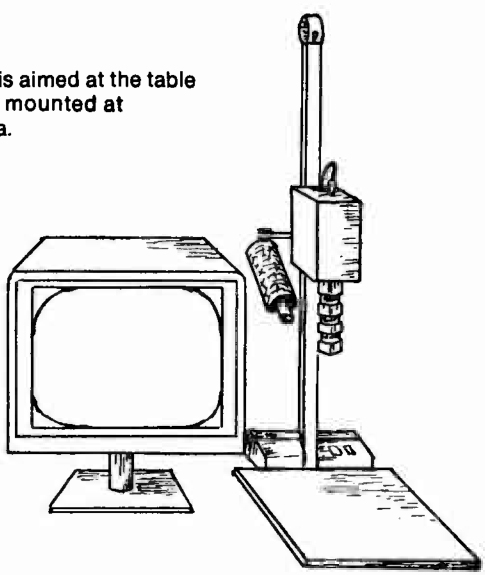
It probably should be pointed out that the system is only full two-way TV when a split-screen effect is used. Since only one channel emanates from the hub of the system, an individual speaker will see only herself or himself on the TV screen. Naturally, speakers would rather see their listeners than a reflection of themselves, so split-screen techniques are often used.

The MRC-TV system has proven, generally, to be of value to the council members because of its ability to foster interaction among government officials where such interaction did not previously exist or was minimal due largely to travel expenses and problems. The council plans to extend the system to more communities and include the addition of smaller and less expensive terminals where only one-way TV but two-way audio would be arranged.

Another two-way TV system of a different sort, on a much smaller scale, has been in use in the Santa Monica, California School District. Although this two-way TV system is designed for use within a single room and has only been in operation since November 1973, it demonstrates some of the distinct advantages of two-way TV for a particular group of people.

Described in the Rand Corporation paper, "An Interactive CCTV System for Educating Partially Sighted and Some Other Types of Handicapped Children," the system contains a handful of two-way TV units in one class-room.[2] Each two-way TV is composed of a TV set and a camera pointed at the desk, as shown in Fig. 6-3. The two-way apparatus is equipped with a

Fig. 6-3. The camera is aimed at the table and a light source is mounted at the side of the camera.



5:1 zoom lens on the camera and an amber light to indicate that the picture is being shown on a room monitor. A control console allows the instructor to communicate with any individual unit, show the student at one unit the work of a student of another unit, superimpose video sources, use split-screen effects, play videotapes, and accomplish other related effects.

For handicapped children, the use of the two-way TV system appears to be beneficial in the teaching process. Paritally sighted students seem to be helped substantially by the ability to reverse black and white tones, options for magnifying material on the screen, and effect of focusing on smaller areas of subject matter under the zoom lens of the camera.

In fact, just as MRC-TV users discovered that two-way TV heightened the feeling of individual contact between instructor and trainee, the Santa Monica experimenters found that handicapped students also indicated an apparent feeling of closer contact with the teacher and were able to spend more time on a given topic.

Both of these two-way TV projects suggest that eventual two-way video communication, on cable systems or otherwise, may not be so much a luxury as a means to satisfy some very real needs. In establishing such services, prototype systems like these will provide helpful guidelines for future system designs.

COMPUTER INSTRUCTION

In the opinion of the director of a university computer center, two-way cable TV systems are the next step in computer-assisted instruction. Dr. Harold Mitzel, in charge of computer-assisted instruction at Pennsylvania State University's College of Education, believes that present methods of bringing computerized instruction to students and others are just preliminary steps. Eventually, two-way cable systems will bring the service to the general population with terminals in community centers, church basements, and libraries.[3]

Some educators have begun to use the word "communiversity" to refer to the process of bringing continuing education to all sectors of society away from the campus and in the community. The distinguished educator and social theorist Robert Maynard Hutchins has suggested that technology such as two-way cable TV could eliminate traditional forms and philosophies of college and university education—home would become the learning center.[4]

Such evaluations of education in general and computer-assisted instruction in particular are obviously long-range suppositions. In the last decade, computerized instruction has failed to make as much of an impact as proponents had earlier thought. During the sixties, major computer manufacturers such as RCA, GE, and Philco launched extensive campaigns to introduce computers into the learning process. But for a variety of reasons these efforts met with little success and were later curtailed. Those schools that did manage to install computer systems for instructional purposes not only experienced problems with developing the courseware but also began to be hurt by rising costs. Computer time became more expensive, as did the leasing of telephone company lines for remote terminals, and federal funding for computer projects began to dry up in the early seventies. From the first days of computer-assisted instruction, and still to some extent, the idea also suffered from hostile attitudes; teachers and administrators would refuse to accept the computer, holding low opinions of its effectiveness, or would simply be uncomfortable using it.

Even though Dr. Mitzel of Pennsylvania State maintains that computers are compatible with almost any course of instruction except those that require physical activity, computers in education have been largely used only for drill and practice work. Successful computer courses are often those for remedial reading skills, mathematics, and science lessons, and similar problem-solving courses.

There have been exceptions of course. In one example, on the university level, a Russian course was offered with marked success at Stanford University. The course attracted a larger number of students than the conventional course, fewer students dropped out, and a higher percentage mastered the material presented; however, the course using the computer cost three times as much and was therefore not continued. Students at the Stanford Computing Center complain that individual professors might wish to use the computers for instruction but that the departments, who must pay for the computing time, are unwilling. According to the students, the opportunities for computerized courses are far less than they would like.

It is on the high school level that most benefits from computer-assisted instruction seem to have come. High school curricula has in the past been more readily adaptable to computerization than that of elementary schools or colleges. It is estimated that 10–20% of all high schools in this country have either a computer or computer terminals for student access.[5] In Canada, Seneca College in Toronto found that computer instruction was quite successful in mathematics prior to college entry. The special course available on a computer network to eight colleges in Ontario and one in Montreal, has prove to be 90% effective and has reduced the learning time to half that of a conventional course for most students and even less for some.

Beyond strict instruction, another service for high school students that seems to be promising is in the area of vocational information and counseling. A computer network linking high schools in the Chicago suburbs of Villa Park, Glen Ellyn, and Elmhurst and a community college in Glen Ellyn provides students with interactive programs to establish career preferences and suitabilities. The computer can even direct students to specific companies, giving them names and addresses. Vocational counselors can also use the computer system when talking with students for calling up student records, academic ratings, and other information kept by school administrations.

Therefore, in spite of the fact that computer-assisted instruction has not assumed an important role in education, there are indications that it eventually will. And there are people working on numerous projects to bring that day closer. One example is the Mitre Ticcit program discussed earlier. Another and even more extensive project is the PLATO (programed logic for automatic technology operations) system for computer-assisted instruction being developed at the Unversity of Illinois.

The PLATO system is one of the few computer facilities to be built entirely for instructional purposes. In the past, computerized instruction has been limited by the fact that computer systems were used that had not been constructed specifically for that purpose. This introduced constraints which many times hampered educational aims.

This system is being designed for as many as 4000 student terminals within an 800-mile radius using telephone company cables or TV cables to link the network. The dimensions of the project seem to make it especially applicable to large-scale urban cable systems, but unfortunately one of the most unique aspects of PLATO—the student terminal—is not and cannot be a standard TV receiver. The reason is that the student terminal does not use a CRT but a plasma display panel.[6]

The plasma panel can accept information and continue to display it without a steady stream of input or without input from a picture-refresh device or frame grabber that is necessary for a standard TV. The plasma panel does so with the help of ionized gases that remain glowing until new picture information is received. In effect, the display is composed of thin glass sheets in which are imbedded tiny wire grids invisible to the eye. A gas between the glass sheets is ionized at selected points in the wire grid producing light; illuminated points can be sustained by a lower voltage applied to the entire grid. The points are so tiny that images on the panel are extremely sharp.

In terms of instructional possibilities, the plasma display panel is indeed versatile. An infrared sensor in the panel allows students to point to any spot on the panel to trigger a response. The panels are also transparent to permit superimposing. In addition to the video features, the student terminal can be used for access to audio play-and-record devices.

Despite the terminal design, PLATO has produced much that is compatible with computer-assisted instruction programs using CRT terminals. Primarily, PLATO researchers developed a special programing language called TUTOR that is tailored to instructional purposes and designed to improve the productivity of teachers. So that the language can be used by all teachers and not just specialists in computer programing, it is structured to require no computer background at all. The development of TUTOR should not be underestimated when considering large-scale instructional computer systems for diverse student needs. Canadian educators recognized several years ago the advantages of a common programing language for teachers to use. The Canadian National Research Council began studying the problem in the early seventies and subsequently established standards for a computer language that are in force throughout that country.

Several courses using the PLATO system have met with the same success in terms of time saved and mastery achieved that was experienced at Stanford University. At the University of Illinois, a Latin course was able to accept four times as many students as a noncomputerized course; most of the students reached the desired level of mastery while at the same time covering 30% more material. And with the use of the computer, twice as many students signed up for Latin as before.[7]

The PLATO system, under development since 1959, has been scheduled for its first large-scale test to begin in late 1973. Using 500–1000 student terminals costing $5000 apiece, the system is to operate for 2 years and then be evaluated by the Educational Testing Service of Princeton, New Jersey.

The age of maturity is still in the future for computer-assisted instruction. A reasonable assumption is that computerized instruction will continue to expand and to embrace more and more students and courses of study. And because of the nature of computer systems, students may find themselves far removed from the computers themselves and perhaps no longer in a classroom situation. Some industry representatives suggest that computer utilities will arise that will market education through thousands of terminals. Those terminals could well be standard TV sets connected to two-way cable or specialized common carrier systems.

VIDEO GAMES

William Arkush is the owner and operator of a modest cable TV system serving the community of Glenwood, California in the Santa Cruz Mountains. He is also one of the top men at Atari, Inc., a leading manufacturer of electronic video games. Not surprisingly, his dual interests have led to feasibility studies for putting the successful coin-operated video games onto cable TV systems.

That there is a large market for electronic video games has been demonstrated by the rapid expansion of the industry in a short period of time. The first game of the recent wave was invented in 1972 by Nolen Bushnell, now president of Atari, and produced by Nutting Associates Mountain View, California. During 1973, video games were being manufactured by nearly two dozen companies in the United States and a similar number in Europe. Sales in this country alone totaled $20 million for 1973. Atari itself averaged about $1.8 million in sales every month as of mid-1974 with such games as Pong, Superpong, Quadrapong, Pong Doubles, Space Race, Gotcha, Grand Trak 10, and others. (A few are depicted in Fig. 6-4.)

Although the pace slackened somewhat in 1974 and several companies discontinued the video games, industry representatives see a fairly steady large market. Atari, for example, produces a new game every 3–4 months and

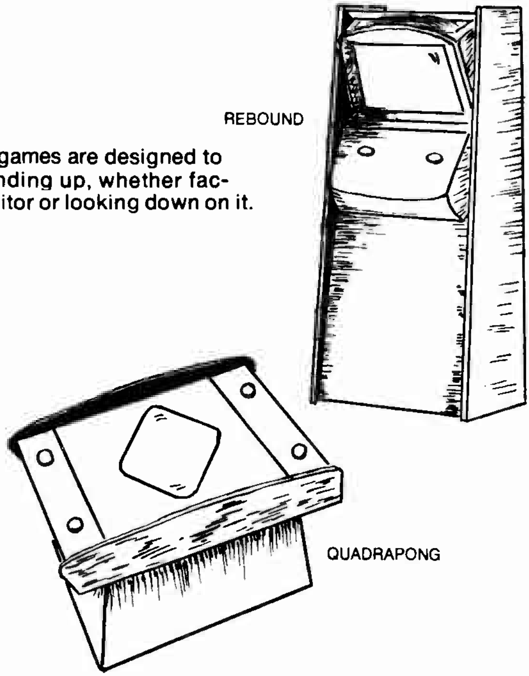


Fig. 6-4. Atari games are designed to be played standing up, whether facing the TV monitor or looking down on it.

maintains that there is always a resale market for the older games. Further, in 1974 Atrai began using lighter weight cabinets for their games in order to ship internationally.

The home market is a potentially lucrative area, relatively untouched, that has been under study by video game producers. Magnavox Company began offering their Odyssey game in November 1972 for use with TV sets and sold some 90,000 units during 1973. There is a basic difference, though, between Odyssey and the electronic video games produced by companies such as Atari. Odyssey—a collection of a dozen or so different games including football, rifle practice, roulette, and table tennis—uses relatively inexpensive analog technology to produce movement on a TV screen. Backgrounds or playing fields for the games are printed on clear Mylar sheets which adhere to the face of a TV set. Even though in early 1974 Magnavox brought suit against several manufacturers of video games charging infringement, there seems to be little similarity in design and construction.

The Atari games, for example, do not use analog technology but sophisticated digital techniques. The brain of the Atari games is a circuit board of over 100 semiconductor devices which is in essence a computer. The computer board, less than 1 foot square (shown for comparison in Fig. 6-5), costs from $300 to $600 depending upon the game. The most expensive computer board to date has been used for Grand Trak 10, a video game in which a driver speeds a racer along a convoluted path—using a steering wheel, gas pedal, brake, and four-speed shift—and is subject to oil spills, spinouts, and simple crashes.

In looking to the home market, Atari engineers have assembled several prototype games for use with TV sets. (The original coin-operated video games did use standard TV picture tubes for the playing field; later the switch was made to transistorized monitors manufactured specifically for video games by companies like Motorola, Inc.) The games use hand-held controls connected by cable to the TV set. Although these prototypes were in the early stages of development, Arkush had already designed a closed-circuit system for adapting video games to a cable TV network.

The design for joining interactive video games with a centrally controlled TV system was produced for a Southern California motel to allow guests in each room to use the room TV to play games like Pong and Space Race. The circuits for the backgrounds or playing fields and other general effects

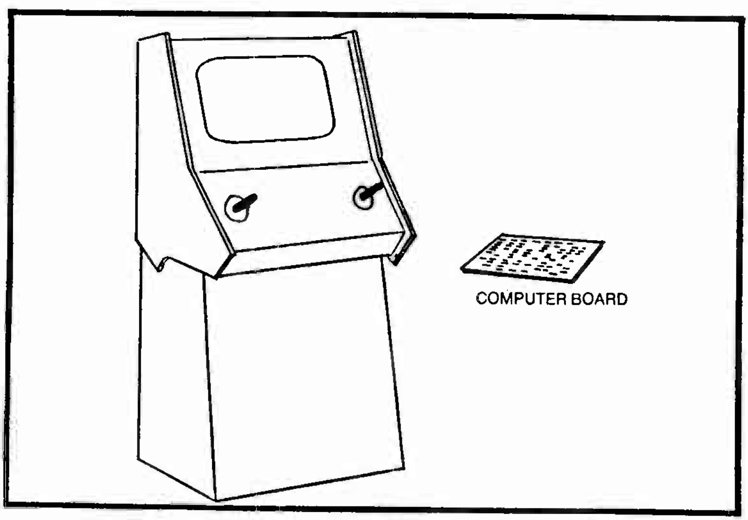


Fig. 6-5. Approximate size relationship of video games and their computer boards. The game depicted here is Space Race with its "joystick" controls.

were located at the head of the closed-circuit system and broadcast to each room on a game channel. Nevertheless, a computer board was still needed in each room to provide the logic governing individual player action. This proved to be almost as expensive as putting a complete Pong game in each room and the motel subsequently did not install the system.

In a different way, Atari's Arkush has designed other systems for bringing numbers of players onto the same computer board circuits. A trio of bar/lounges has been fitted with a system that employs one wall-size TV screen and individual controls at each table. Players at one table can compete with players at other tables. One person, usually the bartender, is provided with the switches to allow tables to play. The video screen used has been a Sony model measuring 30 by 40 inches.

These two examples of electronic video games being part of larger systems indicate what is possible in regard to video games and cable TV, but there are a host of problems to overcome beforehand. In theory, one computer board per game located at the head end would allow a cable subscriber to play the game on his own TV. Signals from the controls in the home could be returned to the head end with relatively little difficulty, as has been demonstrated for similar arrangements. The drawback, however, is that only one subscriber could use the channel at a time. Possibly in limited applications this might be feasible when four or five game channels are provided. For the average cable TV system, though, computer logic at each home terminal would likely be necessary. This solution has been discussed, but at present is economically prohibitive and technically difficult.

Another alternative to the one-game-per-channel idea could be the use of image-retention methods such as those developed by Bell Laboratories for Picturephone. Instead of a picture being continually transmitted, only the segments of the picture that are changing from moment to moment need to be transmitted. In video games, this could reduce drastically the amount of video information that would be flowing to the TV set since relatively little moves. In Pong, for instance, the only moving images are two paddles, a ball, and periodic score changes. Consequently, digitized video signals for a number of games could carry coded addresses for assignment to specific home terminals.

Besides the technical considerations, other factors may serve to hinder video games like the ones being discussed in any move to cable TV. The very versatility of the games could be a problem. Some games require more than a simple joystick or knob to control the action. Home users would be faced with the need to continually add to their stock of control units if they wished to continue to play new games.

Aside from the computer-controlled games and Odyssey, several other games have been marketed for use with TV and cable systems. For example, the Telattach Corporation in Chevy Chase, Maryland began in early 1974 to sell a racing set and an all-purpose game/study board designed for cable TV. The racing set consisted of a steering wheel and dashboard unit connected by wire to a special frame that fits on the front of a TV and borders the screen. The steering wheel and other controls would be used to maneuver the figure of a car fixed to the lower part of the frame. The background of roads, hazards, and so on would be telecast from the head end of a cable TV system in a series of 20 programs lasting 30 minutes each.

The game/study board was a more sophisticated device that allowed for true interaction between a person at home and a person at the control center via a cable TV system. The tabletop unit contained eight rows of eight buttons capable of illumination; the unit would be connected by wire to a tiny photocell that would be held by a suction cup to a corner of the TV screen. Educational programs and games would be sent out from a cable TV head end with coded blinks incorporated into the picture information. The photocell would read the coded blinks to turn on or off the lit buttons. A teacher being televised, for example, could ask homebound students questions requiring the pressing of one or more buttons. If the answer is correct, the buttons would light. The board could also be used for games like chess.

In general, there seems to be a long-standing subtle yet recognized relationship between games and TV, perhaps stimulating the development of games using the TV set itself. Television has long been a medium of entertainment and especially of games. Game shows are a large part of daytime TV fare and in fact have doubled in number over the last 4 years. Now, it seems, the medium may become the entertainment; TV will change from a passive presenter to the game itself. Allen Ludden, a familiar radio and TV game show host, once commented that game shows survive because the viewer becomes a participant.[8] People seek participation, he said, and do not always enjoy being in a third-person position when watching TV. With two-way technology, that desire for participation could spawn new types of video games as well as fascinating combinations of the video game and the TV game show.

The probability for a form of electronic video game becoming a two-way TV service is aided by the fact that games may prove financially successful much more quickly than other two-way TV services oriented toward education or social services. As soon as the technology becomes inexpensive enough, video games could well find a ready audience. It is probably human nature that people will spend money to amuse themselves that they would not spend otherwise. A clear example in cable TV is pay TV, where subscribers must double their monthly payments for a service that is 90% entertainment. Participatory video games, it seems, can realistically expect a secure place on advanced two-way TV systems.

NEWS ON DEMAND

One of the more distant services prophesied for two-way TV has been the electronic newspaper, supplementing or replacing home delivery of printed material whether in the form of newspapers, magazines, or advertising sheets. The future of such a service for home customers is definitely uncertain, but in the business world an electronic newspaper and news recall service is a fact. One of the most prominent examples is the Dow Jones News/Recall Service available since early 1974.

The Dow Jones news/recall service is a joint undertaking involving Dow Jones and Bunker Ramo Corporation's Information Systems Division. The computerized service indexes stories appearing in the *Wall Street Journal*, *Barron's Magazine*, and the Dow Jones News Service and keeps them in an instant-access computer file for 3 months. Any customer with a suitable terminal can call up a list of stories in over 6000 categories and then review the text for any story listed. The news categories include approximately 6000 companies by name, 25 industries, and 15 government agencies as well as broad categories like "Monetary news items—current day and past 90 days."

The Bunker Ramo Corporation is the only company marketing the facilities to handle the service, but plans do call for the indexed information to be sold to other distributors. Presumably, the instant-access news bank will find ready customers in the overall business community. A Dow Jones news/recall representative reported in mid-1974 that the service was being marketed to government, military, and corporate interests and that thousands of customers were expected by 1975. As cable TV systems turn their attention to business uses, it is conceivable that a distributor of news/recall information would buy the data from Dow Jones and then market the service by leasing channel space on an urban cable system.[9]

As it operates now, though, any news/recall service relies on the Bunker Ramo system for automatic stock quotations. Since 1971, Bunker Ramo has provided, under contract with the National Association of Securities Dealers, an electronic stock market information service known as the NASDAQ system (National Association of Securities Dealers Automation Quotation system). The customer terminals in the NASDAQ system come in several models, but the prime model consists of a CRT monitor and a 90-button keyboard. Figure 6-6 shows such a monitor and keyboard. The terminal can be used to watch the stock exchange tickers, get financial information on companies, alert the terminal operator when a designated stock reaches a predetermined level, find current trends and

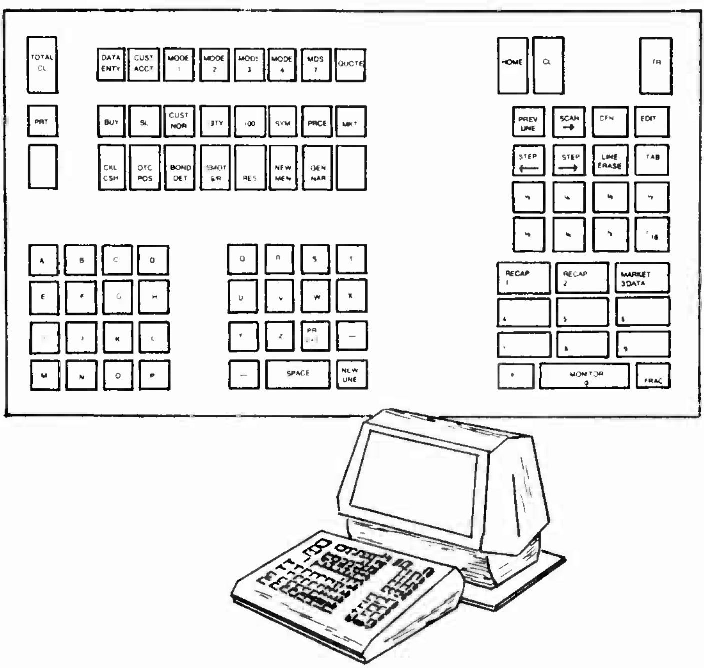


Fig. 6-6. Bunker Ramo System 7 CRT terminal and keyboard.

averages, and perform various other functions pertinent to brokerage offices. These terminals, part of Market Decision System 7, can also be connected to hard-copy printers for a written record of any displayed information.

Some 700 brokerage offices across the country utilize Bunker Ramo's System 7 stock services via high-speed data lines from a central computer complex in Trumbull, Connecticut. The System 7 network was developed at the same time the news/recall service was being designed. Initial work on the news/recall service was announced in December 1971 and it became functional in March 1974, while System 7 planning began in 1971 and culminated in a functional system in 1973.

The Dow Jones news/recall service uses the System 7 terminals for access to the computerized files. For instance, if information is desired on the communications industry, a user would key in I/COM, the code for that industry. The following three keys would then be pressed: SPACE, MONITOR, and RECAP. Finally, transmit key TR would be pressed. A list of headlines would appear, each headline preceded by a two-letter code, the month and day the item appeared, and the news source. For example, WSJ would indicate *Wall Street Journal*. In order to read the text of any story listed, the two-letter code preceding the headline is entered and the TR key is pressed. Stories may fill the screen several times over and be viewed on successive "pages," each page being turned with a flick of the TR key.

The news service not only provides the indexing and recall, but does so instantly before some of the news stories even reach the printed media. *Wall Street Journal* stories are entered the night before the paper hits the streets, while Dow Jones stories are entered simultaneously with appearance on the tape.

The Dow Jones news/recall service, which had 50 subscribers as of June 1974, is indicative of the type of informational service possible with two-way TV on a national scale. The acceptance or nonacceptance of news/recall during this decade will give a general indication of the probable success of that or similar services via cable TV systems. Again, the cable system could be merely the provider of leased lines. Aside from actual news retrieval, cable systems can lease channel space to news agencies for private networks as is evidenced by reported plans in New York City for Reuters News Agency to utilize cable TV channel space for restricted connections.

BUYING and BANKING

Banking in the home has been one of the most mentioned possibilities for two-way TV and has indeed been tried via telephone lines. That particular experiment was not successful enough to continue, lending support to the view that banking from terminals in the home is unwieldy and even unnecessary. But banking from remote terminals, though not remote enough to be in the home, has been instigated and has been popular. One very good example has involved remote banking terminals at supermarkets.

The First Federal Savings and Loan Association in Lincoln, Nebraska put the idea into operation in January 1974. Starting with two grocery stores of the Hinky Dinky chain, First Federal installed IBM computer terminals at checkout stands. Savings depositors had already been issued plastic identification cards 2 years earlier when First Federal began studying the idea by putting computer terminals requiring the plastic cards in branch offices. At the Hinky Dinky terminals, the magnetically coded plastic cards allow checkout clerks to make deposits and withdrawals for customers as well as subtracting the cost of groceries from the customer's First Federal account. For instance, if a deposit of $50 was made, the clerk would take the identification card, insert it in the terminal, press several buttons, and put the $50 in the cash register. The computer would credit the customer's account and subtract $50 from Hinky Dinky's account. In like manner, withdrawals would be made from the store's cash registers.

First Federal felt that the service would be beneficial all around. The terminals cost $500 apiece but reduced the cost of each transaction from $1.75 to 50¢. The service brought a sharp increase in new accounts, although this might have been due in part to special introductory offers. Hinky Dinky personnel favored the service because it seemed to please the customers and increase business, and it provided a good means of verifying checks. Presumably customers benefited in reduced trips to First Federal offices and in being able to use their savings account to buy groceries.

This latter point was the major weak spot in the entire scheme. For in early March 1974, five Nebraska banks sought and obtained a court order to prevent the savings and loan association from continuing what they had called the Transmatic Money Service. Several of the banks cited as a reason the apparent use of a savings account as a *de facto* checking account. The court injunction was soon lifted but the service was kept in suspension because the Nebraska Attorney General charged in further court action that Hinky Dinky was illegally engaged in banking.

If First Federal (the second largest savings and loan association in Nebraska) is able to restart the service and it continues to be successful, the company intends to go ahead with previously drawn expansion plans. After a year of continuous operation, the plans call for banking terminals in all 27 Hinky Dinky stores in the state. Soon after that acomplishment, First Federal plans to have the Transmatic Money Service become an interstate affair with terminals at stores in Council Bluffs, Iowa. In anticipation, several Nebraska banks (other than those who opposed the service) began preliminary studies for establishing their own similar services.

Even though the Transmatic Money Service used leased telephone lines for the remote connections, there is no insurmountable obstacle to leasing channel space on a cable TV system. Selman Kremer, a communications consultant specializing in cable TV, argues that the next evolutionary step for cable TV is the leasing of channels to business and industry. He suggests that long before home subscribers become familiar enough with two-way cable services to want them, such services will be common in the business community.[10] Improvements in computer peripheral equipment and the FCC approval for the interconnection of diverse equipment with telephone systems have both spurred the need in the business world for linking facilities.

Cable systems leasing to business, according to Kremer, will find themselves sharing the receiving end of billions of dollars. The addition of such revenue to the cable industry will not only pay for the business services but will also help pay for the development of two-way services for home subscribers.

Just as pay TV via cable is likely to form the first economically successful stage above standard cable TV service for the cable TV industry, the leasing of channel space to business may well comprise yet another stage. However, that outcome is not as assured as it sounds when placed in the context of the entire telecommunications industry. Business communications are a complex mixture of means and modes. It is extremely unlikely that cable TV systems will replace any existing carriers and it may be many years before cable wins a position of importance. Meanwhile, other telecommunications entities and service companies are studying and test marketing the same two-way services that the cable industry has considered its own.

In short, the revenue from business and government uses of new services such as the ones mentioned in this chapter may indeed fund the extension of two-way TV to the home, but the cable TV industry itself may not be the runaway winner.

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Chapter 7

The Dominant Computer

Throughout this book, computers have been mentioned repeatedly in connection with two-way TV as the generators, controllers, and processors of two-way TV signals. Most of the services that fall under the umbrella of two-way TV require computer assistance in some form or other ranging from computer files to computer switching exchanges. It would be a mistake, however, to conclude a discussion of two-way TV without putting the computer and broadband communications in proper perspective.

In essence, advanced telecommunications are more a product of the computer world than the other way around. Historically, the computer field has prepared the way both directly and indirectly for two-way TV services. Harold Sackman points out in *Mass Information Utilities and Social Excellence* that it was the leading computer communications firms who developed the technology for information traffic on cable TV systems.[1] The two-way TV itself was once even envisioned as a minicomputer center completely independent of cable TV. Such a development was described by Claude A. R. Kagan in a 1967 paper as the "Home Reckoner Set," a programmable terminal with memory and keyboard that would control all kinds of home entertainment and information services.[2] The TV information services were broadcast over UHF channels and the return link for all communications was the telephone line. Stretching back to the previous century, the title "Home Reckoner Set" was borrowed from an 1889 story by Jules Verne, "One Day in the Life of an American Journalist in the Year 2889," in which a reckoner was a computer-like device for storing and routing telecommunications to individual terminals.[3]

Much more recently, computer manufacturers have brought forth similar "smart" terminals for widespread use in merchandising. The computer cash register can read prices stamped on items, and it could be a forerunner of the home two-way TV unit that not only ties into a computer but is itself a minicomputer or microcomputer. This is already the case in supermarkets. Some terminals are merely input/output devices but others are intelligent terminals; that is, they contain within themselves microprocessors. In both cases, the terminals are connected to a central processing computer to operate the system. Many of the big names in the computer industry—IBM, Litton, NCR, Singer, Univac, Bunker-Ramo, National Semiconductor—are active in producing these merchandising terminals and systems. It is only a small step further to intelligent terminals in smaller businesses and even the home when desirable.

The computer was not always intimately tied to communications, though. The first electronic data processors of the mid-1950s were in effect merely more efficient tabulating and calculating machines. The second generation of computers in the late 1950s, however, appeared with transistors and better memories and sparked experiments in telecommunications use. By the early sixties, the third generation of electronic computers had arrived along with solid telecommunications use and the beginning of computer networks.

As one source put it, the "gray area" between computers and communications is now shrinking rapidly.[4] By 1980, most computers will be integrated into communications systems. The estimates range from 70% upwards. Along with advances in semiconductor technology and the miniaturization of electronic components, developments in computer design have facilitated the computer-communications marriage, sometimes dubbed "compunications." Walter Bauer lists in a 1968 paper such technical developments as interrupt capability, executive programs, multicomputer centers, conversational computer languages and techniques, and ever more versatile display terminals as specific steps toward the union of computers and communications.[5] This so-called marriage of the two industries has opened up extensive possibilities in information access, computer networks, computer utilities, and the general interaction of knowledge—an all-encompassing arena of which two-way TV is just a part.

Before touching on some of the broader implications of the compunications complex, though, it would be well to begin with a present-day look at the computer's appearance on the cable TV scene.

At the Head End

Computers were initially used in cable TV installations for preparatory work such as generating design models prior to construction. In *The Use of Computers in CATV Two-Way Communications Systems*, Larry J. Campbell describes computer-assisted design of amplifier distribution as one of the earliest applications of computer programing in cable TV.[6] This was due in part to the growing complexity of cable TV installations and in part to the increasing availability of design programs. He cites the IBM "Continuous System Modeling Program" as a typical example of the many computer languages developed by the computer industry for system design. The language incorporates both standard and specialized elements which can be arranged into relationships resembling the desired system. The relationships are then translated into the program for processing. The computer-generated models can then be used to study the varied technical and economic factors influencing a cable installation. Usually such design methods are used to map out highly technical problems such as transmitter and receiver interference and signal propagation factors.

A fundamentally different version of computer analysis known as discrete system simulation has also been used by cable system engineers, especially in designing two-way systems. A typical language in this category is Simscript, which was created to make system design easier. Simscript allows users to reduce the amount of their own calculations and permits required calculations to be performed in relatively less time. Discrete system simulation has been used for studying subscriber response on simulated two-way cable TV systems in order to perfect the two-way design.

In general, computer programs have served many areas of cable TV operation. Another of the common uses mentioned by Campbell has been in the selection of microwave sites. Numerous computer-developed models have been devised and utilized by telecommunications companies to study broadband and narrowband signals in designated environments. These models are readily available and are often used by equipment manufacturers as part of their sales package. Cable locations, connection points, and amplifier levels have also been subject to computer-assisted design techniques.

Beyond construction and installation, computers are used to run the office, so to speak. The electronic data-processing machines have been used to control the TV programs on different channels, to handle billing and accounting, to assist marketing efforts with population studies and address lists, to handle the payroll, and to generate growth curves and economic forecasts.

In two-way operation, during the design stages, computer programs already developed for other purposes have been used to study and help reduce random data errors and to analyze signal loads and user demands. When the two-way system begins to function, computers (in reality usually minicomputers) control the polling of subscriber terminals, processing of responses, and instigation of remote activity. As described in earlier chapters, the computer center can unscramble pay channels, open restricted channels, call up stored information, dial emergency services, and perform any of scores of distinct remote operations.

As two-way TV expands on cable systems, control computers will not only handle subscriber requests in a closed system but will also act as an interface with other computers and data services. In practice, this could involve several minicomputers, one for operating the cable system and one or more for packaging and routing communications to and from other computerized communications centers.

According to Campbell, a computer specifically designed for cable systems will eventually be marketed.[7] At present, two-way pilot projects use commercially available computers together with specially designed processing units. For example, Tocom, Inc., among others chose an Interdata Model 70 to mate with their own equipment because of the minicomputer's proven capability for data communications. In Fig. 7-1, a typical processing center is shown incorporating an Interdata Model 74. This particular arrangement is based on equipment produced by Oak Industries Communications Group. Interdata, Inc., has placed heavy emphasis on the communications applications of their computers and have designed a series of machines for data communications uses.

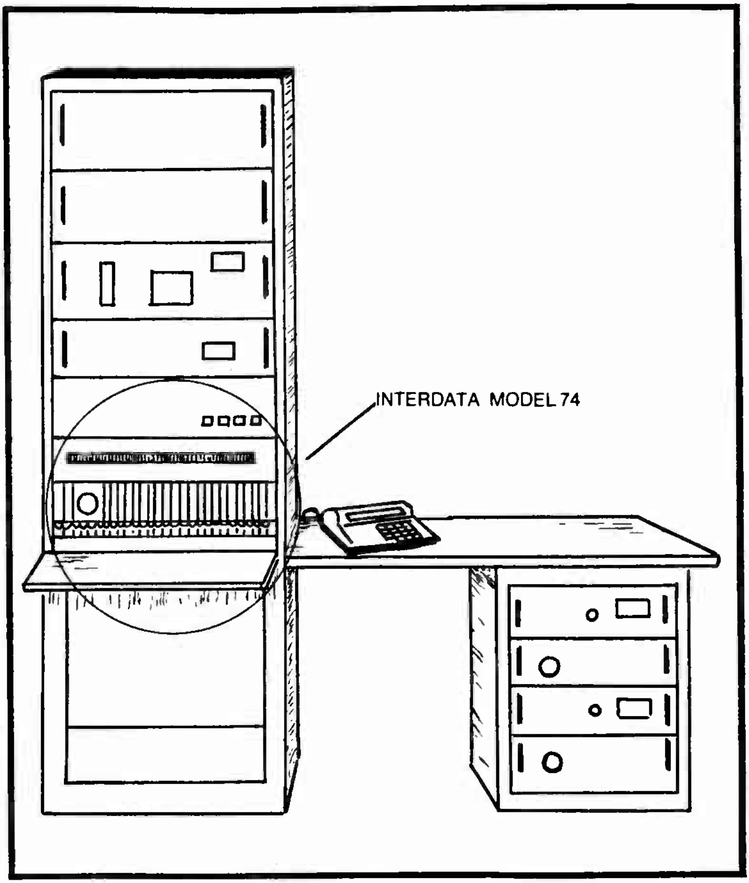

Fig. 7-1. A sketch of Oak Industries Communications Group's computer processing center for two-way cable TV incorporating an Interdata minicomputer.

They are keeping a careful watch on the two-way cable TV market and are well aware of the favorable way their machines have been treated.

The major computer manufacturers have not been blind either to the possibilities for producing computers or related products and services for two-way TV. The matter has been studied by IBM for nearly a decade from a number of angles and in cooperation with different cable TV companies. For example, IBM representatives worked closely with United Cable Television Corporation (then LVO) when they were preparing their two-way pilot project, and IBM has worked with Teleprompter Corporation in regard to digital communications via satellite. Because their role in two-way TV is still in the evaluation stage, some work by IBM remains confidential.

The privilege of confidentiality has also been invoked by Burroughs Corporation who may likewise be studying two-way TV but declined to comment on the grounds that they cannot release information on what might be commercially available as future products.

Eventually, as minicomputers proliferate at cable TV head ends, microcomputers may show up as integral parts of home terminals. A paper by Laurence Schear in the 1972, "Proceedings of the American Federation of Information Processing Societies (AFIPS), sketches the downward trend for minicomputer costs (as low as $1000) and their potential in two-way TV systems. With computer functions available at subscriber terminals, new avenues for services and uses would open up. As just one example, the electronic video games that now incorporate a $300-plus computer board could be adapted to cable systems and home TV units in a way that is not possible now. In general, microcomputers as part of the home terminal could perform limited calculations and remote control functions without taking channel space on cable systems or requiring time on large-scale computers devoted to more complex uses.[8]

The proposal for the microcomputer home two-way TV terminal, and related talk about computers in every home, does not at all detract from the idea that one of the chief assets of two-way TV is the link to a computer. Having a calculator with a small memory at home is far removed from having access to the files and services of large-scale computers. The interconnection of computers and the establishment of computer networks remains as the greatest single avenue of growth for two-way TV.

COMPUTER NETWORKS

There is little doubt that computers will be increasingy interconnected. It is the "wave of the future." In a relatively short time, computer networks have established themselves as a further major step in the progress of electronic data processing.[9] The advantages and savings of the networks have been substantial enough to encourage a broad push for interconnection from nearly all sectors of the computer's public. For one thing, networks allow participants to share the differing capabilities of the interconnected computers. Also, networks provide available backup computers when one malfunctions. And networks in effect increase the capacity of any single computing system manyfold. With data and programs stored at one computer complex at the disposal of users at other computer centers, the total cost for computing power is lower.

The structure and capabilities of computer networks has probably best been illustrated by the much discussed Advanced Research Projects Agency network, or ARPA. The ARPA network has been called "clearly the archtype of future large-scale networks" and the nearest approximation to the conditions for establishing cable TV computer networks.[10]

The ARPA network was put together in the sixties to join the research facilities of universities such as Stanford University and the Massachusetts Institute of Technology and government and private research centers such as Ames Research Center (NASA), Rand Corporation, and Mitre Corporation. But beyond merely joining computers, the network was to study itself to specifically develop computer networking. True to its mission, the ARPA program has continued to advance and improve computer networking, perfecting techniques that were later borrowed by private industry.

The network has been the subject of much interest because it links a large number of dissimilar computers and does so by using smaller computers to package and route the data. As of January 1974, the ARPA net was composed of 36 sites (nodes) stretching from Hawaii to Europe. Each node had one to four large-scale computers on the premises that were part of the system. In all, some 19 different types of computers were represented. To connect these computers into a network, other computers known as interface message processors (IMP) bundle the data streams into packages of 1000 bits or less and route the packages to the proper destination over the best available transmission lines.

An IMP at each node thus communicates with IMP units at all other nodes. Figure 7-2 gives a simplified illustration of this arrangement. In order to extend the network to groups without their own host computer, terminal interface processors (TIP) were added to give remote terminals the same capacity as a node. In another furthering of the same idea, an ARPA network terminal system (ANTS) was also introduced as a sort of "minihost" system to connect remote terminals to the large host computers at any node. The various computers are linked

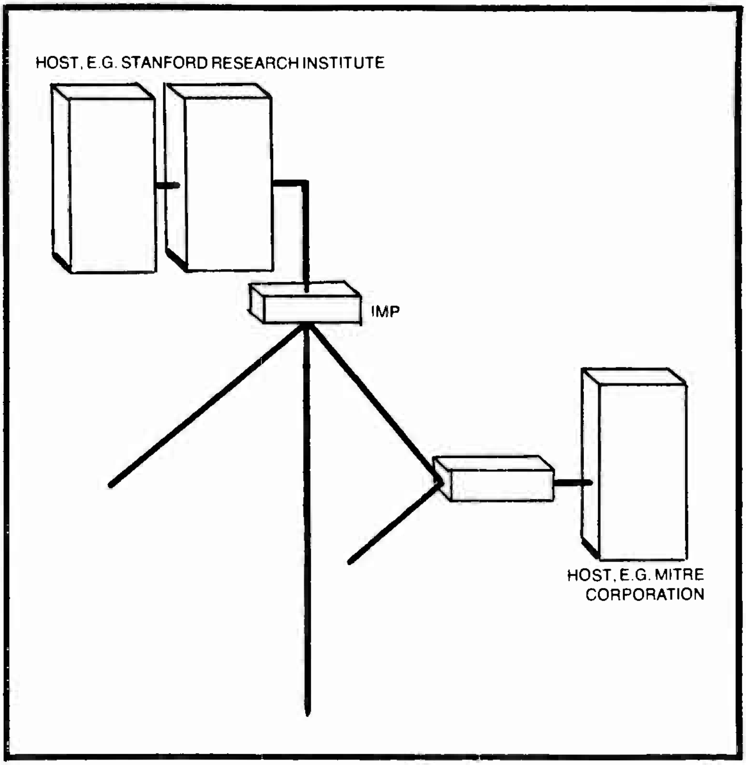

Fig. 7-2. Simplified diagram of the IMP—host relationship in the ARPA network. Approximately 40 host computers are joined through interconnected interface message processors.

together by four 50 kilobit per second channels leased from common carriers using both ground lines and satellites.

The effect of the ARPA network has been to increase collaboration on research problems and to permit wider sharing of many advanced research techniques. To expand the study of computer networks themselves, ARPA has in the past several years explored a number of ways of increasing interaction among the scientists and researchers who use the interconnection. Originally, person-to-person communication via the network was only possible by a limited procedure for typing message strings. As an improvement, a "mailbox" service was instigated in which messages to individuals would be routed to a person's dedicated mailbox file at that person's computer center. When a message arrived, the computer would notify the recipient of that fact when she or he would log in.

The mailbox service has been readily used by ARPA researchers and has apparently taken the place of telephone calls in routine communications. One evaluation of the service rated it so high that in the future the service might be expected to occupy half the network capacity.[11] Use of the sophisticated network for routine communications does not mean that costs are necessarily reduced. In some cases, communication via computer can be quite expensive in comparison to alternatives.

Besides the mailbox feature, ARPA permits other ways of communication among research personnel. Documents can be computer stored, indexed and made available to any terminal. But neither the document service nor the mailbox service permitted real-time dialogue on a group basis; so, in 1973 "Forum" was introduced. Forum is a technique and procedure for holding conferences via the computer network without the burden of using a computer language. In one instance, Forum joined three offices of the U. S. Geological Survey for a conference involving the exchange of data files. Participants discussed and requested information from each other's computer files, and even went beyond the ARPA nework to access files on other computer systems. Some of the data came, for example, via interconnection with a commercial computer network, Infonet. After the exchange of bulk information, the Forum program administered a questionnaire simultaneously to the participants. At the conclusion of the conference, a telephone conference call was placed to take care of loose ends.[12]

The benefits of Forum are expected to be substantial. Conferences can be established for researchers who could not otherwise get together or would have difficulty in doing so. Conferences can also be extended over longer periods of time to allow for better integration with individual schedules. And Forum conferences can bring together staff members who might be out of town, either visiting other research centers or at isolated network terminals. By extension, Forum signals the advent of networking of networks; computer centers can not only engage in real-time group communications but can also tie into other networks not usually part of their system.

The ARPA network is known as a distributed network because the communications are routed not to a central point or hub but directly from node to node. Other computer networks, however, are nondistributed and have used the hub approach effectively. One of the largest commercial networks, General Electric's Mark III, revolves around a computer hub in Cleveland, Ohio. The network covers over half the world and encompasses well over 100 individual computers.

When a GE network customer uses the system, the call is routed to a remote processor, itself a computer, which in turn passes the transmission along to a central concentrator. (See Fig. 7-3.) There are 14 central concentrators located in Cleveland. Two more concentrators are located in Europe. The concentrators, again computers, handle the communications to and from host computers. Everything in the system, which dates back to 1969, is duplicated to insure continuous performance. This includes the transmission routes between remote processors and central concentrators; alternate paths are always available. To speed transfer of data, the GE network enables customers to store their data files in central GE computers for access by scattered branch offices.

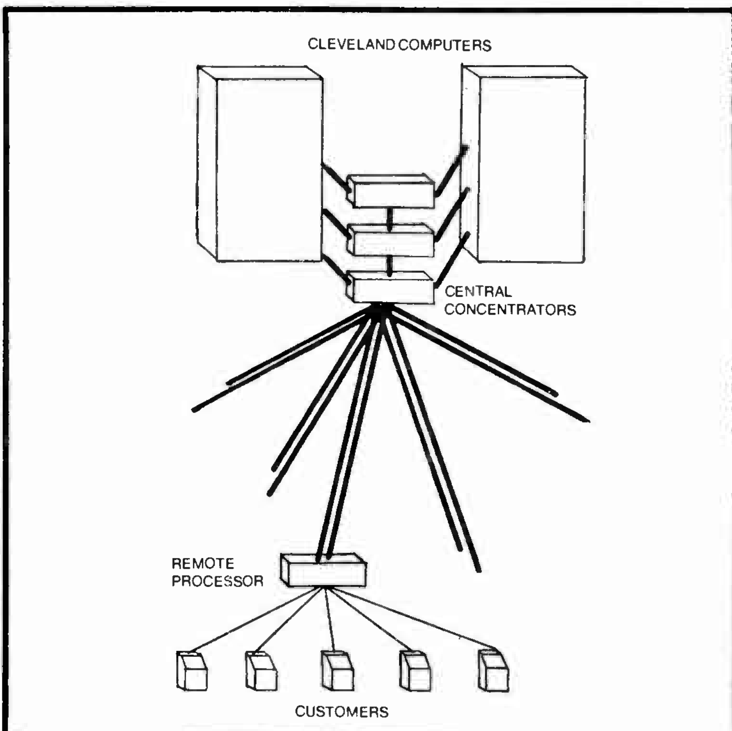

Fig. 7-3. The GE computer network is a star type, centered on a computer hub in Cleveland, Ohio. Every element of the system is duplicated.

A commercial network that is distributed similar to ARPA is Tymnet, operated by Tymshare, Inc., since 1970. Some 80 processors, called Tymsats, interconnect to 4 computers with supervisor functions. Two of these are situated in Cupertino, California, one in Englewood Cliffs, New Jersey, and one in Paris. When a customer logs in, a supervisor computer assigns the desired system to that user. Only one supervisor is active at any one time. Tymnet's largest user, besides Tymshare, is the National Library of Medicine at Bethesda, Maryland. The National Library serves over 200 widely scattered medical libraries, hospitals, and university medical centers.

Tymnet, the GE network, and ARPA are all general purpose computer networks, as opposed to special purpose networks. Special purpose networks such as the interairlines network have been in existence longer and are considerably extensive but they lack the versatility and adaptability of the general purpose nets. The latter are prime models for future interconnection of computers on a large scale. Some of the other major nonspecialized computer networks are: Cybernet (operated by Control Data Corporation), Time Sharing Service or TSS (IBM), Infonet, Singer, Bell Laboratories, Octopus (centered at Lawrence Livermore Laboratory in California), Aloha (based at University of Hawaii), Triangle University Computer Center or TUCC (North Carolina), DCS (centered at University of Michigan), Michigan State University, Wayen State University, and Carnegie-Mellon University (Pittsburgh).

In addition to spurring the development of computer networks, the ARPA project has also in recent years encouraged the establishment of computer-controlled telecommunications known as package switching. Similar to ARPA procedures, package switching divides data communications into small groups and routes them over the fastest possible lines using error-detecting techniques to provide low error rates.

Package or packet switching saves customers money by relieving them of the necessity of paying for idle time on a leased computer-telecommunications system. Instead, the packet-switching company, also called a value-added carrier, leases the lines from a common carrier and charges customers only for the time they actually use. Packet switching is compatible with different types of computers thus opening the way for customers to increase their computing options and to use distant data banks.

Packet Communications, Inc., was the first value-added carrier to receive FCC approval, winning the authorization in January 1974. The company plans to lease lines from common carriers to provide the packaging service to 26 cities. The network will emanate from two operations centers, one near Boston and another on the west coast. As is the case with all value-added carriers, Packet Communications cannot engage in data processing itself. Figure 7-4 shows the proposed network for the company indicating the arrangement of packet processors and host computers.[13]

Telenet Communications Corporation, a subsidiary of Bolt, Beranek, and Newman, Inc., is another authorized value-added carrier, expecting to serve 18 cities. During its first 5 years, the company anticipates investing some $25 million as it expands to serve 60 cities. Some of the proposed locations are shown in Fig. 7-5. Telenet plans to utilize domestic satellites as well as terrestrial links to provide an interconnect pattern for unrestricted joining together of satellite earth stations.

Facsimile has also been found suitable for packet switching. Graphnet Systems, Inc., under federal approval, is

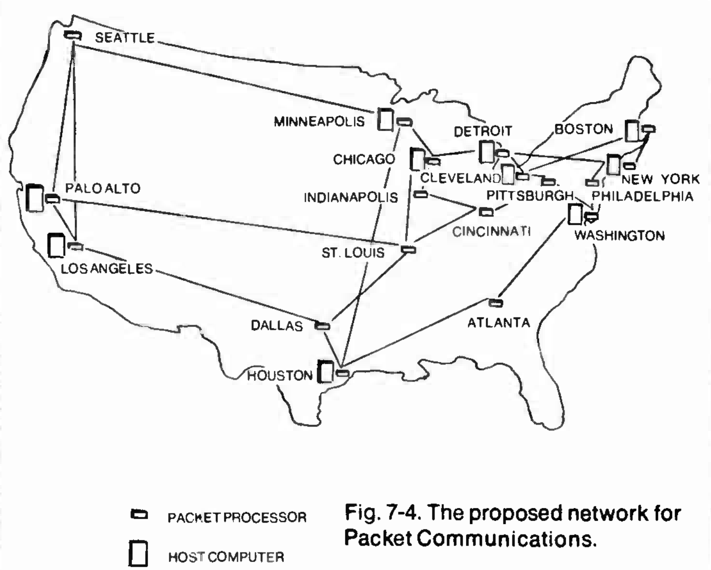

Fig. 7-4. The proposed network for Packet Communications.

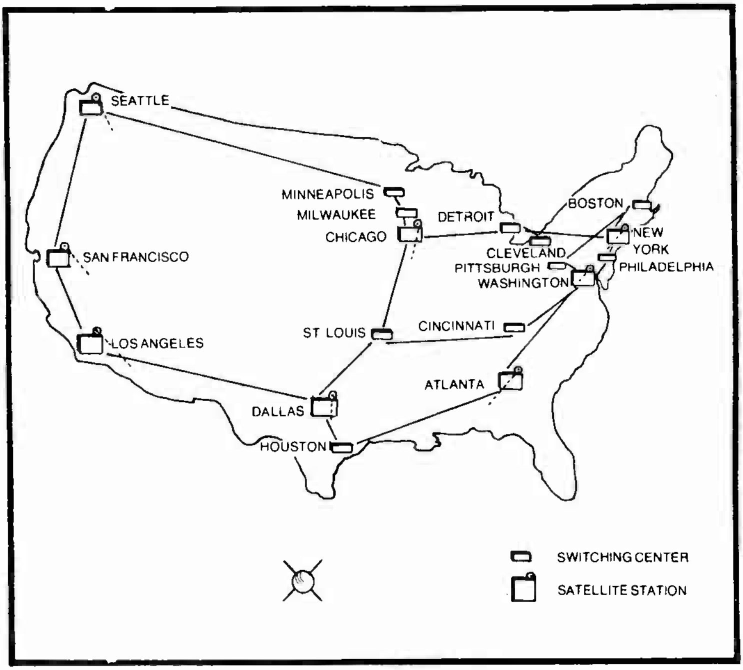

Fig. 7-5. The proposed network for Telenet Communications includes eight switching centers which are also ground stations for a domestic satellite in equatorial orbit.

putting into operation a national facsimile network in which it will operate as a value-added carrier.

The appearance of value-added carriers, and the earlier appearance of specialized common carriers, marks a new direction in telecommunications regulation in the United States. From the status of a highly regulated and essentially noncompetitive industry, the telecommunications carrier business is blossoming into an intricate mixture or owners and renters of transmission lines, controlling computers, data processors, and associated equipment. Such an environment is quite conducive to the development and establishment of the facilities for two-way TV services due to the variety of such services and their interconnect requirements.

The availability of computer files and the opportunities for computer communication presented by data processing networks and value-added carriers bring the most distant features of two-way TV all that closer. The encouragement of, or at least the lack of heavy restrictions on, the new and different telecommunications carriers provides a welcome situation for cable TV expansion. Cable systems can join other carriers as one of several local connection options, partaking of the services developed for all of them. And cable systems can be joined to each other in full-time or occasional networks, using dedicated links or occasional packet switching. Such arrangements will then lead to the fascinating proposition of computer utilities.

COMPUTER UTILITIES

A computer utility is defined as a general information network providing data and computing services to home and business users. Computer utilities, for example, could provide the Ticcit educational programs of the Mitre Corporation on a general basis to numerous cable system subscribers. Or computer utilities could provide access to a wide range of entertainment features and games. Computer utilities for employment purposes could foster diversified job locations and result in more scattered population patterns.

To put it another way, the computer utility is the data processing industry's version of the prophesies for two-way cable TV. Both are talking about the same thing. The shared vision is one of a highly complex, integrated communications web controlled by, and terminating at, computer centers. In a sense, the computer utility is the goal of both information processing systems and cable TV systems (and other broadband carriers).

General purpose computer networks like ARPA are indicative of what can be accomplished with computer utilities. There is no way to predict when the networks will begin to include home users, but there is a fairly solid basis for supposing that the day will eventually come. And when that happens, two-way TV will have fulfilled itself. Observers who look ahead to such an outcome conclude that society will be definitely but undefinably affected. Some speak of ineradicable effects without being able to specify effects as good or bad. Keith Uncapher, the director of the Information Science Institute at the University of Southern California, suggests that there will be a great deal of growth and excitement when there is "general acceptance of the view that everyone is a potential user of a computer in a direct, on-line way."[14] He sees computer utilities and networks as problem-solving entities to be available in home, school, or office.

One of the prerequisites for successful computer utilities is an understanding among the general public of what is involved and a first-hand acquaintance with computer services. Two-way TV, as a union of carriers for TV and data communications, can bring about that understanding and first-hand knowledge by bringing two-way TV services into the home. The understanding will be able to, and will have to, permeate society and grow along with the technology.

One of the prime examples of current misunderstanding of computers' future roles in society is the privacy aspect. Professional and competent opinions can be found on both sides of the argument that data banks can or cannot be engineered to protect the rights of the individual. Some argue that computer-stored data can be provided with even stronger safeguards against wrongful use than possible with paper and film files, while others point to a few dramatic examples of improper data on file and the manipulation and even theft of legitimate files. Alan Westin and Michael Baker, in their book *Databanks in a Free Society*, conclude after extensive research that there are at present sufficient restraints on data banks that might interfere with civil liberties.[15] The authors point to the technical, financial, and human problems that have prevented the sort of centralized data files many people fear already exist. The restraints that operate against such computer files include existing administrative and political constraints and the sociopolitical environment of the organizations involved.

Nevertheless, when many citizens hear of computer networks and interconnected data files they immediately oppose the action as an infringement on their privacy regardless of the purpose or design of the data bank. They might feel that private information of which they have no knowledge or over which they have no control could be used against them. Or they might feel that even if the information is neither harmful nor annoying, the right to withhold data from certain agencies or organizations should be given a higher priority.

There are, without a doubt, dangers to a free society in the massive storage of information when control or manipulation can be exercised by a few. But the attitudes of those almost blindly opposed to data banks are, it seems, based on a divisive *we-they* viewpoint; *they* are the ones who have control over the information files; *they* will use the data and the computers for their own ends; think of what *they* can do to us. *We* on the other hand are the helpless victims; *we* have no access to the information; *we* will become enmeshed and entangled in a computer conglomerate run by the powerful overlords.

That is not, of course, what computer utilities are all about and that is not where computer utilities are likely to led. We all have a stake in the computer-affected society and we should all view the computer as our own tool. The goal that information processing companies have before them is bringing data processing, computer files, and computer-assisted communications to the general public. The public will then use with confidence what it once feared as an intrusion.

It is the use of computer utilities that will ineradicably affect society. For as Robert Fano says in his paper "On the Social Role of Computer Communications," computers provide access to knowledge and knowledge can become power. If society goes astray, that knowledge can give power over many to a few. But if computer-assisted communications are exploited by the general public, all citizens share the power based on knowledge. He goes on to suggest that computer systems will play a social role similar to that of the printing press. Just as the development of the printing press shifted the balance of the population who could read and write, the development of computer utilities will shift the balance of those who can store and retrieve.[16]

This all depends, however, on the ease or difficulty with which the general public acknowledges and embraces computer utilities. Perhaps the biggest challenge to the computer complex is human nature. According to Robert Dunlop in a paper on "The Emerging Technology of Information Utilities," the interplay of human attitudes, needs, and emotions with regard to computers will require more problem-solving energy than the development of the computers themselves.[17]

A NEW AGE

Obviously, when significant changes in society are wrought by the combination of computers and telecommunications, it will be decades, perhaps centuries, from now. The people who talk about a new type of society, of increased knowledge shared by vastly more participants than ever before, are looking far to the past and far to the future. Such an extended viewpoint is not a bad thing, though; once the time span is recognized and appreciated, the extended view can be useful. If the issue is pressed far enough and examined thoroughly enough, the implications can be astonishing.

While it is not easy to foretell exactly what will evolve for two-way TV or computer utilities in 5 years, 10 years or even 20 years, the suggestions for the eventual or ultimate breadth and depth of computer communications fit in remarkably well with independently arrived at philosophies of the future of humanity.

Just what the most underlying implications of computer communications in full flower are can be seen very well, for example, in the writings of the paleontologist Pierre Teilhard de Chardin. In his *Phenomenon of Man*; published for the first time in French in 1955, he argues for the continual evolution of the human race to ever higher levels. Life historically spirals upward. It is not possible, of course, to state exactly when a turn in that spiral is reached, when a new path is struck higher than the one below, but it is possible to detect the turn in general terms. And we are now in a turning process. According to de Chardin, we have been changing course since at least the Renaissance and we are now passing into a new age.[18]

The reasons behind human advance are bound up with the whole history of the evolution of life, but one of the chief reasons behind our continuous rise on the spiral of life is what he calls the "commonplace fact" that the earth is round. On a grand scale, the continual and increasing interplay of human elements brings about an ever more complex and ever more evolved society. It should be no surprise that in the modern age he singles out the discovery of electro-magnetic waves as a "prodigious biological event."[19] For electro-magnetic waves, telecommunications, bring the interplay and interconnection of the human race to substantially higher levels than ever before. Our minds are mutually stimulated under self-accentuating pressure.

This is a process in evloution that has never been seen before—"the coalescence upon itself of an entire phylum." As human thought is intertwined, so to speak, more complexity and ever more consciousness results; human evolution is a series of higher states of interwoven relationships, as suggested by Fig. 7-6. The connection of these events to computer communications is direct; the coalescence of humanity has been and will be substantially forwarded by the electronic meeting and sharing produced by telecommunications systems.

Ultimately, after millions or billions of years, the spiral upward reaches a state completely unlike life as we know it. The evolution process, which we now hold in our hands, will bring us to a superlife. There will be what de Chardin calls a

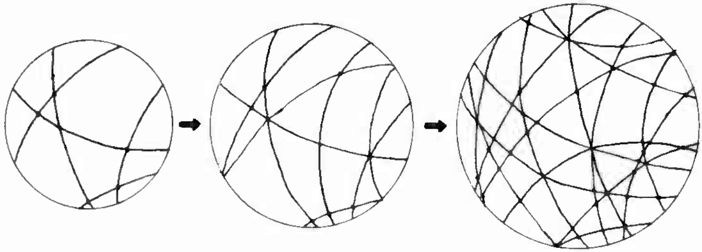

Fig. 7-6. Human evolution. The fact that the earth is round and human interplay comes back upon itself results in an ever increasing intermeshed web of humanity; the process, quickened by telecommunications, leads to higher and more expanded states of human evolution.

superabundance of the mind, a superconsciousness. Paradoxically, humanity will be so interwoven and so intricately brought together that a single thinking envelope will result, and yet each individual consciousness will be exalted in itself and in a state of hyperconsciousness. We will have reached the omega point.

It might be added that the progress of our evolution is almost inevitable. In Chardin's view, it will not arrive "necessarily but infallibly."

This proposal put forth by Teilhard de Chardin is the kind of philosophical background that has knowingly or unknowingly given substance to some of the most distant forecasts for two-way TV and computer utilities. And the same sort of inevitability applies; a higher level of society is bound to come. As a people it is almost impossible that we could turn back and almost inevitable that we will go forward, advancing our means for improving the interplay of minds and the interaction of people and their activity.

Another point that Chardin makes that is pertinent to the topic of telecommunications is the union of physics and biology, exemplified in his description of the discovery and use of electro-magnetic waves as a biological event. As he mentions, the biological cell is the connection between physics and biology—it is the natural granule of life. And it is the next frontier in the development of telecommunications.

Isaac Asimov has written that molecular communication (the cell is a complex of molecules) is being carefully studied in communications research in projects that might lead to superior computer intelligences and a further step in evolution. Future computers could be combinations of molecules and solid-state technology; and their capacity would be tremendous.[20]

Asimov, in an article on molecular communication in *Bell Telephone Magazine*, explains that the cell is a great deal more than an *on-off* switch, which is the basic component of electronic computers. The information storage and transmission capability of human cells is enormously complex. Scientists are just beginning to understand some of the processes. At Bell Laboratories, hemoglobin molecules have been chosen for communications studies which have led to some conclusions, though general, about the electron shifts that occur in the molecules as a function is performed. When a hemoglobin molecule picks up an oxygen molecule (which is its most important activity in the bloodstream) electron shifts take place in a discernable code. Cracking that code could lead to utilizing it in molecular computers.

Computers then might take on the aspects of living brains with just as much capacity. Those writers who report that computer networks are forming a new nervous system of society may turn out to be speaking a lot more realistically than they might have imagined.

The vision of molecular computers and molecular telecommunications is strikingly close to Chardin's union of biology and physics in the evolution of human life to the superconsciousness and the all-embracing integrated and united thinking envelope. This is also a fair indication of what Chardin meant when he said that we hold the evolutionary process in our hands; human beings can engineer the spiral upward in ways that do not seem to be extraordinary measures or drastic manipulations of human life.

This may all sound like so much fodder for science fiction fans, and it is indeed far removed from the present. When a contemporary homeowner finds that his cable TV subscription does not bring him any great new services and may even bring only mediocre TV reception, he is hard put to see the potential that is there. To him the propositions and proposals for two-way TV and computer utilities sound suspiciously like advertising oversell.

But seemingly fantastic scenarios for the future of humanity are not unfounded. The history of civilization gives substantial weight to the statement that science fiction in this generation is fact in the next (or the ones following). Our only mistake may be in expecting advances to come a lot faster than is warranted. The union of computers and telecommunications will give rise to computer utilities and two-way TV, but much still must come before.

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19. "Prodigious biological event," p. 240.
20. Isaac Asimov, "Communication by Molecule," *Bell Telephone Magazine*, Mar.–Apr. 1973, pp. 7–11.

Chapter 8

Plans and Projections

It is a foregone conclusion that two-way TV will become fully developed at some distant time. Not out of absolute necessity, to be sure, but from sheer weight of research and preliminary development. Two-way TV services and capabilities are not of themselves inevitable; nor are they of themselves fundamental requirements for human progress. But the studies and reports, the various pilot projects, the public and private investments, and the simple determination of a whole spectrum of individuals and organizations lead to the inescapable conclusion that two-way TV is here to stay.

Virtually every major sector of the telecommunications industry has considered the institution of some form of two-way TV service or interactive broadband service. The gamut of proposals runs from data-traveling electric power lines to selective information channels over broadcast TV and two-way TV via microwave and laser beam. In between lie the multiplicity of two-way TV services possible on cables increasing in size from telephone lines to videophone lines, and Qwist cable to broadband coaxial cables and fiber optic cables.

Millions of dollars have been spent investigating two-way TV services and capabilities by business corporations and by private research organizations as well. The Rand Corporation has produced over two dozen reports on two-way TV and cable TV. The Stanford Research Institute recently completed a seven volume, $95,000 study of one- and two-way cable TV systems which updated an earlier $340,000 study. Private fund-granting organizations such as the Ford Foundation, the John and Mary R. Markle Foundation, the Alfred J. Sloan Foundation, and the Charles F. Kettering Foundation have channeled a minimum of $6.2 million into research on cable TV and its two-way aspects. Grants by government agencies—Department of Housing and Urban Development; National Science Foundation; and Department of Health, Education, and Welfare—total further millions of dollars for the study and initiating of two-way services.[1] Reports by federal agencies and committees themselves, for example by the Presidential Task Force on Communications Policy, by the Office of Telecommunications, and by a cabinet level committee on cable communications, have also evaluated two-way TV, not to mention studies by numerous state committees and city governments.

All the verbiage does not add up to reality, of course, but there are other indications that two-way TV is being taken seriously. American Telephone and Telegraph is very carefully working on the possibility of converting Picturephone to the 525-line TV standard, which would lead to an integration of telephone and TV facilities. In 1973, RCA developed a silicon storage tube for frame grabbing which they expected to be adding to standard TV sets in the future. Frame-grabbing ability permits, as has been mentioned, hundreds of computerized information channels in the place of one or two conventional TV channels for all sorts of file services including computer-assisted instruction. Plans have also been announced for TV sets specially designed and manufactured for cable TV. Along the same lines, EIA is adopting standards for the manufacture of TV sets with 28 channels that would be compatible with cable systems without the need of channel converters. The FCC is expected to approve the standards within a few years.

Cable equipment suppliers are preparing for two-way TV by offering hardware with plug-in modules, allowing cable TV systems to be gradually but steadily built up for advanced two-way services. The Jerrold Electronics Corporation, which controls over half the cable equipment market and has been the largest supplier of cable TV hardware for over 20 years, offers a series of distribution equipment that can be modularly expanded to accommodate "comprehensive and complete" two-way transmission. The Starline 300 line of repeater and bridging stations (to amplify signals and route them from

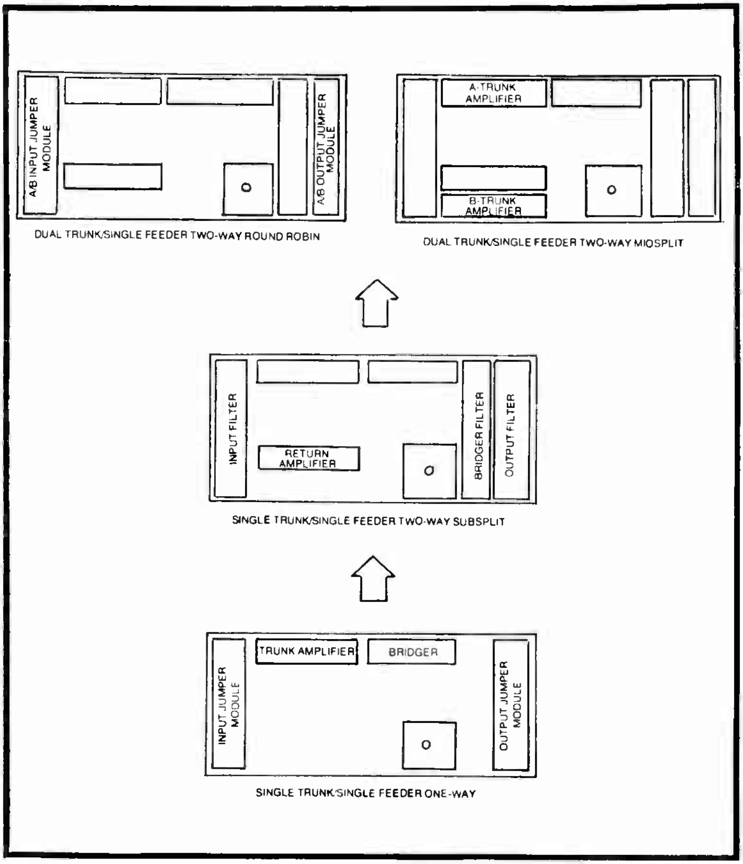

Fig. 8-1. Jerrold's Starline 300 series. The block diagram shows a basic bridging station that can accept various modules for ascending levels of two-way communications; other optional modules not shown can also be plugged in.

trunk cables to feeder cables) can evolve from one-way operation to several types of two-way operation. Figure 8-1 shows a bridging station and some of the modules that can be added to it. The series is designed to overcome the interference and signal distortion that plagued earlier two-way pilot projects and to enable cable systems to carry all manner of digital traffic, especially business or commercial data communications.

In short, preparations for two-way TV services are being carried out with an air of assuredness, albeit with some caution, within related industries. Outside of industry, private and public money has been used not only to study two-way TV services but also to make them a reality. In one far reaching project beginning in June 1974, the social services division of the NSF granted $100,000 apiece to seven teams of research and industry organizations to develop plans for actual two-way TV systems in designated cities. The seven teams, shown in Table 8-1, submitted their proposals at the end of 1974.[2] Several of the participants have already been active in establishing two-way cable TV pilot projects. Prior to the team grants, the educational division of the NSF had given several grants to the Mitre Corporation to develop two-way TV projects in education.

A very ambitious project for two-way TV, funded in part by the Department of Housing and Urban Development, hopes to demonstrate to the nation some of the more drastic social implications of two-way TV and has become known as the *New Rural Society*.

NEW RURAL SOCIETY

Dr. Peter C. Goldmark, the head of Goldmark Communications, has called for a reversal of the "sorry trends of society," particularly the unchecked growth of urban and suburban areas.[3] His theory is that the populations of the nation's cities and environs will cease to grow, and perhaps decrease, if rural living can become as attractive in terms of educational, cultural, social, and employment benefits. His concept, the *New Rural Society*, is based on two-way TV services.

In the year 2000, estimates by urban planners state that 85% of our population will live in the big cities. Already 70% do

Table 8-1. National Science Foundation Grants for Two-Way TV Proposals

1. Michigan State University, Dept. of Radio & Television Radio-CATV of Rockford, Inc.—Rockford, Illinois
2. Denver Research Institute Theta Cable—El Segundo, California
3. Cable Television Information Center General Electric Cablevision—Peoria, Illinois
4. University of Southern California, Annenberg School of Communications Teleprompter Corporation—Los Angeles, California
5. Lehigh University Service Electric Cable TV—Allentown and Bethlehem, Pennsylvania
6. Rand Corporation Telecable Corporation—Spartanburg, South Carolina
7. New York University, Alternative Media Center TV Service Company—Reading, Pennsylvania

so. But Dr. Goldmark believes that can be changed if his project is successful. With two-way TV services such as electronic classrooms, medical service via two-way TV, and facsimile transmission of X-rays; he hopes to remove the economic necessity of living in the city, thereby making rural living more desirable to millions of people. Not only would such rural living be presumably desirable in itself, it would reduce the amount of energy required nationwide. According to Dr. Goldmark, cities use huge amounts of energy for transportation, elevators, air conditioning, and heating that would not be needed in rural communities. Total energy requirements would be reduced, and not duplicated, by shifting populations.

In order to test the idea, the Department of Housing and Urban Development has given two $362,000 grants to the *New Rural Society* and Goldmark Communications through Fairfield University. Together, a pilot project is being developed for the Windham-Williamantic area of Connecticut. In an initial nationwide study, the conclusion was reached that there are at least 6000 rural communities which could support carefully planned population increases of 10,000–16,000 apiece. The increased populations would be those people enabled to live and work in a rural setting by means of two-way TV services. The northeast portion of Connecticut was then chosen for the pilot project because it seemed a prime example of a rural area barely able to support itself and curretly unable to attract a populatin influx.[4]

A survey of a 10-town area centering on Williamantic was conducted to examine the communications systems in existence and the attitudes of the residents concerning *New Rural Society* goals. One of the first services to be actually tested was two-way TV teleconferencing. The conferences were experimental uses of the equipment to test different systems. It was found, for example, that the feeling of togetherness was improved if stereo speakers were beside the video screen to let the sound seemingly "come from" the spot the speaker was seen to occupy. However, after some experimentation, Goldmark concluded that two-way point-to-point TV did not answer a need but only a desire. A properly designed audio system could be just as effective and have the distinct advantage of being economically feasible.

In another move to make the *New Rural Society* financially possible, communications centers of "village greens" took precedence over two-way terminals in individual homes. Such communications centers could serve as the focus for the social, educational, and employment activities via telecommunications lines. As a beginning measure, Eastern Connecticut State College in Williamantic was to be equipped with a dial-access color TV system for the 1974–75 school year. Videotaped lectures, films, slides, and audio programs would be available at student terminals in special classrooms, the library and study areas, and later perhaps in dormitories.

Additionally, Goldmark hopes to test a community center with a TV theater having access to educational video tapes. Although plans were yet to be finalized, the community communications center approach could be based on the large-screen TV concept similar to that of the Advent Corporation. Advent's system uses a screen roughly 6 by 4 feet reflecting a TV picture from a free standing projection unit (see Fig. 8-2). The screen is much like a movie screen in that it

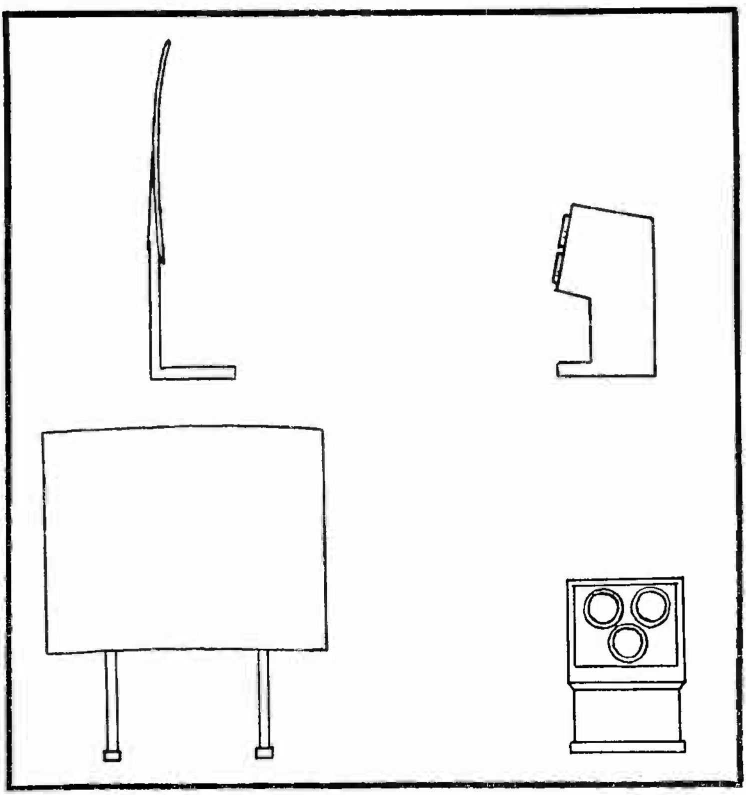

Fig. 8-2. Advent's projector and screen for large-screen color TV. Controls for the receiver-projector are located on the top of the unit.

reflects light, but it is composed of an aluminum sheeting minutely textured. The screen can direct light back along its axis and is said to be at least 10 times brighter than a white surface screen; pictures can be seen clearly even with moderate overhead lighting. For educational purposes, this is an advantage over films that must be viewed in a darkened room, since rooms can often become too dark for students to take notes.

The projector unit stands just under 3 feet high and must be set at a fixed distance from the screen. Three projection tubes—red, blue, and green—contain within themselves 3-inch target screens. The electron beams of the TV picture strike the target screens and the light is reflected back to a mirror in the rear of the tubes which in turn directs the light to the viewing screens. Since three separate projection tubes are used, color efficiency is much greater than a conventional color TV picture where separate color dots must be used on a single picture tube.

The Advent projector and screen arrangement is ideally suited for cable TV and video cassette playing because input connections are provided which will bypass stages needed for broadcast TV; this results in improved quality.

The sound system is arranged so that high-quality speakers in the projector unit beam their output toward the screen where it is reflected back to give the same impression as a conventional TV set. Controls and output jacks on the projector also allow users to adjust color convergence and focus, to route the sound to an independent speaker system, and to record sound and picture directly from the projector.

The possibilities for large-screen TV terminals in a two-way TV system are largely unexplored, although electronic video games have been adapted to large-screen TV with individual player controls. In the community center approach, large-screen TV outlets might supplement individual terminals.

The Connecticut project intends to study carefully as many options as possible over a long period of time. The *New Rural Society* is not expected to emerge before the year 2000. During the intervening years, Goldmark and his associates will investigate numerous two-way TV services using a variety of means. If problems arise and no solution is available with existing equipment, chances are that Goldmark Communications, a subsidiary of Warner Communications, will simply invent a new device. The orientation toward invention is a reflection of Dr. Goldmark himself, who spent 36 years with CBS research laboratories and has been responsible for over 160 patented inventions including the long-playing record, electronic video recording, and the first compatible color TV system. Since forming his own company in 1972, he and his staff have produced new devices for improving video tape recording quality, polling TV sets on a cable system, and scrambling TV signals in both broadcast and cable TV systems.

To demonstrate nationally some of the benefits of the *New Rural Society*, Goldmark proposed at one point to establish a continental satellite-cable TV network for the 1976 American Bicentennial celebration. The network was to bring national and international cultural events to homes and large-screen TV theaters. After the bicentennial, the network, using three commercial satellites, would have been used for educational and health services and possible employment opportunities through electronically linked miniplants.

BUSINESS USES

While plans to utilize two-way TV in rural settings are going ahead, other projects to put urban business communications on two-way TV systems are likewise being developed. Most major cable TV companies have at least looked into the matter of carrying business data on urban cable systems; however, in a 1974 Rand report, Walter Baer stated that in general cable TV companies were not moving in that direction.[5] Most of the advances in business communications in the recent past have resulted from activity by the specialized carriers and by the common carriers. But now, several TV cable companies are entering the field. Sterling Manhattan, for example has investigated the details of using their New York City cable system for data flow between banks and brokerage houses. Cablecom-General, Inc. plans to use two-way techniques for business communications on systems under construction in Topeka, Kansas, and Menlo Park, California.

The impediments to putting business data on cable TV systems have largely resulted from signal interference and distortion due to the presence of the TV signals and to a lesser extent from the construction and installation of the cable systems themselves. But business data on cable can be technically and economically successful according to preliminary reports from several research projects including investigations by the Mitre Corporation and Goldmark Communications.

The project at Goldmark Communications has been underway for some time, under the direction of Dr. Joseph Garodnick, to develop an effective system for putting business data on cable. The system is being designed for data speeds for 75–56,000 bits per second, which is the standard range for business data. In regard to using the data system for digitized point-to-point voice communications, Garodnick singles out secure voice transmissions (coded for security reasons) as the only foreseeable application for cable TV systems.[6]

The study by the Mitre Corporation regarding business data on cable TV systems has resulted in an interface system called Mitrix. The system can be added to any two-way cable TV installation without modification, and can be used for point-to-point data communications as well as point-to-center communications in speeds ranging from 70 bits per second to 30,000 bits per second. The data can be digital signals to and from computers, facsimile machines, Teletypes, CRT displays, and so on. The interface unit that was developed is needed to connect the machines to the cable systems.

The digital stream in the Mitrix method is segmented into repeatable frames 2.56 seconds long. Each frame has 8192 slots composed of 256 bits each. Figure 8-3 presents a graphic illustration of this arrangement. Of the 256 bits, 17 are used for distinct address codes accommodating 131,072 different terminals. The Mitrix time-division procedure means that some 8000 separate terminals can be engaging in data communications simultaneously.[7]

In general, opinions differ widely as to whether or not the business communications market is large enough to support both cable TV and the more traditional data communications carriers. Western Union, for instance, cut back its 1974 capital spending by $75 million largely because of slower than expected growth in specialized business communications. On the other hand, while not delineating the market, the Mitre Corporation estimates that business communications in cable TV systems are likely to be successful because such operations may be much less expensive than existing common carrier systems.[8] The situation is decidedly unclear simply because it involves speculation and not fact.

The potential, of course, is there. Looking to the distant future, John P. Thompson of Arthur D. Little, Inc., sees a great many opportunities for business use of advanced

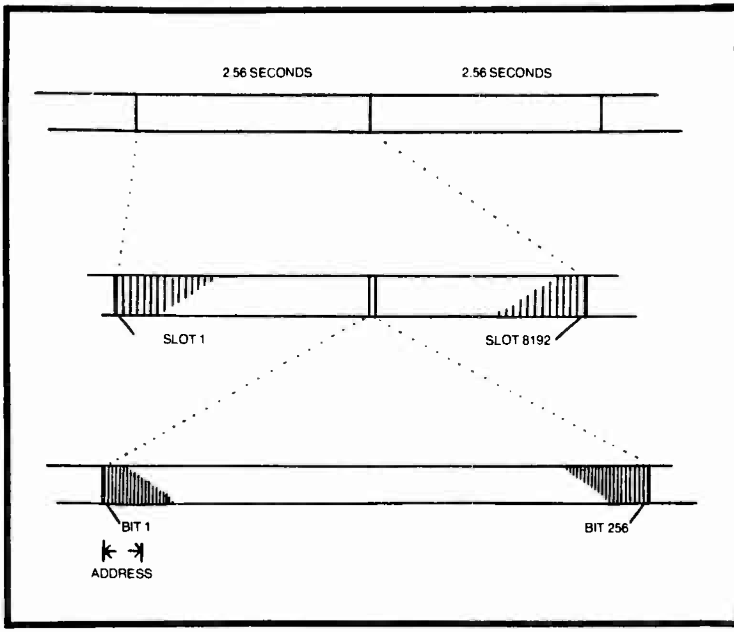

Fig. 8-3. The Mitrix digital stream is composed of repeatable frames 2.56 seconds long; each frame can communicate with 8000 separate terminals

telecommunications systems, especially with fiber-optic cable TV systems.[9] Accordingly, A. D. Little is currently engaged in a project to determine if fiber-optic TV systems can be economically competitive with coaxial cable systems. With or without the fiber-optic cables, though, broadband telecommunication lines can be used to allow executives and business personnel to work away from the office and outside of office hours. A group at the University of Southern California has been studying an insurance firm that has tested dispersed job sites where face-to-face communications were relaced by telecommunications. The results are not yet in, but indications are that employees would save up $1000 in commuting costs annually while the telecommunications system would cost $500–$1000 per employee annually. On a more general basis, according to Thompson, a British survey by the telecommunications authorities and the University of Cambridge in London estimated that 20% of the business travel by plane between Glasgow and London could be replaced by videophone and 40% by better use of audio lines.

Eventually, the businessman or businesswoman will be able to conduct visual, audio, and data communications from home or from selected remote sites and will also be able to have printed material produced at both ends. And it may be cheaper than not doing so. In a paper on the "Office of the Future" Thompson states that telecommunications costs have steadily declined, while costs for the paper-based traditional office have steadily gone up. One of the technological developments that might hasten the paperless and wall-less office is the CCD camera. Fairchild Semiconductor has developed a TV camera using CCD arrays that is almost as sensitive as the human eye at low light levels and is only twice as big as a pack of cigarettes. Thompson adds that this could play a major role in bringing video communications into the business world.

Twenty years ago the business world did not have many of the technological devices and facilities of today; 20 years from now, ideas that are novelties today will most likely have blossomed into commonplace adjuncts of the business world. The technology of two-way broadband systems will surely be a part of that change.

FUTURE GROWTH

Two-way TV is expected to make its impact on society sometime after 1980–85 and before 1995. A report by Walter S. Baer, "Cable Television in the United States—Revolution or Evolution?" written in early 1974 concludes that widespread installation of two-way cable TV systems is not likely in this decade but may be a factor in the following decade.[10] The combination of telephone and TV systems for two-way TV services may, however, bring such services a little sooner, beginning in 1980. Another Rand supported study, *The Information Machines* by Ben Bagdikian, gives two-way TV services a 30% chance of being widespread by 1980 and only a 51% chance by 1990.[11]

A noteworthy point, though, is the word widespread. Two-way TV services may profoundly affect certain limited geographical areas long before they are widespread on a national basis. In view of present developments in two-way cable TV, particularly in the retirement community area, it seems reasonable to assume that subscriber-originated services stand a better chance of being commonplace if they are judged in a restricted environment.

A series of studies by the Stanford Research Institute, available to investors for $2750, also concludes that two-way TV services will appear on expanded cable systems sometime after 1980.[12] Many of the companies involved in two-way TV endeavors have set the decade of the eighties as the time for a return on their investments; Tocom, Inc., calls the eighties the time for great profits.

Before that time occurs, however, there will probably be several years where little actual development can be seen. In fact, due to general economic factors, some predictions call for a slowing in cable TV growth and development until 1976 or 1977. The one exception, and the one area of expansion, is likely to be pay cable.

In 1971, a Malarkey, Taylor, and Associates report to the Office of Telecommunications Policy, *Pilot Projects for the Broadband Communications Distribution System*, pointed out that subscription TV, or pay TV, would be one of the likeliest candidates for initial two-way TV services.[13] And at least one company, Coaxial Communications, has established a seemingly successful two-way pay cable system since then. But all are not agreed that pay cable will lead to two-way TV services. Kenneth Penchos, author of a Stanford Research Institute report on pay TV which foresees a mushrooming pay TV industry, feels that pay cable will not necessarily lead to two-way techniques. The probability for commercially successful one-way pay cable systems is quite high. Moreover, pay TV as a two-way service could fairly easily involve the telephone or telephone lines for subscriber-computer interaction rather than a two-way cable system.

Pay TV will, according to the Stanford study, bring in the profits and at least in that way contribute to two-way TV development. The number of pay TV subscribers in 1985 is projected to be over 25 million, producing annual revenues of $4 billion. At first, pay TV is expected to be a feature of both broadcast stations and cable systems, with broadcast stations having the upper hand. Within a decade though, the Stanford researchers say, cable systems will dominate the market.

Besides the possible use of two-way techniques for pay TV, such things as fire alarm monitoring and limited polling services are expected to be on their way to a level of significance in society soon after 1980, according to a market survey by Frost and Sullivan, a New York market research firm. Tocom, Inc., for example, is establishing itself with fire alarm and security alarm monitoring services. The Coaxial Scientific system for pay TV is essentially a channel polling service. Given the fairly certain market for pay TV, the future for channel polling services in relation to pay cable seems rather good.

Another type of two-way TV service, the computer file for news, information, or education, is also a projected front-runner in the development of two-way TV. Such informational services, as a form of two-way TV, are given a 50–50 chance of being commonplace by 1980 in the Bagdikian study. It is necessary to note, however, that Bagdikian does not limit the forecast to cable TV but includes any type of wire or cable system linking homes.[14] The work of the Mitre Corporation in computer-assisted instruction and information files, the news files of Bunker-Ramo, and the experiments of Theta-Com in frame grabbing all point to serious activity which might lead to the introduction of these sevices to the home user. On the cautionary side, timetables for pilot tests of these services have lengthened since Bagdikian's book was published in 1971 and it is likely that the probability should be less than 50–50 by 1980.

When two-way TV does begin to catch on, at-home shopping is forecast as an early favorite. The Arthur D. Little organization has concluded on the basis of their extensive research into broadband communications that the direct ordering of mercandise from the home is one of the few early profitable two-way cable TV services.

Significantly, both meter/alarm monitoring and at-home shopping services are being pursued by the telephone industry as well as by cable TV. This tends to increase the probability that such services will be the first to be established in the over-all concept of two-way TV. In Chicago, Illinois Bell

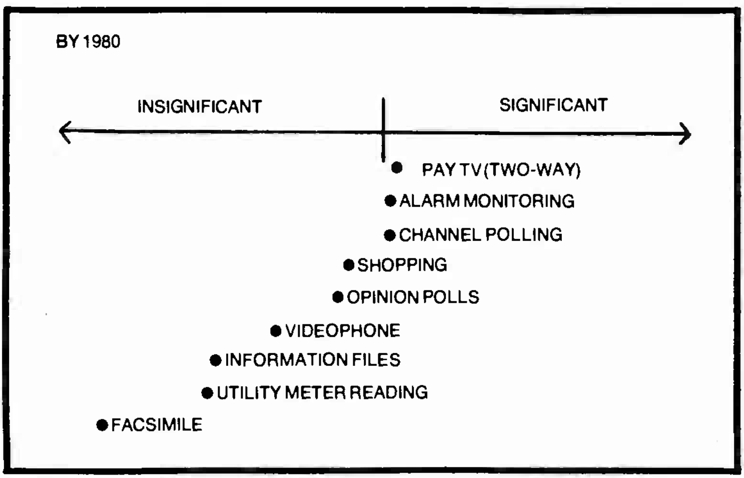

Fig. 8-4. Estimated levels of significance by 1980 for two-way TV services.

Telephone has installed Picturephones in Bonwit Teller's beauty salon to encourage women to buy items viewable on the screen while having their hair done. Since part of the Picturephone is the Touch-Tone telephone, a keyboard for ordering does not have to be added.

In Fig. 8-4, a number of these and other two-way TV services are rated according to their predicted level of use by 1980. Very few services are likely to reach a significant level of use before that time.

Although, as Walter Baer asserts, the telephone will be a formidable competitor with cable TV in the indefinite future as a conduit for two-way TV services, the growth of full two-way TV development is nonetheless undoubtedly tied to the growth of cable TV in general.[15] Directly and indirectly, the growth of cable TV systems is preparing the way for the absorption by society of two-way TV services.

According to Frost and Sullivan, the 1972 total of 6–7 million cable TV homes will jump to some 23 million by 1980.[16] A survey of opinion in the July 1973 *Michigan Business Review* set the predicted range at 18–28.5 million subscribers by 1980.[17] The Stanford Research Institute estimates that there will be 36 million subscribers at the end of 1985.[18] In percentages, A. D. Little reports that their sources say 30%–50% of the nation's homes will be on cable by the end of this decade.[19] Others push the figure higher, with one wildly optimistic observer offering the possibility that 85% of all TV viewing will be done via cable in the 1980s.[20]

Consequently, the eventual spread of cable TV throughout society seems relatively certain, sooner or later. In the same way, the eventual permeation of two-way TV seems highly likely with the realization that it cannot be necessarily held to proposed timetables. Various unknowns can affect the outcome in either a positive or negative manner. For example, the relationship between two-way TV communications and transportation needs in the light of energy consciousness can change substantially over the next several decades. A report in a recent issue of *Engineering News Record* states that any drastic changes in transportation methods will be delayed for quite some time due to development timetables and costs.[21] Two-way TV, however, is on the brink of full technical feasibility and nearing economic feasibility.

Dr. Goldmark, for one, believes that two-way TV services can reduce transportation needs by almost half, that is if the *New Rural Society* can attract upwards of 10 million city and suburb inhabitants away from job commuting situations.[22] As an indication of the interdependent relationship between communication and transportation, a report of the Bell Telephone System in 1974 stated that the fuel shortage of the recent past had reduced travel and increased long-distance telephone usage.[23]

Communication usually stimulates transportation in traditional theory, but, according to Edward Dickson, manager of the Resources Program at the Stanford Research Institute, future telecommunications will have a different effect on transportation.[24] In essence, two-way TV services would establish for themselves uses that would simply rule out consideration of a transportation alternative. Certain types of travel, for example, may be seen as poor substitutes for videophone calls. Dickson also points out that on the local scene videophones are competitive with cable TV for two-way TV services.

In simple terms of energy alternatives in a crisis situation, there is no contest between transportation and existing two-way TV communications. Of all energy consumed in the United States, 37% is for home and personal use, and roughly half of that energy is used by the private automobile. The other half is the energy consumed in running a household and annual cost estimates for such energy find TV operation at the lower end of the scale. It costs about $174 a year for a water heater but only $3.47–$13.36 a year to watch a TV set 4 or 5 hours a day.[25] The cost for TV viewing varies according to the size and construction of the set; a 19-inch solid-state monochrome set is cheaper to operate than a 19-inch hybrid color set. In actual practice, the undetermined energy requirements of the head end computers would have to be considered, but even so the total would fail to match the requirements for automobile use.

If two-way TV services are seen as low-energy substitutes for present practices such as traveling to work and to do shopping, two-way TV might be subsidized into full flower. Subsidizing is mentioned because of the high cost of initially constructing two-way cable TV systems within fairly strict engineering specifications. The Mitre Corporation, for instance, has estimated that a new two-way TV system serving a city the size of Washington D.C. would have to operate for 4 years with 70% of the city as customers before a break-even point would be reached; and the time, of course, would lengthen as the percentage of customers lessened. In the long run, Mitre estimates that two-way TV services can be provided to consumers at a price equal to that of current telephone service.[26]

NO PANACEA

In view of the cost of two-way TV services seen against the background of some of the advertised benefits, it must be emphasized, at the risk of stating the obvious, that two-way TV is not a cure-all. Two-way TV offers the opportunity for doing things differently, but that should not lead to the conclusion that differently necessarily means better.

Friendly observers of two-way TV development have attributed a great deal of potential social good to the proposed services. Jerrold Oppenheim, writing in *The Progressive*, speaks of two-way TV opening up lines of communication that never existed before.[27] The editors of *The Network Project* have explained that, theoretically, two-way TV can provide a greater fulfillment of the First Amendment than is possible today.[28] The contributors to *Cable Television in the Cities* go so far as to say that the opportunity two-way cable TV offers for "greater freedom of spirit and mind is staggering" and the opportunity for misuse or evil is just as immense.[29] Others compare the introduction of two-way TV services with the building of the first printing press.

There may be some truth to all of these statements when looking centuries ahead, but the truth will result from the way people handle the new medium and their communications via the medium and not from any inherent good in the medium itself as some seem to think. In this rather grim novel, *The Book of Daniel*, E. L. Doctorow satirically says that a husband and wife, arrested and later executed for treason, were "arrested for conspiracy to give the secret of TV to the Soviet Union."[30] The irony rests in a sober evaluation of TV; and yet TV, when it was first introduced, was hailed by some as a great boon to educational and social betterment.

Dr. Baer, in his *Cable Television: A Handbook for Decision Making*, says that most cable researchers feel that cable's growth will serve the public interest.[31] This is about the best that can be said for two-way TV development—it is *likely* to serve the public interest. This does not place an unwarranted value on its use. The telephone can be said to serve the public interest and to have made a social impact, and so probably will two-way TV. But it would be difficult to prove that the telephone made life better except in a most extended view and in relation to all its contemporary social, cultural, and technological changes. The history of two-way TV will not be much different.

Only in a general sense can two-way TV be associated with the word revolution to describe current times, and only then in the company of virtually every other technological and scientific advance of the last century or so. In that way, our age has been compared, with some accuracy it seems, to the industrial revolution as a period of social and technological changes. Looking back, the industrial revolution caused many short-term evils while generating long-term advances. Our age may not see such drastic short-term evils as appeared then, but it seems quite clear that the ultimate good or social benefit that is generated by advances in medicine, chemistry, physics, and electronics will only truly be seen centuries from now in hindsignt.

CONSIDERATIONS

A realistic assessment of two-way TV is necessary for planning and designing the implementation of the services. A healthy skepticism regarding supposed social benefits of two-way TV can do much to prevent costly mistakes and to foster as much true progress as possible.

Of the many options open to two-way TV services, one of the most basic involves the merging or nonmerging of facilities. Should the ultimate goal in telecommunications be a single all-purpose cable to each home? Such a cable might be a multiconductor conduit like Rediffusion's Qwist cable or like Mitre's wires for the college projects, or it might be a single fiber-optic cable. The cables would terminate at switching exchanges where signals would be filtered out and directed to and from long-distance telephone facilities, TV stations, utility companies, computer utilities, and so on. In such a configuration, one company would be responsible for the link to the home for all the services. Figure 8-5 presents a simplified sketch of this arrangement. If the Bell Telephone System goes ahead with their discussions of bringing Picturephone up to TV standards, would it be beneficial or not to pay for two TV-wide links to be strung separately to each home? Would it be a better idea to let the telephone companies concentrate on providing the switching exchanges while the cable TV companies concentrate on installing the cables to each home?

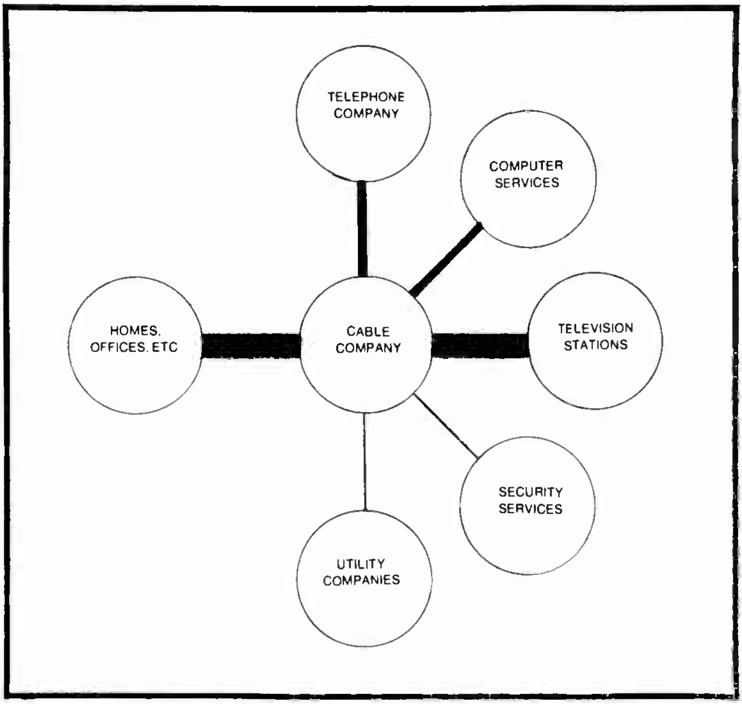

Fig. 8-5. An idealized two-way TV Distribution Plan. In this design, one company would provide a single cable link to each user and the link would be shared by the companies providing the two-way services. The thickness of the lines represents general bandwidth requirements.

Probably, the ultimate goal should not be the single-cable concept. For one thing, if the cable malfunctions the home resident could lose not only TV and telephone service but mail, newspaper, and security services as well. More important, the existing structure of the telecommunications industry virtually rules out mass consolidation without replacing billions of dollars worth of equipment.

Besides facilities, there is also a question of duplication of services. If both the telephone company and the cable TV company can provide at home shopping services, is it good to allow both to do so in the same area? Quite probably, yes. Competition in the market place has historically been accepted in this country as a motivating force behind improvement. Only in areas where the public would clearly and substantially benefit from monopoly status for an industry has competition been restricted. For many years we have assumed that regulated monopolies such as the telecommunications common carriers would provide the best service if they did not face undue competition.

However, in the case of the common carriers, recent events seem to indicate that now at least competition may bring about better and cheaper ways of doing things. The specialized common carriers, after winning FCC approval, have demonstrated that they can provide data services faster and at less cost to the customer than can American Telephone and Telegraph. That is somewhat of an oversimplification because common carrier rates are set by regulation and cannot fluctuate without authorization, but in general it is true. So far, the new data services have not had any ill effects on the telecommunications industry such as causing decreased service or increased costs for less populated areas of the country. In a free enterprise system, the extent to which curbs are introduced must be carefully considered, infringing as little as possible on the public's right to choose.

The question of restrictions leads naturally to the debate over common carrier status for cable TV. The final report of the 1968 President's Task Force on Communications Policy foresees the possible necessity of imposing partial common carrier status on cable TV systems.[32] Martin Seiden notes in *Cable Television USA* that the FCC thinks that the public interest would best be served by some cable channels being regulated as common carriers.[33] The 1974 cabinet committee report on cable TV has suggested that cable system operators lease their channel space in common carrier fashion. And Ralph Lee Smith in *The Wired Nation* argues that cable TV systems "meet every historic test" for common carrier or public utility status.[34]

Not immediately, but eventually, partial common carrier status for cable TV is likely to be enacted. This would result in close regulation of charges and profits and would insure the availability of channel space to potential users without discrimination. This may be beneficial to the development of two-way TV services in that the services are many and varied and are more apt to be developed and improved by independent companies leasing channels than by the cable system owners. The weight of two-way TV communications would be spread over many backs.

Would common carrier status erase the advantages of market competition and create an unresponsive monopoly? It would not seem so since cable TV competitors, in the two-way field, are already common carriers. Within regulatory bounds, common carriers can be allowed to compete with one another to provide the services of two-way TV. Figure 8-6 provides a simplified illustration of how the carriers could be interconnected between the users of the services and the providers of the services. Competition among the carriers might surface as an influential factor in the 1980s. Several studies recognize the potential rivalry between telephone companies and cable companies for two-way TV services.

In Canada, where a similar situation exists, a Department of Communications study found that many cable operators view themselves as common carriers and that "sharp" competition was sometimes evidenced between cable TV owners and common carrier companies.[35] Interestingly enough, it is the

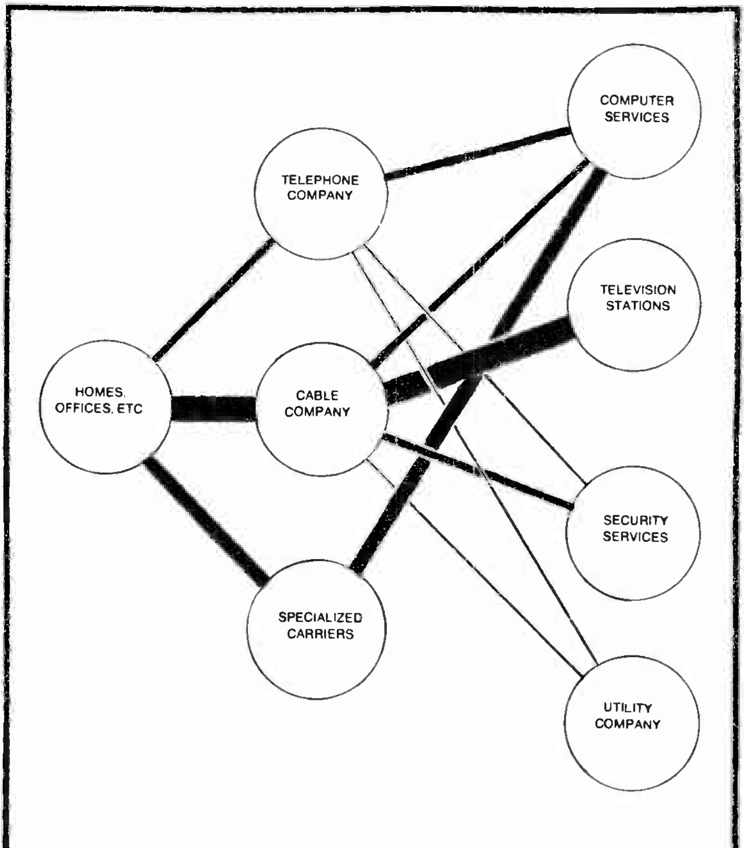

Fig. 8-6. Another possible outline for the web of two-way TV. Again, the thickness of the lines represents bandwidth differences.

telephone system, Bell Canada, that is planning a 1000-terminal test of two-way TV services. The home terminals are to be divided between an experimental installation in Quebec and one in Ontario.

Hopefully, two-way TV services will succeed on their ability to serve the public, tested by competition, and not as a result of preset plans by a corporation that can create a service in a monopolistic atmosphere and then plant the consumer need. A president of a major cable TV has been quoted as saying that (in regard to pay TV) his company will try to make the consumer feel that "you have got to have it or your whole family is culturally retarded."[36] A competitive marketplace would not necessarily prevent such approaches to cable TV services, but a monopolistic market has the potential for being much worse. While it may be argued that it is the free marketplace that propels companies into creating needs, the monopoly of an area like two-way TV is likely to stifle the variety and experimentation which contributes to expansion and improvement.

The options, then, for two-way TV involve more than one facility and a large number of potential service suppliers. Consequently, it is advisable for individual geographic areas to sort out their own particular mix. For example, a study of the Minneapolis-St.Paul region conducted by the Cable Television Information Center examines cable TV, multipoint distribution service, microwave, and satellites in a broad design for integrated two-way services.

The report, *Planning Interconnection Systems: Options for the Twin Cities Metropolitan Area*, was the culmination of 8 months of study and research in a joint project by the Information Center and the Metropolitan Council of the Twin Cities area. In late 1972, the council had been urged by its advisory committee on cable TV to instigate such a study; the next year the Minnesota legislature established a state committee on cable and likewise urged the Metropolitan Council (which had itself been created by the state in 1967) to study regional cable communications.[37]

The report is dedicated to the proposition that interconnection of telecommunications facilities is in the best public interest. The authors believe that interconnection will give as broad a base as possible to new services, overcome the limitations of individual ventures, and provide various new services to citizens whether or not they subscribe to a cable TV system. The starting point, and goal, of the report is the public interest. Only after the researchers had established public preferences and desires for potential services did they construct hypothetical networks to meet the demands.

The result was a description of five possible plans for interconnection to provide one- and two-way broadband communications within the metropolitan area.

The first plan ignores cable TV, relying instead on a small number of microwave links between several university campuses and a central control. Video communications would be one-way only, but return audio would be available via the microwave system or telephone lines. Such a plan, based on the assumption that cable TV systems might not be available, seems to be suited primarily for educational (classroom) applications.

The second plan, again forsaking cable TV, calls for community centers to act as information depots. Each of 25 centers would have a conference studio of several hundred seats and a large-screen TV projections system, a small studio for videophone calls, limited information terminals, and two-way video terminals. The limited informatin terminals would supply visual information in much the same manner as the Mitre system did in Reston, Virginia; a computer sends individually addressed video frames to designated terminals where the frame is caught by a frame-grabber or video-refresh unit. Instructions from a 10-digit keyboard at the terminal would determine which frames are to be held from the many present on one channel. The two-way video terminals would be more sophisticated in that a full alphanumeric keyboard would be included along with the provision for moving video (regular TV); a videotape recorder and a camera would also be provided. The 25 centers would be linked by their own coaxial cable system to a control center at the University of Minnesota. The neighborhood information depots would be located largely at schools but also to some extent at public libraries and city halls. The system is designed to bring two-way TV services to those who would otherwise be neglected. The one disadvantage of the system is, of course, that users must travel to the centers and use public facilities. The large number of centers located at schools indicates that the system has primary applications in education. In order to further the use of the system, the report states that channel space could be leased to business users and medical complexes.

The third plan is almost totally based on cable TV. The plan merely calls for microwave interconnection of the various cable TV head ends in the region and microwave linking to a central control point. The interconnection would facilitate distribution of locally originated shows, instructional programs and pay TV. The plan leaves the development of two-way TV services up to the cable operators.

The fourth plan is an expanded version of the third, with dual-cable links replacing some of the microwave connections. More channels to and from the head ends and the control point would be possible. Again, the interconnection design would be most suited for live programing exchange.

The fifth plan, admittedly hardly feasible until public demand greatly increases, combines the cable-microwave interconnection of head ends with the community information centers. It would obviously be the most expensive of the five plans, costing over an estimated $7.3 million. The bulk of the cost would be for the community centers' equipment which alone would account for some $4 million. The second plan by itself would cost a little over $6 million.

Besides the exploration of interconnect possibilities, the regional report conducted an economic analysis of the plans and a legal survey of regulatory strictures. The Metropolitan Council will probably use the report as a basis for monitoring, suggesting, and guiding the introduction of cable TV and two-way TV systems in the Twin Cities area.

Planning Interconnection Systems does not, certainly, cover all the ground of two-way TV. And it essentially ignores the home terminal and the possibilities and proposals for bringing two-way TV services to individual residences, which is what two-way TV is all about. But it is a very graphic illustration of the fact that two-way TV is more than cable TV; it is a unification of telecommunications facilities bringing together under one umbrella a host of telecommunications services.

Robert Sarnoff, chairman of RCA, once said that the TV set is somewhat like the human brain, it operates at about 10% of capacity.[38] If two-way TV continues to develop, the TV could be even more like the human brain in that it would be a vast maze of electronic channels responding to stimuli with a wealth of interconnected feedback.

It has been the thesis of this book that two-way TV is an abstraction, a concept cutting across all telecommunications means and modes. As such, the concept is a unifying principle;

it ties together into an ordered whole the varieties of electronic communication sparked by cable TV. When *Wiring the World* was published by U. S. News and World Report in 1971, it carried the note that perhaps it would contribute to the debate of two-way TV, calling two-way TV "another great miracle of out time."[39] While the optimism may be overstated, the debates continue and decisions have been made and are being made. Hopefully, this book will make some contribution also, by looking at what has been done and by suggesting directly and indirectly factors for consideration. With some refinement,perhaps the integrated concept two-way TV could be a useful guide for weaving the web of upcoming communications confiurations.

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Appendix A

Electrical Characteristics of Wires and Cables

Various factors affect the ability of a wire or cable to carry electrical signals without excessive loss of energy, degradation of the signal and so on. Basically, ignoring for the moment other considerations, electrical signals are affected by the size, the material, and the construction of the conductor, and the frequency of the signal. These are the major factors accounting for the difference in transmission capability between coaxial cable and ordinary wire pairs.

The size, material, and construction of conductors generally determine the amount of resistance an electrical signal will run into, the preferred condition being a very low degree of resistance. For DC (direct current) signals and low-frequency AC (alternating current) signals (up to a few thousand hertz), the resistance is inversely proportional to the cross-sectional area. This means the thicker the wire the less the resistance. Resistance r is also proportional to the length of the conductor, as would be expected. Mathematically, this is expressed:

$$R = \rho L/A$$

where L is the length of the conductor, A is the cross-sectional area, and ρ is a factor called the specific resistance. The specific resistance, or ρ, brings into the discussion the matter of material of the conductor, since ρ is a function of the material and the temperature of the conductor.

Using the formula, standard tables have been devised to give the resistance of certain types of wires of given lengths. For example, a 12 AWG copper wire (which has diameter of 2.053 mm) has a resistance of 1.619Ω (ohms) per 1000 feet at 25° C. On the other hand, a 10 AWG copper wire (which has a much smaller diameter of 0.0799 mm) has a resistance almost 1000 times as large for the same length and temperature.

These calculations do not work, however, when the frequency of a signal moves above a few thousand hertz. Here is where the special construction of the coaxial cable gives it immense advantage over wire pairs such as those to your telephone.

As the frequency of a signal increases from audio frequencies (about 15 Hz to 15 kHz) to the radio frequencies (above 20 kHz), the current tends to flow on the outside edge of any wire. This phenomenon is called "skin effect." The result of skin effect is that a thin tube can conduct RF signals just as well as a solid wire. Practically all of the current would be flowing within a few thousandths of an inch of the conductor's surface in either case.

A glance at the mathematical expression for the function of skin effect shows the other factors involved and the relationship between them, although it is not necessary to go into further explanations here. At high frequencies, the increase in resistance due to the skin effect is roughly proportional to:

$$t\sqrt{\mu f/\rho}$$

where t is the thickness of the conductor, f is the frequency, μ is the permeability of the conductor, and p is the specific resistance.

A major result of skin effect is the fact that at high frequencies, signals flowing near the edge of the conductor lose a great deal of energy through radiation. The coaxial cable was developed to combat skin effect and thus reduce signal radiation losses. To do this, one wire in effect was put inside another. In reality, the coaxial cable consists of a single wire or wire strand conductor inside a tube-shaped conductor. Some of the ways of doing this are shown in Fig. A-1. With this configuration, the energy of the signal is described as being in the space between the outer and inner conductors, rather than radiating off the outside edge of a wire.

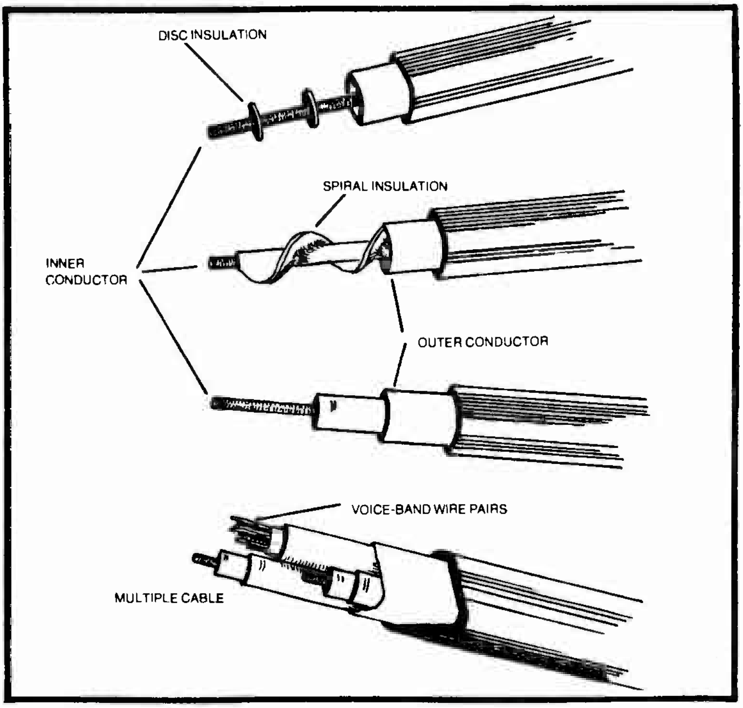

Fig. A-1. Types of coaxial cables.

Coaxial cables not only defeat skin effect, but also minimize interference among adjacent circuits. The special construction of coaxial cables also means that they can carry signals of great bandwidth since the latter is related to the frequency range of a conductor. A brief explanation is in order.

The bandwidth of a signal is the range of frequencies within that signal. For example, the human ear can detect a frequency range of somewhere between 20 Hz and 20 kHz; the signal duplicating this range therefore has a bandwidth of 19.980 kHz. However, most conversation ranges only from about 300 Hz to 3300 Hz. Consequently, the telephone wires to the average home were designed to accommodate a bandwidth of a mere 3000 Hz. This is ample for spoken conversations but it is not adequate for the range of frequencies in music or in TV. The bandwidth of TV is over 1000 times larger than the bandwidth of telephone communications.

Actually, a pair of telephone wires is able to carry signals of greater bandwidth than is commonly the practice. Properly prepared, a pair of telephone wires can carry a unidirectional

Picturephone signal which has a bandwidth of 1 MHz. This is still only 1/6 as wide as a single TV channel.

By comparison, the average coaxial cable has a total bandwidth of 300 MHz, theoretically wide enough for 50 individual TV channels. In practice, not that many TV channels can be carried because of some cross interference problems and, at the present time, some limitations on the precision of the manufacturing process. At best, a coaxial cable can handle about 45 TV channels or any combination of TV, voice, and data channels adding up to about 270 MHz.

With improvements in the engineering of coaxial cable, the total bandwidth could possibly be pushed up to 400 MHz accommodating some 60 TV channels. It has also been suggested that with pairs of cable, or even with more capacious cables, the number of TV channels to each home could rise to 80 and beyond.

Above 400 MHz the coaxial cables that we have today begin to lose their ability to carry signals effectively, and other transmission means become more feasible. For example, millimeter waveguide systems, in which the signals in effect travel through hollow containers, are being developed which can carry some 120 TV channels. Another transmission line now being put on the market, the fiber-optic cable, has even greater potential. By the end of this decade, fiber-optic cables may be in use having a total bandwidth wide enough for 360 TV channels, or over 2200 MHz. Hypothetically, some laser systems could have a total bandwidth of nearly 10 THz ($T = 10^{12}$).

A study by Martin Marietta Aerospace for the Air Force has concluded that optical links and millimeter waveguide systems will be combined for broadband digital channels at high speeds. During the 1980s, these transmission facilities will begin to supplement existing microwave and cable channels. The study found that optical links were superior to millimeter waveguides for distances of less than 1 km (kilometer); the two systems appeared equal for distances of 1–3 km. Millimeter waveguides became superior after that distance.

While we do not really need cable systems with a huge capacity for this century's two-way TV services, it seems quite probable that cable systems of 40–60 TV channels (which is the upper limit of coaxial cables) will be necessary for two-way TV to truly begin to show its worth.

Appendix B
Two-Way TV Directory

Advent Corporation
195 Albany Street
Cambridge, Massachusetts
02139

American Telephone and
Telegraph Company
195 Broadway
New York, New York 10007

American Television and
Communications Corporation
360 South Monroe
Denver, Colorado

Atari, Inc.
14600 Winchester Blvd
Los Gatos, California
95050

Big Valley Cablevision, Inc.
P. O. Box 7577
4955 West Lane
Stockton, California 95207

Bunker Ramo
Information Systems Group
Trumbull Industrial Park
Trumbull, Connecticut
06609

Burroughs Corporation
Burroughs Place
Detroit, Michigan 48232

Cable Television Information
Center, The Urban Institute
2100 M Street, N.W.
Washington, D.C. 20037

Cablecom-General, Inc.
P. O. Box 7251
4705 Kingston
Denver, Colorado 80207

Case Western Reserve University
Health Sciences Communications
Center
2119 Abington Road
Cleveland, Ohio 44106

Community Information
Systems
Jonathan Village Center
Chaska, Minnesota 55318

Computer Television, Inc.
15 Columbus Circle
New York, New York 10023

Control Data Corporation
Research Division
P. O. Box 1249
Minneapolis, Minnesota
55440

Cox Cable Communications, Inc.
Suite 300
53 Perimeter Center East
Atlanta, Georgia 30346

Electronic Industrial
Engineering, Inc.
7355 Fulton Avenue
North Hollywood, California
91605

GTE Laboratories, Inc.
Waltham Research Center
40 Sylvan Road
Waltham, Massachusetts
02154

Home Box Office, Inc.
Time & Life Building
Rockefeller Center
New York, New York 10020

Hughes Aircraft Company
SRS Department
Box 6013
Annex Unit
Inglewood, California
90301

Illinois Bell Telephone
Picturephone Services
212 West Washington Street
Chicago, Illinois

Interdata, Inc.
2 Crescent Place
Oceanport, New Jersey
07757

International Business
Machines, Inc.
600 Mamaroneck Avenue
Harrison, New York 10528

Jerrold Electronics
Corporation
CATV Systems Division
200 Witmer Road
Horsham, Pennsylvania 19044

LVO Cable of Northern Illinois
300 Carpenter Boulevard
Carpentersville, Illinois
60110

Arthur D. Little, Inc.
Acorn Park
Cambridge, Massachusetts
02140

Magnavox CATV Division
133 West Seneca Street
Manlius, New York 13104

Magnavox Research Laboratories
2829 Maricopa Street
Torrance, California 90503

Malarkey, Taylor and
Associates
1225 Connecticut Avenue, N.W.
Washington, D.C. 20036

Mitre Corporation
1820 Dolly Madison Boulevard
McLean, Virginia 22101

Northern Virginia Community
College, Alexandria Campus
TICCIT Project
3001 North Beauregard Street
Alexandria, Virginia 22311

Oak Industries, Inc.
Communications Group
Crystal Lake, Illinois
60014

Optical Systems Corporation
11255 Olympic Boulevard
Los Angeles, California
90064

Phoenix College
TICCIT Program
1202 West Thomas Road
Phoenix, Arizona 85013

Premier Cablevision Ltd.
Century Plaza
1015 Burrard Street
Vancouver 1
British Colombia

Rand Corporation
1700 Main Street
Santa Monica, California
90406

Rediffusion, Inc.
c/o Delta-Benco-Cascade, Ltd.
124 Belfield Road
Rexdale, Ontario M9W 1G1

Rediffusion International
Limited
P. O. Box 451
Carlton House
Lower Regent Street
London SW1Y 4LS

Scientific-Atlanta, Inc.
Cable Communications Division
Box 13654
Atlanta, Georgia 30324

Stanford Research Institute
333 Ravenswood Avenue
Menlo Park, California 94025

Sterling Communications, Inc.
120 East 23rd Street
New York, New York 10010

TM Communications
3303 Harbor Boulevard
Suite G-3
P. O. Box 2378
Costa Mesa, California
92626

Telecable Corporation
P. O. Box 720
Norfolk, Virginia 23510

Telecinema of Columbus
3770 Livingston Avenue
Columbus, Ohio 43227

Tele-Communications, Inc.
P. O. Box 10727
University Park Station
Denver, Colorado 80210

Teleprompter Corporation
50 West 44th Street
New York, New York 10036

TheatreVision, Inc.
641 Lexington Avenue
New York, New York 10022

Theta-Com of California
9320 Lincoln Boulevard
Los Angeles, California
90045

Time Cable Communications
Time & Life Building
Rockefeller Center
New York, New York 10020

Tocom, Inc.
P. O. Box 47066
Dallas, Texas 75247

United Cable Television
Corporation
522 Boston Avenue
P. O. Box 3423
Tulsa, Oklahoma 74101

U. S. Department of Commerce
Office of Telecommunications
Institute for Telecommunication Sciences
Boulder, Colorado 80302

Video Information Systems, Inc.
230 Park Avenue
New York, New York 10017

Warner Communications, Inc.
10 Rockefeller Plaza
New York, New York 10020

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