CHAPTER II

PUBLIC SERVICE AND COMMERCIAL USES OF BROADBAND COMMUNICATIONS IN RURAL AREAS

This Chapter examines the potential of broadband communications for responding to rural needs, both in the public service sector and as they relate to rural economics. Each application is considered individually, with a view towards determining whether current experiments are grounded in a realistic appreciation of rural needs and, secondly, whether they are designed to produce the kind of data necessary to determine their ultimate feasibility in functioning rural systems. Later chapters will describe how these services might be combined to support a rural broadband system which could contribute to the broad goals of rural development.

The following categories of broadband applications are addressed:

- public service (health, education, law enforcement, governmental/administrative uses); and
- commercial (security systems, information services, data transmission, pay-TV).

Each of these categories is examined in terms of:

- rural needs for the service tested;
- representative experiments conducted; and

. Potential rural applications including the feasibility and value of the service in meeting rural needs.

It should be noted that several recent studies, notably those by Peg Kay, Social Services and Cable TV (1)[1] and by the Cablecommunications Resource Center, A Preliminary Review of Current Practices And Trends In Rural Telecommunications Development And Recommendations For Future Development (2), have reviewed experiments for the applications considered in this Chapter. No attempt is made here to duplicate these efforts and the reader is referred to them for additional information.

Public Service Applications

Health

Major studies analyzing rural health needs and relating these to existing and potential broadband applications have not been done. As part of this study, a preliminary analysis of these needs was attempted and is summarized below. However, the results are not definitive and additional research is required.

Rural needs. Appendix C contains an analysis of health conditions, health manpower and facilities resources, utilization of resources by rural populations and Federal initiatives in delivering rural health needs, The following brief summary is drawn from Appendix C.

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1 References are numbered consecutively in the order of their first appearance in the text. The first number is the reference. The number after the dash is the page number in the reference.

Significant health care problems exist in rural populations. Comparative analysis of the health of rural vs. urban populations shows higher infant and maternal mortality rates and greater incidence of chronic illness in rural populations.

Another indicator of rural health is the rejection rate for military service from physical and mental conditions. The rate for rural residents is at least twice that for metro residents and residents of small cities and towns.

As for injuries, rural nonfarm residents show higher injury rates than metro residents. However farm residents show a lower incidence of injuries. Thus, medical care requirements for injuries in rural as compared to urban areas are not clearcut.

There is a shortage of physicians, especially specialists, in rural areas. The combined ratio of general practitioners, specialists and hospital-based physicians per 100,000 population is 69.0 for nonmetro areas and 145.7 for metro areas. For specialists alone per 100,000 population, the ratio is 30.3 for nonmetro areas and 81.5 for metro areas. Dentists, pharmacists and registered nurses are also in very short supply in nonmetro compared to metro areas. Contributing factors to the rural shortage of medical personnel include isolation from peers, and the difficulty in remaining current in professional specialties due to lack of ready access to facilities equipped with the latest instruments and technology, as well as to specialists for referral and consultation. Also of significance is the greater workload associated with attending a larger group of people who are also widely distributed.

As for health facilities, statistics show that there is a greater number of community and psychiatric hospital beds per capita for rural populations compared to urban populations. However, the accessibility of these facilities in terms of location, available transportation systems and costs for utilizing them present severe problems for many individuals residing in rural areas. In addition to having lower income levels, the percentage of persons covered by hospital and surgical insurance is also lower in rural areas than in urban areas.

Studies of the utilization of health services by rural residents show that the latter tend to visit physicians, specialists and dentists with less frequency than urban residents. Because hospitalization rates for rural nonfarm residents and rural farm residents over 65 are proportionately higher than for metropolitan populations, it is unlikely that this lower utilization of health services reflects better health of rural residents but is more likely a function of access and a tendency to allow conditions to become more serious before medical attention is sought.

A related problem is availability of emergency medical services. Difficulties arising from health manpower shortages, distance to health facilities and access to transportation suggest inadequacy of emergency medical services.

In summary, available information on health conditions, resources and services points to inadequacies of health care delivery systems in rural areas. The needs of rural populations in health care delivery systems include:

- need for increased primary health and dental services based on evidence of fewer physicians per capita, higher hospitalization rates, greater incidence of infant and maternal mortality, and higher incidence of medical disqualification for military duty;

- need for less expensive medical care and improved physical accessibility to medical facilities and services due to maldistribution of facilities and physicians, the distances rural people must travel, inadequate transportation services or alternatives, and low membership in health insurance plans as well as relatively lower income levels as compared to urban areas;

- need for emergency medical services due to chronic illness conditions, injury rates, and distances to facilities; and

- need for continuing medical education for physicians, specialists and allied health manpower because of physician isolation, physician (specialist) shortages, and difficulty of access for consultations and referrals.

In light of these needs, it is important to evaluate existing communications experiments as a health service delivery tool for rural populations.

Experiments. Representative telemedicine experiments of likely application in rural areas are listed in Table 1, which summarizes the funding source, location of the project (that is, urban or rural), operational status, technological characteristics and medical services provided in the sixteen telemedicine experiments evaluated.

As shown in the table, most projects have been supported by the Federal government. The Department of Health, Education and Welfare has been a major supporter of telemedicine projects and NASA and the National Science Foundation have also provided funds. A noteworthy exception is the Blue Hill project (the ninth project in Table 1) which involves a broadband link between a hospital in Blue Hill, Maine, and a nurse practitioner in the isolated community of Deer Isle. This project was originally funded by the Maine Regional Medical Program but increasingly support is being provided by the community of Deer Isle.

Some experiments analyzed are located in urban areas. Although the emphasis in this study is on rural applications, urban experiments have been included to provide a broader data base for assessing the value of telemedicine efforts.

The table also shows that a variety of technologies have been used and combined in various ways. Picturephones have been used. Black and white or color television terminals have been connected by cable and/or microwave and/or satellite. The common denominator of the technologies used is that they have permitted two-way (interactive) exchange of information between sender and receiver, generally in both audio and visual modes.

Of particular interest are the health services provided in the experiments, which are indicated in the last column of the table. Following Rockoff (3-22), these services can be classified in five categories: consultation, supervision, direct patient care, administration and management, and education and training. The table lists services in terms of these five categories. Additional descriptive terms have also been used (such as lab tests, prescription and record transmission, etc.) to provide more detail on the specific services provided. As can be seen,

TABLE I

TELEMEDICINE PROJECTS

Experiments	Funded by	Location	Operational Status	Technology	Services
Massachusetts General/Logan Airport/Bedford Veterans Hospital (4-108ff, 205ff.)	HEW Veterans Admin.	Urban	Bedford still operational Logan operational to a minimal extent	Microwave, cable, black and white, telemetry (ECG's, EEG's), lectronic stethoscope, inter-active audio-visual capability	Diagnosis and consultation, therapy, specialists consultation, Lab tests, in-hospital patient observation, prescription and record transmission, administration public health education, continuing medical education, (emergency consultation)
Lakeview Clinic (4-101ff, 220ff.) (3-22), (5-59) (13) Minnesota	HEW	Semi-rural	Not operational	Cable, portable video-carts, black and white, electronic stethoscope, inter-active audio-visual capability	Diagnosis and consultation, therapy, specialist consultation, In-hospital patient monitoring
Mt. Sinai (4-119ff.) (3-22) (5-75ff.) New York	HEW	Urban	Not operational	Cable, black and white, electronic stethoscope, interactive audio-visual capability	Diagnosis and consultation, therapy, specialist consultation public health education, medical education
Bethany/ Garfield (4-69ff.) (3-21) (5-21ff.) Illinois	HEW	Urban	Will be terminated shortly	Picturephone, cable, video-discs, black and white, interactive audio-visual capability	Diagnosis and consultation, therapy, specialist consultation lab tests, prescription and record transmission, supervision of pharmacist technician

TABLE I
TELEMEDICINE PROJECTS

Experiments	Funded by	Location	Operational Status	Technology	Services
Case Western (4-69ff.) (3-21ff.) (5-53ff.) Ohio	HEW	Urban	Operational	Laser, cable, one-way color, one-way black and white, remote controls, interactive audio-visual capability> data transmission	Diagnosis and consultation specialist consultation: in-hospital patient monitoring, prescription or record transmission, supervision of nurse anesthetists, intensive care monitoring, newborn nursing observation, (training)
Illinois Mental Health (4ff, 218ff) (3-21) (5-53ff.)	HEW	Urban	Not Operational	Picturephone	Diagnosis and consultation, therapy, administration, medical education
Cambridge (4-76ff., 212ff.) (3-21ff.) (5-31ff.)	HEW	Urban	Not Operational	Microwave, black and white interactive audio-visual capability	Diagnosis and consultation, therapy
Vermont/New Hampshire INTERACT (4-129ff., 235ff.) (3-21ff.) (5-87ff.)	HEW	Rural	Operational	Microwave, telemetry, one way color, one way black and white, interactive audio-visual capability	Diagnosis and consultation therapy, specialist consultation, in-hospital patient observation, public health education, medical education
Blue Hill, Maine (4-73ff., 211) (6)	Maine Regional Medical Program	Rural	Operational	Microwave, black and white, interactive audio-visual capability	Diagnosis and consultation, therapy, administration, public health education, supervision

TABLE I

TELEMEDICINE PROJECTS

Experiments	Funded by	Location	Operational Status	Technology	Services
Rural Health Associates (4-135ff., 240ff.) (7) M	OEO/HEW	Rural	Operational	Microwave, black and white, interactive audio-visual capability	Diagnosis and consultation, therapy, lab tests, radiology, administration, supervision
STARPAHC (4-150– (13) Arizona	NASA Lockheed HEW	Rural	Operational	Microwave, land/mobile units, interactive audio-visual capability, computer data link	Diagnosis and consultation, therapy, specialists consultation, lab tests, radiology, prescription and record transmission, administration, medical education
Alaska ATS (4-149) (lo-2ff.) (13)	NASA/HEW	Rural	Not Operational	ATS-6, ATS-1 satellites, interactive audio-visual capability (4 sites), one-way Video/two-way audio (1 site), black and white	Diagnosis and consultation, administration, public health education, medical education, supervision (emergency care)
Miami-Dade (4-144ff.) (8) (9) (19) Florida	NSF	Urban	Not Operational (Research experiments completed) Evaluation still being conducted	Slow-Scan, electronic stethoscope; microwave black and white; micro-wave-color; interactive audio-visual capability	Diagnosis and consultation, therapy, prescription and record transmission supervision
Ohio Valley (4-145ff.) (14)	ARC	Rural	Operational	Microwave, color interactive audio-visual two-way capability (3 sites), audio-visual one-way (1 site)	Diagnosis and consultation, education, training, supervision conferences

TABLE I

TELEMEDICINE PROJECTS

Experiments	Funded by	Location	Operational Status	Technology	Services
Boston City Hospital (11) (12)	NSF	Urban	Operational	Narrowband (augmented) facsmile	Diagnosis and consultation, administration, specialists consultation, prescription or record transmission
Washington, Alaska, Montana, Idaho (WAMI) (4-149ff.) (10-2ff.) (13)	HEW	Rural	Not Operational	ATS-6, ATS-1, audio-visual capability inter-active (2 sites), one way audio-visual capability	Medical education, diagnosis and consultation

the communications systems usually provided more than one of the five types of services and in some cases all five.

For the purposes of this study, there are basically three groups of questions to be answered with regard to the telemedicine experiments which have been conducted. These are:

- Was the technology adequate to provide the service? (Included in this question is the issue of whether the technology used is excessive -- e.g., were both audio and visual interaction necessary or would audio have been sufficient?)

- Were the services provided related to the needs of the population served?

- Were the economics of meeting health care needs by broadband communications considered? (This question includes not only the economic viability of the system but also analysis of the costs and benefits of meeting health care needs by some method other than broadband communications.)

To assist in considering these questions, Table 2 was prepared. It summarizes the objectives and results of the same sixteen experiments described in Table 1. The last column (labelled Comments) provides additional information on the issues raised above.

TABLE II
TELEMEDICINE PROJECTS

Project	Objectives	Results	Comments
Massachusetts General, Logan Airport Bedford, Veterans Administration Hospital (4-108ff.) (205ff.)	To determine clinical applications of technologies; to determine manpower/technology combinations; to develop ways in which provider /consumers can adapt to technologies; to develop cost-effective models.	Project proved technical feasibility and clinical applications; records showed health care provided was of sufficient quality. System at Logan was not cost-effective partially because of the presence of physicians at Airport site and because system was not fully utilized. High level of patient acceptance, provider acceptance was also apparent.	Systems have not been used to a maximum extent. Some problem with technical systems due to atmospheric conditions or human error. *These two projects are placed together because they are connected to a central link (Mass. Gen.). The Logan Airport link originated because the principal investigator initially saw the potential of the technology for providing emergency medical care to accident victims. The Bedford link was initially established to provide specialty consultation (psychiatric and neurological) to Bedford which is a long term health care facility (4-25ff.)
Lakeview Clinic (4-101ff, 220ff.) (3-22)(5-59)(13)	To test clinical applications of technology in consultation, emergency care, patient monitoring; to determine provider/consumer attitudes; to determine technical benefits (save time, etc.) and feasibility in contrast to telephone; to determine if physician availability is increased; to determine if more personal relationships are established	Easier access to consulting physician; patient anxiety reduced; more continuity in care, greater understanding of diagnosis and treatment. Consumer attitudes favorable; technical system provided versatility; physician practice did not increase; systern made specialist more available.	Peak-utilization was less than 2%, system not used to full capacity; legal issues did not arise. Technical problems with availability, set-up time, reliability, operational complexity, and maintenance; No significant economic advantages seen for physician. Security and confidentiality of patients did not arise as an issue, however doctors used telephone for most confidential situations.

TABLE II

TELEMEDICINE PROJECTS

Project	Objectives	Results	Comments
Mt. Sinai (4-119ff.) (3-22) (5-75ff.)	To determine patient/provider acceptance of technology; to determine effectiveness of system for health care delivery in lieu of "in-person" contact; to determine cost-benefit.	The system allowed for availability of specialists when there had previously been none; expanded role of mid-level practitioner; allowed for improved emergency care; reduced physician time; cost-effectiveness was identified as slightly lower than direct patient care.	Some technical difficulties with audio-video quality due to poor studio conditions; difficulty with facsimile reproductions; some "down time"; some technical problems due to human error.
Bethany/ Garfield (4-69ff.) (3-21) (5-21ff.)	To assess impact of technology on basis of contributions to health care and costs.	System demonstrated more rapid access to geographically dispersed internal resources; demonstrated technical feasibility; high acceptance by provider; allowed greater utilization of specialist services; greater use in emergency care.	Picturephone designed for face to face communication and proved inadequate for document transmission. Picturephones relocated during project to reflect increased knowledge of developers on need. Project originally used broadband, but was discontinued after brief period.
Case Western (4-69ff.) (3-21ff.) (5-39ff.)	To evaluate viability of using two-way broadband audio-visual and data communications to remedy shortage and maldistribution of anesthesiologists; to determine manpower/technology combinations; to determine if quality health care could be provided.	Demonstrated effectiveness and viability of using technology for providing improved health service in anesthesiology; demonstrated effectiveness of supervision of mid-level practitioners by specialists; provided better emergency care; provided consultation where it wasn't previously available; provided training; and generated closer teamwork.	Mid-level prefer direct contact; cost systems not identified; some procedural problems such as scheduling and simultaneous monitoring have not been resolved. This system has expanded to include connections with a community-hospital in a low-income area. Changes in the training of personnel for that hospital and the quality of care have resulted.

TABLE II
TELEMEDICINE PROJECTS

Project	Objectives	Results	Comments
Illinois Mental Health (4-92ff. 218ff.) (3-21) (5-39ff.)	To determine the extent to which the technology could enhance mental health delivery; to determine specific applications of technology.	System increased communication and information exchange of providers; diminished need for patient/provider travel.	Problem occurred with installing systems in most effective sites; technical deficiency for transmitting financial and medical data. Due to lack of effective planning and subsequent reorganization of technology to better sites, firm conclusions on video benefits could not be made.
Cambridge (4-76ff. 212ff.) (3-31ff.) (5-31ff.)	To test manpower/technology combinations; to test consultative applications and to determine if there would be reduction of referrals and improvement in quality of treatment; to test consumer/provider acceptance. Project compared telephone and television consultations.	Project demonstrated similar referral rates for TV and telephone although consultation time was substantially longer for television, in part, due to set up time and also because TV tended to enrich personal contact; demonstrated good technical quality; increased amount of information available; provided on-going education. Physicians had major problems due to location of technology.	Problems with accessibility of video consulting rooms for physician, rigidity of experimental design. System was not utilized to full extent.
Vermont/ New Hampshire INTERACT (4-129ff., 235ff.) (3-21ff.) (5-87ff.)	To explore technical feasibility and provider/consumer acceptance of speech therapy and dermatology delivered via technology.	Speech therapy was highly accepted by provider and consumer; provided means for training mid-level persons; increased usage of referral services; provided services not otherwise available; promoted inter-staff communications; reduced transportation time/costs; use of color for dermatology not significant.	Minimal technical problems. Speech therapy now self-supporting. Project personnel are now trying to determine ways to make system cost-effective.

TABLE II
TELEMEDICINE PROJECTS

Project	Objectives	Results	Comments
Blue Hill Maine (4-73ff,211) (6)	To use technology as the mechanism for providing mid-level practitioner with necessary support thereby enabling her to provide primary health care to island population. Based on community needs.	System gave nurse practitioner assistance in emergency care, consultation over primary health care problems. Showed the validity of using mid-level practitioner to provide primary health care.	Because the mid-level practitioner was only health care provider on the island, system proved useful. The idea of using system originated because island built a clinic but could not keep a physician. The Project Director stated that the system had to be coordinated with an institution. Community now paying for great portion of system's usage.
Rural Health Assoc. (4-135ff. , 240ff.) (7)	To establish a comprehensive health care delivery system to serve West Central Maine by developing a group practice of doctors and mid-level practitioners; to provide and increase health care for a dispersed population; to find payment mechanisms for low-income families and to determine if prepayment for health care in rural areas is a viable mechanism. Based on community needs.	RHA used technology as a mechanism for providing service. Project proved the validity of using mid-level practitioners for health care delivery. Feasibility of using the technical system was demonstrated although questions regarding its necessity remain. Technical systems were exceptional for peer-group interaction among health care providers and for administrative functions. Also the intangible benefits of the doctor-patient/doctor-practitioner relationships appear positive, though not adequately evaluated. Satellite clinics have to be partially subsidized by main clinics.	Project based on health needs of community. Technical problems due to poor system planning and installation; some problems also due to weather conditions. These were overcome. The technology was not a primary purpose of the project.
STARPAHC (4-150) (13) (17-3)	To provide data for developing health care for future manned spacecraft by testing physician/paramedic link; testing technology; identifying technology advancement needs areas; improving the delivery of health care to remote areas.	Data has not yet been obtained.	

TABLE II

TELEMEDICINE PROJECTS

Project	Objectives	Results	Comments
Alaska ATS-6 (4-149) (10-2ff.) (13)(18)	To explore the potential of satellite video consultation to improve health care to a highly remote area, to provide education and training to health care providers to the public; to provide health information system; to determine feasibility of using health care proivders (mid-level) for health delivery to rural areas.	Satellite communication can reliably provide signals of sufficient quality to be useful for health service delivery for rural areas; useful consultations for a variety of medical problems could be conducted; satellite video consultation can be successfully carried out by health care providers at all levels of training; the unique features of video transmission may be critical in 5 to 10% of cases selected for video transmission> otherwise there is little measurable difference between audio vs. video consultation; Health care providers involved felt video consultations improved health care system capability, but questioned whether it was worth the costs - providers placed stronger emphasis on audio as mandatory for health care delivery in rural areas.	Experiment designed as a means for potentially reducing rural health delivery problems;- some sites in experiments were almost inaccessible by land, and had no audio communication prior to satellite.
Miami Dade (4-144ff.) (8)(9) (19-143ff.)	The objective of the telemedicine phase was to determine cost/benefits of telemedicine using nurse practitioners; to gather data on the relative merits of different types of video communications which can be used in telemedicine systems. [The total project (Phase I and II) looked at organizational structure of delivery systems, manpower possibilities, and technologies as a part of health care delivery systems.]	There was no difference in quality of care given by on-site physicians compared to care given over telemedicine. Nurse primary practitioners provided medical care equal to that of physicians. Telemedicine links not cost-effective when compared to cost of care administered by nurse practitioner; telemedicine was equal in cost to care provided by on-site physician.	Research experiments are completed; evaluation of project is still being conducted. This experiment was conducted in two stages: <u>baseline</u> which introduced medical record system and extensive use of nurse practitioners; and <u>telemedicine</u> which introduced technology. Principal investigators have stated that telemedicine may prove cost effective in settings where transportation is a major problem, and where costs of physician time . are equivalent to those of physicians in nonacademic settings. The physicians used in this experiment were from academic environments and as such, have generally lower salaries.

TABLE II
TELEMEDICINE PROJECTS

Project	Objectives	Results	Comments
Ohio Valley (4-145ff.) (14)	To use technology for providing primary health care and diagnosis.	Evaluation and results not yet available because of relative newness of the system.	System became operational in 1975. Project was not developed as intended. System has been used more for education/grand rounds and medical conferences.
Boston City Hospital (11) (12)	To demnostrate and test feasibility of using distributed health and delivery system for nursing home populations by using nurse practitioners; to test quality of care rendered by NP's; and to determine comparative costs, benefits of NP vs. traditional physician visits system.	Use of NP's proved beneficial. 80% of NP work did not require physician consult; frequency of care was better than traditional system; quality of care slightly better than traditional system.	Project is being continued. Technology demonstration (telephone and some facsimile equipment) was not a purpose. Technologies were chosen because they were inexpensive and provided necessary backup to NP. Key factor of any health care system using technology is the function and organization of the people. Problem in financing Medicare through NP due to state law.
Washington, Alaska, Montana, Idaho (WAMI) (4-149ff.) (10-2ff.) (13)	To demonstrate feasibility of satellite technology as a support for program in decentralized medical education.	Experiment demonstrated the feasibility of using satellite for teaching, administration, and patient care. Broadened potential of medical education alternatives for relieving maldistribution and shortage of physicians for rural areas.	This project was originally designed to provide a new system of medical education to three states who did not/could not build a medical school. When satellite became available it was used to increase ability of system to provide educational service. Some malfunctions in technology occurred due to design flaws, arrangement of equipment, weather conditions.

Adequacy of technology. A useful framework for reviewing developments in telemedicine over the last decade is that proposed by Bashshur.[1] He divides the development of telemedicine in the U.S. into three stages:

- 1964-1969: experimental efforts by independent medical practitioners to test the applicability of the technology to clinical needs. The general objective during this period was testing the feasibility of two-way communications for diagnosis and clinical use (20-6).

- 1969-1973: continuation of the first stage but with Federal support for research and development in telemedicine (20-3). HEW, NSF, OEO and NASA participated in programs to establish the technical capability of communications techniques for various clinical uses (20-6).

- 1973- present: treatment of telemedicine as a method for delivering health care. Program objectives shifted to assessing whether telemedicine could be self-supporting or economically viable and to assessing the quality of care relative to other methods (20-4).

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[1] Bashshur, Rashid and Armstrong, Patricia. "A Review of Telemedicine as a New Mode for the Delivery of Health Care." (In press: quoted with permission of Inquiry.)

As can be seen in Tables I and II, telemedicine experiments have largely been concerned with testing the technology and clinical applications using the technologies. Most experiments were initiated during one or the other of the first two stages. However several experiments implemented during the third stage described by Bashshur, have been designed to address questions of economic viability and the adequacy of health care provided by various technology/manpower combination alternatives (Boston City Hospital and Miami-Dade projects). In addition, subsequent evaluations of several projects conducted in the first and second stages of telemedicine have shown important findings regarding economic viability and alternative technology/manpower combinations.

As is apparent from Table "II, a variety of technical problems were encountered during the telemedicine experiments; however, most of these problems were overcome. Such difficulties included large amounts of "down time" when systems were not operational; noise interference with the use of certain equipment; and difficulties in focusing and placing the cameras. In addition, adverse weather conditions affected the operation of equipment in certain locations, and lack of an adequate power source held up usage in some instances. Nevertheless, most technical difficulties and problems were solved in the course of the experiments. In general, it can be said that (20-11):

> "By the end of the second stage, the capabilities of telemedicine equipment had advanced to a level where technological difficulties were no longer an important determinant *in* its effectiveness, and initial observations about the clinical applicability of telecommunications to specified diagnostic problems were made" (20-11).

Although technical feasibility was demonstrated, an important issue raised by telemedicine experiments is the level of technology necessary to meet health care requirements. In other words, while two-way interaction is clearly required for most functions in health care delivery, are both audio (voice and data) and visual interaction necessary, or is audio sufficient?[1] The question is important because audio-only systems are less expensive and can be served by conventional telephone rather than more expensive technologies.

One study evaluating the manpower/technology combinations for rural health care delivery systems states that an augmented narrow-band network used to link professional with mid-level practitioners is a viable means for providing effective health services to rural populations (74). Concurrently, the Boston City Hospital Nursing Home project also demonstrated the feasibility and value of using augmented narrowband technologies for providing health care.

In contrast, other telemedicine experiments using broadband technologies have shown advantages of the visual modes provided by such technologies. A specific experiment funded by the Department of Health, Education and Welfare (Cambridge Hospital Project) tested two-way audio-visual vs. standard telephone for consultation between three low-income neighborhood health stations and the Cambridge Hospital (5-31 ff.). The health service stations were staffed by nurses who consulted with physicians at the hospital using the two different techniques. It was found that:

[1] Considering the increased capability of telephone lines for transmitting data, it has been suggested that more creative use of telephone systems ("augmented narrowband") may be an option for use in health care delivery systems.

> “there were significant referral pattern differences between television and telephone. This is of key importance in the rural setting where the economic, physical, and emotional penalty suffered by the consumer may be lessened with the utilization of television. Regarding the desirability of the two, both consumers and providers (physicians and nurse practitioners) expressed a slightly higher degree of satisfaction for television than telephone consultations” (5-32).

Also of significance is the fact that the television consultations took longer than the telephone consultations and that more information was transferred using television. As a result, “more than twice as many telephone consultations resulted in immediate hospital referral than with television. The television made it possible to handle a significantly greater proportion of the referrals to physicians entirely within the neighborhood health center, by reducing the need for immediate referrals to the hospital” (5-37). This is of critical significance to rural applications where access to hospitals may be difficult and the economic penalty of hospitalization tends to be greater than for the average urban resident because of lower average income levels and lower rates of health insurance.

To summarize, the technical feasibility of using broadband or augmented narrowband communications technologies to provide health services has been demonstrated. With the telemedicine experience of the last ten years, technical problems have been resolved. As regards audio-visual vs. voice only, what now needs to be provided is hard and more detailed data on the value of adding the visual mode. Bashshur points out that:

> “To obtain quantified answers concerning the visual contribution to specific benefits and problems in terms of the quality of care, access, and cost of health care delivery systems will require additional well-focused research” (5-7).

Relationship between the experiments conducted and rural needs. This is the second question raised earlier. There are at least four aspects to be considered. One is the degree to which telemedicine can serve the range of rural health needs identified at the beginning of the Chapter. A second is the adequacy of health care provided. A third is the acceptability of telemedicine to both patient and the health care professionals. Finally, one may ask whether telemedicine experiments have been based upon an analysis of the particular needs of a given rural area which might be best served by telecommunications.

As previously indicated, telemedicine experiments have been successfully conducted in various aspects of each of the five categories of health services identified by Rockoff (3-22). Telemedicine has been successfully used for consultation, supervision, direct patient care, administration and management, and education and training. It appears that telemedicine has the potential for contributing to each of the four areas of specific rural needs identified at the beginning of this Chapter. This is because of the demonstrated feasibility of using midlevel practitioners for primary health care. Thus, by linking a nurse-practitioner or physician-assistant in remote areas to physicians and specialists, telemedicine can help fill the need for increased primary health and specialist care. One exception is that dental service experiments appear not to have been done. (However, it is possible to visualize diagnostic dental service via telemedicine.)

Generally, telemedicine can increase accessibility of rural residents to health care personnel and reduce the need for travel to remote hospitals and clinics unless such travel is necessary. Similarly, telemedicine can increase access to emergency medical services. It can also provide for continuing education of remote health personnel, reduce feelings of isolation and provide access for medical peer consultation and referrals. Thus, telemedicine could help attract or retain medical personnel in rural areas. Coupled with the stated preference of the majority of the population at large (which presumably includes some medical personnel) for nonurban living as described in Chapter III, telemedicine could be a significant inducement to medical personnel to locate in rural areas. Unfortunately, data from rural telemedicine experiments are not adequate to evaluate this potential.

Experiments have demonstrated that telemedicine can increase the adequacy of health care by providing access to services to underserved populations which were not available before or were only available to a minimal extent. Significant data on this point comes from the seven exploratory two-way audiovisual telemedicine projects supported by the Department of Health, Education, and Welfare beginning in 1972 (these are experiments 2-8 listed in Tables I and II). The projects took place in both rural and urban settings and involved a variety of health care services. As stated in a review of the benefits and problems associated with the seven experiments:

> "...New services were provided to the patient by the telemedicine system that were not available before its introduction. Patients accept the recommendations of their doctors and rely on their judgment. As such, no appreciable patient dissatisfaction with telemedicine care was detected or registered. It would appear that from all projects the patient received <u>increased quality of care</u> in one form or another (e.g., received emergency treatment sooner, received physician supervision of non-physician, and received specialist consultation where it wasn't available previously)" (5-19).

Aside from quality of care, acceptability of telemedicine by both patients and health care personnel are important facts to be known. As indicated in the last quote, patients appear to find telemedicine acceptable. There also seems to be a change in attitudes before and after exposure to telemedicine. Just one exposure to telemedicine appears to bring about this change in attitude. Data on this point were collected by survey in the Rural Health Associates project. Even those exposed to telemedicine for the first time seemed quite satisfied as shown below:

> "When asked, 'compared to seeing a doctor in person, how satisfactory did you find seeing a doctor over TV?' about seven in every ten (71%) checked that it was the 'same as seeing a doctor in person'. Only about one in six (16%) thought it less satisfactory than seeing a doctor in his office. It will be remembered that over four out of every five (78%) of the general population, almost all of whom had not received any medical care over TV, felt that seeing a doctor over TV would be less satisfactory than seeing him in person. What is more, although only about a third (32%), of the persons who had not received medical care over TV thought that it would be about as easy or more easy to explain medical problems over TV, about four in every five (79%) of those who had received TV care indicated they found that it was 'no different', that it was about as easy to explain their medical problems over TV as it was in person"[1] (21-8).

Patient acceptability of telemedicine is further shown by data from the same project when patients were asked whether they would rather wait to see a doctor in person rather than having more rapid access through TV. Thus:

> "The fact that these persons have had pleasant medical experiences over TV probably explains why almost four in every five (75%) felt that they would rather wait only one day for an appointment to see a doctor on TV than to wait either three days to see a doctor in person or two days for an apointment to see a nurse-practitioner or physician-assistant."[1] (21-10).

The three quotes above suggest that patient acceptability to telemedicine is high and that positive benefits in the way of access to increased health services accrue. In addition, patients appear to have minimal problems with the equipment (5-19).

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[1] Weeks, H. Ashley, "Changing Attitudes toward' Telemedicine". Preliminary Survey results presented in paper at the Second Telemedicine Workshop, Tucson, Arizona, December 4-6, 1975. (Unpublished, quoted with permission.)

While health professional note benefits associated with telemedicine (such as increased access to patients, reduction of the need for their physical presence, consultative support, etc.) they also cite problems. For physicians, privacy, confidentiality and other legal issues were raised in nearly all seven of the HEW project (5-8; 5-18). Ease of access to television facilities is also an important aspect of physician acceptance. For nonphysician medical personnel, many favored direct face-to-face interaction. There is also a "Big Brother" syndrome associated with a physician monitoring a nurse or physician assistant via TV. However, these problems were generally overcome. Proper location of television facilities is also important in facilitating acceptance among nonphysician medical personnel (5-18).

Thus, acceptance of telemedicine on the part of health care personnel is somewhat less than for patients. Another problem relates to the resolution of legal issues. Aside from general issues of privacy and confidentiality, some laws will require change if maximum benefits are to accrue from telemedicine. An example is drawn from the Bethany-Garfield experiment (see Tables 1 and 2):

> "...the State of Illinois requires one pharmacist to personally supervise one pharmacist assistant. When considering the shortage of pharmacists and evening and weekend coverage requirements, the one-to-one state requirement and personal supervision are formidable obstacles in a community hospital complex such as Bethany-Garfield, which would like to use its Picturephone system to supervise apprentices by remote control" (5-8).

A second legal issue arises from Medicaid reimbursement. As far as is known, it has not been established that reimbursement can be made under the circumstances surrounding health care provided by telemedicine. Also to be considered uncertain and open to further analysis is the degree to which the experiments have been based upon actual needs analysis and detailed attention to those needs which could be best met by tele-

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communicant ions. In general, this level of sophistication of application is only beginning to be addressed. However, in both the Blue Hill and Rural Health Associates projects, the central purpose of the experiments was providing care to meet the health needs of the communities served.

Economic considerations. Turning to the economics of meeting health care needs by broadband communications, two aspects must be considered: 1) the economic viability of the service; and 2) the costs and benefits associated with use of telemedicine vs. some other method. These are issues which fall into Bashshur's third stage in the development of telemedicine; concern with questions of this sort date from about 1973. Several recent evaluations of telemedicine experiments have been designed to determine the costs and benefits of using different technologies and manpower combinations. One cost analysis study suggested that field trials should be directed to use voice and data transmission without video. However, it should be noted that the authors of that study also state that "consideration of alternative technologies from the standpoint of the patient may point to broadband" (i.e., video as well as voice) (22-87). Several studies which have evaluated costs of telemedicine have generally found that the costs of using such systems with mid-level practitioners are marginally lower than the costs of having a physicians services (Miami-Dade and Mt. Sinai projects). However, others feel that the case for telemedicine has yet to be proved in view of the short periods of time over which most research and demonstration programs are conducted. Thus, "none of the programs operated optimally at peak patient loads to warrant a true test of cost effectiveness (20-11).

The difficulty of drawing conclusions from government field trials conducted to date has been considered by Elton. As summarized by Bashshur (20-ll) , Elton, identified two major problems:

> "(l) the length of time involved in these projects and (2) the problem of uncertainty. Field trials are conducted for a specified period of time-- usually one to two years. Hence, the time constraints tend to influence the course of the trial, that is, the results may or may not occur when the time constraint is absent. A program could be termed unsuccessful when the actual problem may have been lack of an appropriate time period to develop the program. Field trials are set up to reduce uncertainty by developing and conducting a Program and then evaluating it. The problem is that the evaluation is tacked onto the trial rather than included as an intregral stage during the process of the trial. Thus, the issues to be evaluated are not clearly separated, and it is difficult to determine exactly what issues are being effected, and in turn are effecting the outcomes. The trial often is not successful in reducing uncertainty, or does so only partially. Elton suggested that the field trial is a necessary form of research, but, to be meaningful, the evaluation process must be clearly defined for the field trial."

Rockoff clearly states the need for additional data:

> "Although the exploratory experiments have yielded 'clinical impressions' about areas where this technology (i.e. , visual telecommunications) is likely to be quite beneficial, such as scheduled specialty teleclinics, careful research and experimentation will be required to clarify and quantify the benefits and the associate costs in order for health-care system planners to have the information they need to decide on visual telecommunication in the face of the other options available" (3-28).

Potential rural applications. A review of the experience with telemedicine has shown that meeting many rural health needs by broadband communications is technically feasible. In addition, patient acceptance of telemedicine is high and the potential of broadband communications to improve quality of care by increasing patient access to services previously unavailable to them has been demonstrated. While ensuring privacy and confidentiality remain problems for physicians, these have not prevented application of telemedicine so far. However, broader application will probably require resolution of these issues. In addition, some laws constrain reaching the full potential of broadband communications for improving health care. As for nurse-practitioners and physician assistants, benefits in terms of access of consultation have been demonstrated but there have been some problems such as a feeling of too close supervision. These have generally been overcome.

While the use of telemedicine has been demonstrated in a number of experiments, many demonstrations have not been economically viable and have been discontinued when Federal funds were no longer available. In part, this may be based on lack of adequate needs analysis of the particular community before the project was undertaken. An interesting exception is the Blue Hill project, which was specifically oriented to meeting health care needs of the community. The isolated community of Deer Isle first attempted to attract and retain a doctor with a community clinic. When this failed, attention was turned to telemedicine with a midlevel practitioner and microwave connection to the Blue Hill Memorial Hospital. This proved successful. While the project has been supported by the Maine Regional Medical Program, community support is now the primary financial base for the system (6).

While telemedicine appears to be a feasible way to bring health care to rural areas, data are inadequate to assess its value and benefits in cost-effectiveness terms. However, for rural applications in particular, cost-effectiveness may not be the only criterion. This is because alternatives to telemedicine are limited or perhaps even nonexistent in some rural areas. For example, one alternative is to build more hospitals. However, this alternative has already tried and rejected. “Small hospitals of 50 beds of less were built in rural areas under the Hill-Burton Program to provide specialized services to rural physicians. However, this program has been discontinued because the facilities have proven to be uneconomical in operation and the volume of work has not permitted adequate quality control of professional activities or laboratory studies” (Harrell in 23-14). As another example, if physicians find remote areas unattractive, the alternative of improving health care by increasing the health manpower in the area is not likely to be successful. Thus, telemedicine could be the only alternative for improving health care in some areas. Paradoxically, by enabling physicians to consult with their peers, have access to specialists, and continue their education, telemedicine could also remove many of the reasons physicians do not locate in rural areas. Thus, a redis-tribution of health manpower could occur just because of the solution imposed to meet a manpower shortage. This, however, remains speculative at the present time.

As a further note on costs, it seems unrealistic to suggest that a broadband system would be built solely for its use in providing health services. Others have noted that to encourage telemedicine system to become “self-supporting”, sharing of communications links with other social services should be considered (20-17) and some calculations have even been made on the effects of cost-sharing in which 50% of broad-band system costs are picked up by other services (23-16). However, if a broadband system is viewed as a means for making a variety of services, including subscriber-supported entertainment, available to a community, telemedicine might be required to support considerably less than 50% of system cost. This approach is pursued further in Chapter IV.

In summary, it appears that there is considerable potential for telemedicine to contribute to rural health needs. Lack of adequate data on value and costs suggests the need for further study. However, it is suggested that the keynote for such study should be evaluation of economic viability. An approach is outlined in Chapter IV of this report.

Education

Equal access to education has been a goal in the United States for the past two decades. However, statistics on educational resources and grades of education completed suggest that rural residents are at a disadvantage with regard to educational opportunities compared to their urban counterparts. This section examines rural education needs, experimental efforts to provide education via broadband communications and the potential of broadband communications to supply educational services to rural areas.

Rural needs. Opportunity for education depends upon adequacy of educational resources and services at each level of education sought (primary school through adult education), and accessibility to these services by students. Unfortunately, lack of data limits the following analysis to a description of general differences in nonmetro as compared to metro areas. Further, as discussed in the next Chapter, rural areas differ significantly from each other in population and socioeconomic characteristics. Thus, while some aggregate differences between metro and non-metro areas can be shown, the characteristics of particular rural areas may differ from the general description provided here.

Major factors which influence quality and access to rural education are:

- economic characteristics of the community; and
- organizational structure of educational systems.

The importance of economic characteristics lies in the fact that major financial support for education comes from the local community. In 1971-1972, on a national basis, financial support for public elementary and secondary schools were derived from the following sources (24-47) :

- 53% from local funds;
- 38% from state funds; and,
- 9% from Federal funds.

Analysis of financial resources for rural areas showed that, in 1973, 45% of the revenue for local school systems in nonmetropolitan areas was from property taxes (25).

Concerning the availability of financial resources, rural communities generally are found to have lower per capita income and a greater percentage of people living below the poverty level. In 1974, the Census Bureau reported that the median income for metropolitan residents was $12,844 compared to $10,327 for nonmetropolitan residents (26-98). In addition, 9.7% of metropolitan populations were below the poverty level compared to 14% of nonmetroplitan populations (26-16). Although the median income and poverty level of nonmetropolitan areas varies greatly among states, the statistics indicate that rural populations generally have a smaller economic base for tax revenues. The significance of the reduced economic base for nonmetro areas is that educational resources are likely to suffer. Educational programs will be more limited, facilities and equipment will be reduced and teachers will receive lower salaries and possibly have lower qualifications than in urban areas.

In addition to the funds available for rural education, the organizational structure of educational systems also influences the quality and accessibility of rural education. By organizational structure is meant the degree to which schools are consolidated, which is reflected in the number of one-teacher schools and the number of pupils enrolled in each school. Previously many rural populations had one-teacher schools as the main education resource in the community. In 1960 there were 40,500 school districts and 20,000 one-teacher schools within those school districts. Considerable consolidation occurred in subsequent years and in 1974 there were approximately 16,700 school districts and 1,365 one-teacher schools. Of the 16,700 school districts, 16,300 were operating schools within their districts and the other 300 were providing for their students by other means, i.e., transferring them to nearby operating districts (27-6; 28-53). Consolidation increases the enrollment in each school which in turn influences the services and resources for a given school system. However, 4,723 school systems in this country (28.9% of the total) have enrollments of fewer than 300 students (24-55). These may be compared to a HEW Report which concluded that "a system should serve at least 500 students in order to offer what is now considered a full program" (24-55).

In considering the densities and distribution of rural populations, it appears that many of the schools with fewer than 300 pupils are located in rural areas. Consolidation of school systems can increase the diversity of educational programs by reducing per pupil costs. According to one report "the most important single factor causing high per pupil costs in rural schools is a relatively high ratio of professionals to students" (29-2).

While consolidation of schools has aided in alleviating costs incurred by high teacher-student ratios, in some rural areas it may have increased the financial burden of transporting students greater distances. According to Thomas, "on the average, school districts in rural areas pay high per pupil costs for transportation. A large proportion of pupils in rural areas are transported, and costs per pupil mile are also relatively high... where state aid does not cover the full costs of transportation, rural school districts must pay the difference in costs from funds that would otherwise be available for instruction" (29-6).

In light of the population density and distribution, the economics of rural populations, the financial resources for rural education and the organizational structure of school systems, it appears that many rural communities have fewer economic resources available to finance their educational systems, reduced accessibility of schools to students and teachers, and a need for a wider array of educational services than are presently provided. While consolidation and financial reform in education may be steps toward resolving the problem or providing equal educational opportunity, the economic and demographic characteristics of rural areas today still hinder the abililty of rural communities to deliver quality education which is both accessible and cost-effective.

Another indication of equality of educational opportunity is the enrollment of students at different levels of education. Relevant data are:

- proportionately fewer nonmetro residents attend institutions for higher learning. For those 18 to 34 years old, 17% of metro residents were enrolled in colleges compared to 11% for nonmetro residents

- the Department of Health, Education and Welfare estimates that about 54 million adults have not received a high school diploma (33). Of adults over age 25, 13.9% from nonmetro areas received no more than an eighth grade education compared to 10.1% from metro areas (26-10).

- particularly startling are the differences in participation in adult education courses. Of the 822,000 participants in federally sponsored adult education courses, only 13% of those enrolled lived in nonmetro areas (31-7).

The above data indicate that nonmetro residents receive less education than their metro counterparts. Exact reasons are unclear. On the one hand, it may be hypothesized that educational opportunities are there but simply are not used. On the other hand, it may be hypothesized that the lower quality of and/or reduced access to educational resources accounts for the lower educational levels achieved by rural residents. Support for the latter hypothesis is provided by a 1969 survey of 32,000 Appalachian teachers. This survey of a predominantly rural area indicated that teachers in locations with few inhabitants generally had less opportunity for in-service training, received smaller salaries and were teaching in schools with less than adequate facilities (32).

In summary, although direct data are sparse, it appears that rural areas are not equal to metro areas in educational opportunity. The following appear to be the major areas of need:

- greater diversity of educational programs including improved resources and services;
- increased accessibility to education;
- increased opportunities for adult education; and
- increased opportunities for continuing education of rural teachers.

The following discussion covers communications experiments in education and the potential for broadband communications to meet rural education needs.

Experiments. Table 3 summarizes ten experiments using two-way communications techniques for educational purposes. (It should be noted that there have been many one-way applications, including conventional educational television. These are not considered here.) The funding sources, location of the experiment (urban or rural), operational status, technology used and services provided are indicated.

Several comparisons can be made between the education experiments and those which have been conducted in health (Table 1). As in health, the major funding source for education experiments has been the Department of Health, Education and Welfare. Fewer experiments have been conducted in education than in health. Only one semirural and three rural education applications were found. The technology used in the educational

TABLE 111

EDUCATION PROJECTS

Experiments	Funded By	Location	Operational Status	Technology	Services
"Cable Television Project" Tulsa School Systems (34) Oklahoma	Tulsa School System	Urban	Operational	Cable; color one-way audio-visual capability, one-way visual with two-way audio-capability; two-way audio-visual. System interconnects four schools with Educational Center at school system administration offices.	Provided a number of courses to elementary and secondary students, some of which were not previously available. Provided teachers and students with opportunity to plan and produce educational programs. Provided in-service training and conferences between school administrators and teachers.
Program for Homebound Handicapped Amherst, N.Y. (35) (36) (40)	Bureau of Education for the Handicapped (funding for two years at totals $738,404) Expected to secure funds from other sources once BEH grants have expired However, Federal funds end in FY 75. Whether other sources will be found is questionable.	Urban	Operational	Cable used to transmit time-shared, interactive computer controlled information television (TICCIT); - the TICCIT systems modifies material for television format. Interactive digital response unit.	Currently provides 26 homebound students with individualized instruction. Scheduled to serve up to 100 students. System provides for library requests.

TABLE III

EDUCATION PROJECTS

Experiments	Funded By	Location	Operational Status	Technology	Services
Handicapped Project University of Kentucky (35) (38)	Bureau of Education for the Handicapped funding for two years, total = $286,965	Urban	Operational	Telephone lines used to send computer signals to homes with individualized teaching units; two-way audio; tactile response capability	Provide specialized/individual education to 18 homebound mentally retarded children (O-6 years old) with zero behavior skills
		All BEH projects expected to secure funds from other sources once BEH grants have expired However, Federal funds end in N 75. Whether other sources will be found is -questionable			
Handicapped Project **New York** **(35) (38)**	Bureau of Education for the Handicapped funded for two years Total = $598,240	Urban	Operational	Cable television used to transmit instructional programming, video-taped programs and computerized programs; digital response unit.	Provides specialized instruction for handicapped students at five community centers.
Appalachian Education Satellite Project (41-106 ff.)	HEW HEW funded programs NASA satellite Satellite in India; no money to continue.	Rural	Not Operational	ATS-6, ATS-3 satellites black and white, ground receiving units-telephone transmission for some ground functions; one-way audio-visual capability, two-way audio capability Also used computers for information storage and retrieval.	Provided graduate (continuing education) courses during summer in career education and elementary reading for rural teachers; provided in-service training in career education and reading during academic year; produced video software for programs which can be reused elsewhere; serve *1200* teachers initially.

TABLE III

EDUCATION PROJECTS

Experiments	Funded By	Location	Operational Status	Technology	Services
Federation of Rocky Mountain States Satellite (40-100 ff.) (43-21)	HEW (Educational Programming portion) NASA (satellite) $11,000,000 rough cost to HEW: $11 million	Rural	Not Operational	ATS-6, ATS-3, one-way video; two-way audio capability cable, translators	Provided career education courses to junior high students in 56 rural communities; provided materials distribution systems for teachers; provided continuing education courses for adults on topics such as health care, problems of aging, land use, etc. Provided teacher in-service training.
Tager System H (2-43) (42) Texas	Private philanthropy provialed some original funding for technology. Annual operating budget $225,000 schools and institutions support system through enrollments.	Urban	Operational	Microwave; one way video, two-way audio capability; black and white.	Provides 70-80 three credit hour graduate and undergraduate courses to students at nine universities and eight industrial firms.

TABLE 111

EDUCATION PROJECTS

Experiments	Funded By	Location	Operational Status	Technology	Services
Northern Virginia Community College and Manicopa Count y Community College (Phoenix) (40)	NSF	Urban	Operational	TICCIT (Time shared, Interactive Computer-Controlled Information Television)	Provides courses in English composition and mathematics to community college students.
Spartanburg, South Carolina (44,45,46, 47, 48)	NSF ($1,106,566)	Urban	Operational	Cable. Adult education; one-way video with push-button response. Daycare education: two-way audio-visual.	Adult education. Training of daycare personnel. (Also other noneducational services.)
Alaska ATS Experiment	HEW: (education programs) and receiving stations NASA: (Satellite)	Rural	Not Operational	ATS-6, ATS-l; two-way audio, one-way video	Programs broadcast to 17 remote communities in instruction of basic oral language development, health, education, and in-service training; community information broadcasts

applications was more diverse with various combinations of cable, translators, satellite, microwave and computers. It will be noted that two-way capability was generally more limited than in the health applications discussed earlier (where both audio and visual modes were typically available in both directions). In the education experiments, transmission typically involved both audio and visual, but response was generally limited to voice and/or data (e.g., digital response by pushbutton). This difference in response mode derives from the nature of the use made of communications for education: typically teaching of courses to a group of students. Whether such teaching is done by a teacher or by a computer, the responses required can be accomplished with voice or pushbuttons. For some purposes, pushbutton responses are more useful than voice. This is because digital responses can be analyzed for a group of students as they occur permitting the teacher to keep track of student understanding as material is presented.

A further difference between health and education is that more progress has been made in applying communication technologies to health needs than to educational needs. As has been shown the technical feasibility of using communications to meet a variety of health care needs has been demonstrated and experimental efforts are now moving into such areas as the best ways of combining manpower and technology into total health care delivery systems, with increasing emphasis being laid on cost-effectiveness studies.

By comparison, educational efforts appear to be less well-organized, with less clearcut objectives and with more work needed on how best to use available technology for educational purposes. However, there does seem to be increasing recognition of these deficiencies and efforts are underway to remedy them. Noteworthy in this connection are the plans and studies of the Rehabilitation Services Administration (RSA) of the Department of Health, Education and Welfare, which should go far to consolidate findings and provide a structure for vocational rehabilitation and education uses of communications. Current RSA efforts include assessment of available software and hardware; assessment of legislative, regulatory and attitudinal aspects of using communications technology for education; and methods for coordinating programs between RSA agencies (49).

Potential rural applications. To assist in considering potential rural applications Table 4 was prepared. It summarizes the objectives and results of the educational experiments listed in Table 3.

Though some problems have occurred (such as adverse effects from weather conditions in the Alaskan satellite experiment), the technical feasibility of using broadband communications to meet rural education needs has been demonstrated. Thus, the ATS satellite experiments have demonstrated that broadband communications can be used to increase the diversity of and access to educational programs, increase opportunities for adult/community education and provide in-service teacher training. However, a number of areas require further work.

First, the effectiveness of the technology as a tool for improving the quality of education remains to be demonstrated. It is unclear whether students learn as much over television with response capabilities as they do in a classroom, and the way to maximize the effectiveness of communications techniques for education remains to be worked out. Evaluation programs should be an integral part of future experimental efforts.

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TABLE IV

EDUCATION PROJECTS

Project	Objectives	Results	Comments
Tulsa School Systems (34)	Phase I & II designed to demonstrate feasibility of using technical systems with different capabilities; to determine educational applications and student reaction; to learn whether students would interact over systems; to demonstrate that supplementary enrichment,not previously available, could be provided; to test feasibility of expanding computer-assisted instruction.	Feasibility of technology was adequately demonstrated, but some problems still need correction. New courses were provided, two-way interactive transmissions were generally preferred. Other potential uses for system were recognized particularly administrative, community outreach, adult education, special education, security, staff development.	Project has been conducted in different phases with different objectives. It was designed to be used continuously. Technical problems with visual imagery and sound occurred. Idea for project originated in Tulsa; channels donated by Tulsa cable television as a part of fulfilling FCC regulations. Project originally planned to also aid in improving race/ relations and was a part of Tulsa's school integration plan. Services cannot be expanded to other schools due to lack of funds for equipment installation.
Amherst, New York (35,36,40)	To demonstrate the effectiveness of computer-based instruction delivered via closed-circuit television to severely multi-handicapped students, to demonstrate use in metropolitan areas with already established cable television capabilities.	Evaluation and results are not yet available, however results will be based on frequency of use. System appears to have a positive impact on families as well as students.	Project now operational. Technical problems have occured. System has not yet been used to full capacity although it has component to determine the extent to which it will be used. No cost analysis written into original plans, although project personnel are working on it. Planning involved agency and hospital referrals of students.
University of Kentucky (35,37)	To develop an electronically programmed environment for preschool children with severe mental retardation and attendant multiple handicaps.	Evaluation and results are not yet available since project is still in operational phase.	Project now operational. Computer system is a modified version of the clinical physiology. System allows for highly individualized instruction, as well as analysis of responses at the end of each teaching session. No cost analysis included.

TABLE IV
EDUCATION PROJECTS

Project	Objectives	Results	Comments
New York City (35, 38)	To determine how and the extent to which telecommunications can aid in the development of severely emotionally disturbed children; to develop learning modules and to test technology feasibility.	Evaluation of results not currently available because program is still operational. One major thrust of the program has been to develop the software (educational) programs for handicapped. Evaluation will look at student progress.	Some technical problems have occurred (i.e., digital response units not strong enough to handle students with major motor skills handicaps) . Cost analysis was not included in project.
Appalachian Education Satellite Project (39,41-106 ff.)	The educational objectives were to improve the effectiveness of classroom teacher by upgrading skills in career education and reading.	Generally viewed as successful project. Explored and demonstrated feasibility of using satellites to link up with terrestrial sites to provide educational programs; demonstrated positive response of participants; used trans-state structure to deliver educational services; developed procedures for software development; demonstrated feasibility of central computer system for information delivery via satellite	Conducted needs analysis in planning phase in order to determine greatest needs; technical problems were minimal. Delivery of courses via satellite excluding satellite costs, appears to be potentially cost effective; greater understanding of rural education problems evolved.
Satellite Project Federation of Rocky Mountain States (41-100 ff.) (43-21)	To demonstrate feasibility of using satellite technology for delivery of educational services to rural areas; to test and evaluate user acceptance and the cost of various delivery modes.		Minimal technical problems. Project covered four year period including planning implementation, evaluation from 1971-1975. Based on needs of system's potential users. There were numerous problems with conflicts in federal, regional, state and local objectives.

TABLE IV
EDUCATION PROJECTS

Project	Objectives	Results	Comments
Tager System (2,42)	To provide courses needed by educational institutions and industry by sharing resources and using technology.	Highly successful; technology used extensively; students do not hesitate to use interactive audio capability; 99% efficiency in the technology (Industry does not originate courses)	System has been operational since 1966. TAGER was originally established as interconnection and sharing of resources among institutions. Sponsoring participants realized that technology could save time and make courses more accessible; system is now self-supporting, flexible and allows versatility and freedom in educational policy for participating schools and industries; System designed to be used continuously.
Northern **Virginia** community College and Maricopa County Community College (Phoenix) (40)	To determine if computer assisted instruction (CAI) could be made a more viable, cost-effective method of instruction to test the value of instruction provided by computer technology.	Evaluation not yet available.	Prior to TICCIT, computer assisted instruction had been used as an adjunct to traditional classroom instruction. This project is aimed at determining the effectiveness of using computers as the main form of, instruction with proctor and/or teacher support. The technology systems has proved 99% reliability. Acceptance has generally been good although evaluations are still underway.

TABLE IV

EDUCATION PROJECTS

Project	Objectives	Results	Comments
Spartanburg, South Carolina (44,45,46,47,48)	To test the use of broadband communications to provide adult education, training of day care personnel and other noneducational public services; careful evaluation of broadband compared to alternatives; cost-benefit analyses.	Not yet available	Selection of public services for the experiments was based on a careful analysis of community needs and consideration of how broadband communications could help meet these needs.
Alaska ATS Experiment (41)	To explore uses of technology for providing educational instruction to highly remote populations of Eskimos, Indians, etc. to assess program effestiveness and acceptance; and, to determine the value of operational techniques		Based on need, Services were provided to teachers, citizens and students in very remote regions which are often inaccessible; language barriers present problems to students, teachers are isolated.

A related problem is the need for a data bank on educational programs or at least guidelines on how to effectively use interactive communications techniques for educational purposes. This would assist rural communities wishing to use broadband techniques for educational purposes to make effective use of them.

A third area of concern is the need for cost-effectiveness data. Some cost data were developed for the Appalachian experiments. Additional analyses are anticipated from the Spartanburg experiments (see also Chapter IV for discussion of the Spartanburg project). However, the Spartanburg project is located in an urban setting.

Overall, it seems that inadequate consideration has been given to the economic viability of education uses of broadband communications. Further attention is given to this topic in Chapter IV.

Law Enforcement

Rural needs. Rural area law enforcement authorities face similar problems and utilize similar operating procedures to those found in large municipalities. Many of the same administrative procedures are in use. Police officers attend roll calls and training sessions, and receive much of the same kind of administrative information, including wanted and missing persons circulars. They are also expected to prepare, submit and receive similar forms and reports.[1]

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1 Interviews with Captain William McCaa, Communications Department, Boulder County Sheriff's Department, Boulder, Colorado, and A. J. Anderson, Division of Communications, State of Colorado, Denver, Colorado. Although the analysis in this section is based upon rural law enforcement operations in the State of Colorado, these operations vary sufficiently in different parts of Colorado as to provide a broad sampling of conditions of operation.

A major difference between rural and urban law enforcement officers is the distance separating the officer from the central station. The rural officer must travel long distances just to interact with fellow officers, attend training sessions, and/or process arrested persons, As a result, he is away from his patrol area for long periods of time. It has been reported that in one area of Colorado, police officers typically spent up to one-quarter of their working time traveling to and from the central station.

The larger distances in rural areas have forced law enforcement officers to rely more heavily on telecommunications. Present day tele-communication networks in county sheriff departments now range from complex integrated systems employing leased telephone lines, multi-channel radio and microwave links down to simple single channel radio systems. These networks provide communications with the central station, sub-stations, vehicles, and individual officers at home or in the field. They further provide intercommunication, through the central station, with city police in counties with large municipalities, with state police and investigative agencies, and with fire and medical units.

Concerning the needs of rural law enforcement authorities, it is clear that communications are already being used extensively to overcome problems caused by distance. The issue thus seems to be whether cable might be a lower cost alternative to such means as microwave and leased telephone lines, or whether cable might offer features not now available that could further reduce unproductive travel time.

As one example, it has been estimated that the use of cable is generally less costly than microwave for distances up to 10 miles (50-95). Over 10 miles, it might be possible in some instances for law enforcement departments to install dedicated microwave links or share existing microwave links between town clusters in rural broadband systems.

Anticipating the next section's discussion of the Philadelphia Police Department's use of broadband communications, it has been demonstrated that broadband can be effectively used for televising roll calls and briefing sessions, transmitting fingerprints and other related documents and conducting administrative pre-trial arraignments. Whether volume or present travel costs might make the widespread provision of those services by broadband economically attractive will depend upon the characteristics of the individual rural area in question.

Experiments. In the terminology used in this Chapter, home burglar alarm services -- on the assumption that they are not likely to be paid for by the local government -- are included in a later section under commercial applications. Because programs designed to educate the public in such subjects as self defense and crime prevention are not revenue-generating, they also are not covered.

According to a recent NSF survey, only three tests of law enforcement broadband applications have been conducted in recent years. None could be classified as experiments in the conventional sense, and two of these, now discontinued, involved only the use of closed circuit for simple surveillance purposes (l-33).

The third of these, involving the conversion to broadband delivery of a number of important functions at a major U.S. police department (Philadelphia, Pennsylvania), stands alone in terms of magnitude and significance.

The Philadelphia system is comprised of two coaxial cables each with a capacity of 64 channels. One cable is being used for downstream service, the other for upstream. When the system is completed in the spring of 1976, it will connect the city hall, main police headquarters, nine division headquarters, and 22 district stations at an overall estimated cost of approximately $3.5 million (51).

The project began in 1969 with a study conducted by the Franklin Institute Research Laboratories. The objectives were to:

1) determine what police communications functions could be better and more economically performed on closed circuit television;

2) establish an appropriate systems configuration; and

3) develop and install a pilot system to demonstrate the capabilities of cable television to perform the tasks assigned (51).

The Franklin Institute study not only determined that existing communications functions could be done more economically, it also identified a number of new procedures which are now in the process of being implemented. The functions involved, together with the benefits anticipated through the use of broadband, are as follows:

FUNCTION	BENEFIT
1. Video conference calls between high-level police personnel.	Elimination of travel time to some meetings, more frequent and effective communication resulting in better understanding, unity, and smoother operation.
2. Television addresses to policemen at roll call by top command.	Better understanding of policies and situations at all levels, improved morale.
3. Dissemination of television training material to the divisions served.	Reminders to policemen of safety, legal and administrative procedures, etc.

4. Facsimile transmission of messages and bulletins between the Police Administration Building (PAB) and divisions served.	Faster and more economical dissemination of written and photographic material.
5. Van mobile unit with microwave permitting recording and monitoring special events throughout the City.	Provides concrete evidence of events for police or court review and a limited means for police to centrally monitor live certain events of a highly critical nature.
6. Decentralized photographing and fingerprinting of arrestees with transmission of fingerprint images by high-resolution facsimile.	Expedite the identification process, reduce crowding at the PAB.
7. Release-on-own-recognizance interviews and preliminary arraignments conducted over closed circuit television between divisions and PAB.	Eliminate the need to transport prisoners to the PAB (thereby saving time and money and reducing the chance of prisoner escape) and reduce the time an arrestee is detained unless he is committed to jail.

Other future possible functions for the system, listed briefly, include videotaping and transmitting lineups, regular live monitoring of special events throughout the City, monitoring traffic, surveillance of potential trouble spots (business districts and stores), and making videotapes of arrestees for an identification record (52-7).

The major monetary savings estimated at this time are related to the elimination of the need for transporting arrestees from the nine division headquarters to the main headquarters for fingerprinting and preliminary arraignment procedures.[1] At the present time, that step, which requires one

1 These procedures have raised legal and other objections. The public defender originally contended that the required "in-person appearance before a judge" was not being met by the use of cable TV (51). The promise of a reduction in process time helped to overcome this objection. The use of a telephone overcame the second objection of not being able to talk to the defendant in person privately. The other objection from the public defender's office dealt with the less personal nature of television. Civil rights group have objected to the use of TV for surveillance, citing possible invasion of privacy. Problems dealing with bail, e.g., the desirability of having the divisional or district police stations collecting money, have been resolved by allowing persons paying bail to pay at police headquarters, following which release documents are transmitted to the division stations by facsimile (56).

wagon and two officers in each instance, is estimated to cost $750,000 a year, Other advantages anticipated are: decentralization of the arresting process and allowing the person to be arraigned in his own neighborhood; reduction in backlog; and freeing-up of police officers for other duties (53-4).

Potential rural applications. At the time of this writing, no funding source had been located by the Philadelphia Police Department to conduct a cost-effectiveness study of the conversion of the described functions to broadband delivery (53). This is especially regrettable because this law enforcement application is the only one of its kind and conceivably might have a major effect in streamlining procedures and saving money in urban as well as rural departments. Without a cost-effectiveness study, there is no way of determining the net savings resulting from the use of the system or arrestee processing and pre-trial arraignment procedures; all that is known is that the previous procedures cost the Police Department $750,000 annually, There is also no hard data on the net savings that have resulted from the use of the system for training, teleconferencing, roll calls, facsimile transmission, and other functions described earlier. It might be noted that the Federal government, through the Law Enforcement Assistance Administration grant, already has a sizable stake in this project. The additional observation might be made that funding of a cost-effectiveness follow-up study could be relatively inexpensive compared to its potential worth in assessing the value of this unique effort and its possible use elsewhere.

Pending the availability of such information, this use of broadband can only be considered of potential application in rural areas. From what is known about the project generally, however, it might be one which could be profitably explored in connection with the suggested system demonstration program described in Chapter IV.

Governmental/Administrative Uses

One likely application of broadband systems is use by government in processing citizen claims and applications when more than one agency and more than one location is involved. Especially when the poor are involved, as in welfare applications, the costs to the government for transportation between agencies can be substantial. One experiment bearing upon this use of broadband communications was identified during the course of this survey. That experiment, involving inter-agency processing in Spartanburg, South Carolina, is discussed in Chapter IV.

Commercial Applications

There are four broad classes of auxiliary services which could utilize the capabilities of broadband communications systems and which have profit-making or commercial potential. These four classes are identified and briefly described below.

1) Security Systems. Included in this group are: 24-hour smoke and fire surveillance, intrusion surveillance, police call, medical request, and emergency alert services. These services are generally paid for by the home or business subscriber as part of, or in addition to, their standard cable television service.

2) Information Services. By information services is meant updated information-on-demand such as stock and commodity market reports, sports information, and educational information. A fee is charged for these services and paid by a home or business subscriber.

3) Data Transmission Services. These services are used where large amounts of information must be transferred among various offices. Potential users are banks, government agencies, and public utility companies. Dedicated channels leased by a business subscriber for computer-to-computer, computer-to-terminal or terminal-to-computer data communications are used to provide these services.

4) Pay-Television. Pay-TV provides entertainment services which subscribers are willing to pay for beyond the traditional network programming supplied to all subscribers. Services include: first run and other current movies, live sports events, live theatre, and other special events.

Each of the above classes of commercial and business services will be examined to give some insight into their current status and applicability to rural applications. As will be subsequently discussed in Chapter IV, these services are important in that they can be a source of revenue that can help defray the installation and operating costs of broadband systems. It is important to note that some of these types of service require that the system have bidirectional capability. This may rule out consideration of such services for the older established one-way systems generally found in rural towns. As a further note, since research in each of these areas is privately funded, it can be anticipated that in the future detailed cost and revenue information might not be available for competitive reasons. This could make it difficult to forecast their application in rural areas with any degree of precision.

Security Services

Financial losses from fires on farms rank with those from weather, plant and animal disease, and insects. In addition, recent crime statistics indicate that the unlawful entry in rural areas is increasing rapidly. This section provides some background on rural needs dealing with fire and crime problems, discusses how telecommunications systems are being used for fire and smoke detection and crime surveillance and outlines how such systems may be applicable to rural and farm communities.

Rural needs. Fire and lightning strike about two of every 100 farms each year. According to the Insurance Information Institute, fire losses on the nation's farms in 1970 were $242 million almost twice the $131 million loss estimated for 1950 (54). Losses are increasing at a rate of 10-12 percent per year. In 1971 the insurance premiums paid by farmers to cover fire and wind damage totaled $441 million (55). When fire occurs on rural property, damage is typically three to six times greater than on properties located in urban areas (56). Factors contributing to higher rural damages include the high value of major farms, isolation, lack of fire-fighting facilities and less rigid wiring, heating, and construction standards.

Up to now, minimizing losses from fires in rural communities where households are isolated from modern fire departments have depended on the following traditional approaches:

1) Preventing the fire in the first place by learning to recognize and correct potential fire hazards.

2) Constructing buildings so as to reduce the chances of a fire starting and spreading.

3) Training residents in fire fighting techniques to prevent the spread of fires once started.

Schools, fire departments and insurance companies are continually disseminating information to aid in identifying fire hazards. Newer rural buildings are being constructed to minimize fire hazards. Metal or asbestos roofing materials are being used instead of wood shingles; approved central heating systems are being installed in place of kerosene space heaters; and approved permanent electric wiring is being used instead of temporary, easily overloaded extensions. In open areas, farm buildings are being equipped with lightning rods to minimize lightning-caused fires. Fire extinguishers are now standard equipment in many rural homes and some homes are being equipped with smoke detectors. Volunteer fire departments are also better equipped and better trained. In spite of these efforts, however, fire is still a major concern in isolated rural areas, especially in older structures, and especially when the residents are away from their homes.

Concerning crime, one category in particular -- unlawful entry -- has been increasing in rural areas at a rate nearly double that in cities and four times that in Standard Metropolitan Statistical Areas.

Unlawful Entry Crime Rate (per 100,000 population)

	SMSA*	Other Cities	Rural
1970	1311	730	437
1973	1411	842	564
% Average Increase per year '70-'73	2.5	5.1	9.7

* SMSA - Standard Metropolitan Statistical Areas (54)

As to action being taken to combat crime, rural departments in recent years have received better equipment and training. In the section on public services the telecommunications capabilities of rural police authorities were discussed. Nonetheless, one of the weakest links in these systems continues to be the inability of the law officer to provide surveillance of isolated properties at sufficiently frequent intervals to deter unlawful entry.

Technologies presently exist which allow continuous monitoring of isolated buildings from central locations for both fire and crime detection. These technologies and their principal uses to date are described below.

Remote security monitoring. The burglar alarm industry has foreseen the need for providing continuous 24 hour security service. However, manual on-site surveillance costs have restricted the market to larger commercial and industrial clients.

It is now possible to provide security surveillance service over existing telephone lines, or through special leased lines which will function even if normal telephone service is interrupted. Installation charges using the existing telephone system are approximately $30 with a $2 per month charge for the required protective coupler. Special leased lines typically cost $6 per mile installed. Installation costs to residential subscribers are typically $300-500 for fire detection systems and $500 and higher for burglar alarm systems. Monthly fees are approximately $20-60 for each service (57). Household or business establishments can be surveyed from a central private station or from the local fire and/or police station. Systems are computerized and can provide an immediate printout of the location and time a problem has been detected.

At the beginning of this decade, many within the cable television industry actively considered using their systems for security services. It was anticipated that these services might have high potential for generating additional revenues. Services most discussed were home protection services such as smoke detection, heat sensing and intrusion (unlawful entry) detection. The systems were conceived as having a centrally located computer and a switching system capable of "polling" sensors in the subscriber households at regular intervals, usually in a matter of seconds.

In spite of this widespread industry interest, there apparently are only two firms active in the area of security services: TOCOM and Intech Laboratories. TOCOM, Inc., of Irving, Texas, has developed working and commercially available security systems. The firm is prepared to supply, operate, and maintain a complete system which is comprised of the following: central interrogator, memory bank, complete cable system, subscriber converters, subscriber-identified digital transmitters, smoke and fire

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detectors, and manually operated police and/or medical call stations. The TOCOM systems also have the capacity to provide such optional services as perimeter intrusion detection (e.g., wired windows), pay television, opinion polling, and meter reading. The TOCOM system is made up to two sub-systems -- a central data system and a remote transceiver which is located at each of the subscriber households. The central data system controls the whole system, supervises overall communications and interprets information.[1] The remote transceiver performs the function of decoding communications information intended for that transceiver and executing subsequent commands as instructed by the central data system. The central data system and the transceivers are interconnected with a bidirectional cable network (58).

TOCOM's primary markets have been new communities where systems are installed during the construction phase. At the present time TOCOM is working with six communities, the largest being a projected 50,000 unit community called "The Woodlands" located 25 miles north of Houston. The company installs, operates, and maintains all parts of the cable system. Woodland CATV, Inc., a subsidiary of TOCOM, is paying for the cable distribution plant and the home builders are paying for the home wiring, including the installation of the security devices. Plant construction and wiring are both component costs at the Woodlands development. According to TOCOM officials, these costs are similar for all TOCOM systems (58).

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[1] Remote monitoring raises issues of privacy and confidentiality. For a discussion of these issues the reader is referred to Kay, Peg. Social Services and Cable TV. Final report submitted by the Cable Television Information Center to the National Science Foundation under contract No. APR 75-18714, February 1976.

TOCOM Systems Component Costs (in dollars)

Cable Distribution System	
Head-end plus central data system	$150,000-175,000
Distribution system per mile of cable	$5,000-10,000
Subscriber Location Costs	
Wiring (usually paid by builder)	$400-600
Two-way terminal (transceiver)	$250
optional intrusion system (wired windows, etc.)	$150
Monthly Subscriber Fees	
CATV only	$7
CATV plus basic security services	$12

To date 97.7 percent of the 500 occupied homes in the Woodlands complex have elected to subscribe to the combined CATV/Security service. As an added incentive to encourage the *homeowner* to purchase the security services, a homeowner insurance policy premium discount of almost 20 percent is available to the two-way subscribers having a fire detector and a manually operated police call system. This discount, applied to the homeowner policy on a $30,000 frame home, is about five dollars per month; applied to a $65,000 brick veneer home, it is about nine dollars per month. An additional 10 percent discount, beyond the 20 percent described above, is provided to those homeowners who have the perimeter intrusion system. The system discussed has already demonstrated its effectiveness by averting actual fire damage in the home of one of the subscribers in the Woodlands area (58).

The other company which is currently active in the security systems field is Intech Laboratories, Inc., located in Ronkonkoma, New York. Intech is presently developing a system under contract to Manhattan Cable to be used in the Roosevelt Island Project in Manhattan. The system being developed will be a modification of their automatic multipoint CATV analyzer/monitor subsystem. The central processing unit will be capable of addressing and reading four sensors in each of 1000 apartments every second. The location of a trouble signal, along with any special instructions regarding the specific resident, will be printed out on a cathode ray tube terminal at a central guard station.

The cost to wire each apartment in the Roosevelt Island project will be approximately $150. The central processing unit is expected to cost $20,000. Manhattan Cable is installing the cable network during construction of the buildings.

Rural applications. Both telephone and cable television systems could be used for monitoring buildings in rural areas for fire and unlawful entry. Each system uses techniques and system components with basically similar functions. Each, however, has its own advantages or disadvantages depending on the characteristics of the specific area in which it is to be employed. Hybrid systems consisting of both telephone lines and cable are conceivable for servicing communities where households are separated by distances too great to justify a cable-only system.

Probably the greatest merit of remote surveillance of isolated rural buildings is that such surveillance can be done even while the residents are not on location. A second advantage is that non-residential buildings, such as barns, can be monitored even while the owners are asleep in their homes. An immediate phone call to a sleeping owner could be sufficient to prevent a fire from getting out of control.

While home terminal and operating costs for supplying security services would likely be paid for by the individual subscriber through monthly fees, it is possible that the central processing console and installation costs might be paid for in part by local law enforcement and fire fighting agencies. In light of the precedent set by the insurance company serving the Woodlands project discussed above, it should be noted that lower insurance premiums might offset a large part of the costs to the subscribers.

Concerning the economic feasibility of these services as provided by means of a rural broadband system, it is important to recognize that Woodland's costs to subscribers assume that the substantial costs entailed in wiring the homes ($400-600) are paid for by the builder. Whether these services might pay their own way and yield some net revenue to a broadband system in rural areas will depend upon this and many other variables which are beyond the purview of this study.

Information Services

Rural needs. Newspapers, news letters, business periodicals, and radio have long been used by rural residents to keep abreast of day-to-day fluctuations in the stock markets and commodities exchanges, as well as for business and other professional information. The paper media, although ' not suitable for constant updating of information, have had the advantage of being able to provide such information in very detailed form. The much faster broadcast media, in turn, have the disadvantage of not being able to provide more than a superficial review of happenings in the marketplace. In short, for both rural and urban residents, there has existed a need for a service with the capability of conveying as much business information as cost effectively as the newspaper at the speeds one takes for granted with the broadcast media.

In this instance, it does not appear that the needs of the rural businessman are greater than those of his urban counterpart, except that to the extent that improved information services are available in urban areas, he might suffer in competitive terms. Ultimately, with the advent of extremely high volume technologies such as fiber optics, the ability to "call up" business documents and correspondence might enable increasing numbers of people to work at home or in remote areas, thereby contributing to the trend of business decentralization to the countryside. For the moment, however, the kind of information services described below, while useful and representing a possible source of revenue to rural broadband systems, will not have revolutionary effects.

News wire services. Reuters, Ltd., the international news wire service, now provides a major information service available for transmission via cable television. Reuters' primary product for cable television is a two-channel package called "News-View" which supplies general news around-the-clock, financial news during the day and sports news at night. Until now, because of a lack of a reliable filter, or trap, to prevent non-paying viewers from using the service, cable television operators have been generally providing the

Reuters' service free of charge. Recently, however, the Long Island Cable Communications Development Corporation installed a microwave receiver at their cable system head-end, located on the roof of the Nassau County Medical Center, to receive such Reuters' services as updated stock market prices and race results. The added subscriber's fee for receiving this information is $3 per month (59).

To be able to offer this service, the cable operator must buy or lease a character generator from Reuters and then pay a monthly, or weekly, fee for the updated information. Reuters News-View rates are displayed in the following table:

Reuters-News-View Rates

News Fee Schedule

Size of System Number of Subscribers	Rate per Week
Under 1,500	$ 50
1,500-3,500	60
3,500-6,000	75
6,000-10,000	90
10,000-20,000	110
20,000-30,000	125
30,000-40,000	150
40,000-50,000	175

50,000 and more subscribers shall be at the rate of four cents per month for each subscriber in excess of that number.

Equipment Costs

Type of Equipment	Sale Price	Lease Price
Black and White Character Generator	$1,500	$95 per month
Color Character Generator	5,000	55 per week
Multi-Signal Input Character Generator	9,300	75 per week
Local Crawl Input	2,400	25 per week

Reuters transmits and updates the information provided to cable operators over leased common-carrier microwave channels. The service can also be provided with an optional "crawl" feature which allows the cable operator to insert locally generated information such as agricultural commodities data.

In addition to its News-View service, Reuters also supplies specialized information to professional clients such as commodities dealers, stock brokers, and bankers. Reuters calls this service "The Reuter Monitor" and clients can obtain such information categories as:

- Grains/Oilseeds Index
- Livestock Index
- Coffee/Cocoa/Sugar Index
- Financial Index
- Metals Index

In these cases the client has a terminal by which he can select desired "pages" of information. In New York these services are transmitted via Manhattan Cable's CATV system. The fees for the Reuters professional services will range from $300 to $1500 per month, depending on the type of service purchased.

Late in 1976, Reuters plans to distribute the professional and "News-View" service to cable operators throughout the United States by satellite. Traps, now being used by the cable industry for entertainment pay-TV service, can make it possible to restrict these services to paying clients.

Reuters estimates annual growth revenues for these services to be in the $20 to $40 million range within five years. Half of the revenue is expected from sales of their professional services, the other half from their News-View services.

Over-the-air information services. Systems are now being tested in Great Britain which are capable of supplying information, similar to that being supplied by Reuters, by broadcast. Encoded signals, sent during the vertical blanking interval (the interval when the television beam returns to the top of the screen to begin a new trace), are decoded and printed out on the subscriber's television screen (60). Neither of the "Teletext" systems will have the page capacity of the Reuters service. They will however, offer an over-the-air alternative to cable television delivered information systems.

Rural applications. In contrast to the public and commercial services considered thus far, the above applications do not require two-way broadband capability for their operation and could be used, if profitable, on any cable system with unused channel capacity. Together with pay television to be considered later in this Chapter, these services exist in a "canned" form and thus do not differ in kind from the news and entertainment services offered on conventional cable systems. Beyond the necessity that they be geared to generate sufficient revenue in the market served, no particular effort, as contrasted to the other services considered in this Chapter, has to be taken to develop or tailor the content of the services to be offered to the specific audience and set of institutions to be served.

Data Transmission

Rural needs. According to a recent NSF study, much of the research on business uses of telecommunications (especially as they might serve as a substitute for travel) has concentrated on the conduct of management operations (61-32).

While such research is essential, it seems likely that decentralization to rural areas of the so-called "information industry" (insurance companies and the like) is not going to occur until the capabilities for, and economic advantages of, the use of telecommunications by clerical and middle management workers have been demonstrated. Involved in the latter would be high-speed, high volume -- and routine -- handling of great quantities of information.

Because a great deal of literature already exists on "teleconferencing" similar broadband services appropriate to the needs of management personnel (61-17 ff.), no attempt will be made here to duplicate such analyses. Instead, this section will be limited to a state-of-the-art survey of high-volume data transmission technologies, and their use in two-way cable systems, and will conclude with a description of the only known application to date in which an operating broadband system is being used for these purposes by a major commercial institution (Bankers Trust Company of New York). A section on automatic meter reading will also be added in view of the potential this service offers for providing revenues and helping to underwrite the costs of broadband systems in low density rural areas.

Data transmission services. Until a decade ago, most remote data processing could be handled by low-speed teletype circuits. While technological advance in the computer industry have kept pace with the enormous growth that has taken place in the demand for data and information, the traditional telephone network, in spite of significant improvements in its data handling capability, has been hard-pressed to keep pace. While it is now possible to achieve processing rates of 9600 bits per second (bps) on leased telephone lines, throughput capabilities of the data processing equipment that originate the information to be transmitted have achieved levels of a million bits per second.

Thus, alternatives modes of data transmission are under study. The Bell System has been investigating developments in fiber optics where cables assembled with thousands of hair-sized "light pipes" will be used to carry voice and data communications (62). Throughput capacities will be orders of magnitude greater than any other system in use today. Another approach has been to set up a separate network, using microwave paths as the transmission media, which are dedicated exclusively the data transmission in digital form. Such systems provide up to 48,000 bps transmission rate. Still another approach has been to use coaxial cables. By using cable, it is conceivable that immediate and near-future data transmission demands could be met. A single half-inch diameter cable, for example, has a throughput capacity equivalent to 30,000 full duplex telephone wire pairs.

There are a number of large industrial activities presently using two-way cable networks for internal communications. These include plants of General Motors, American Motors, Dow Chemical, and Kellog Cereal.

The systems are used to carry multi-channel closed-circuit-television, digital data and voice communications.

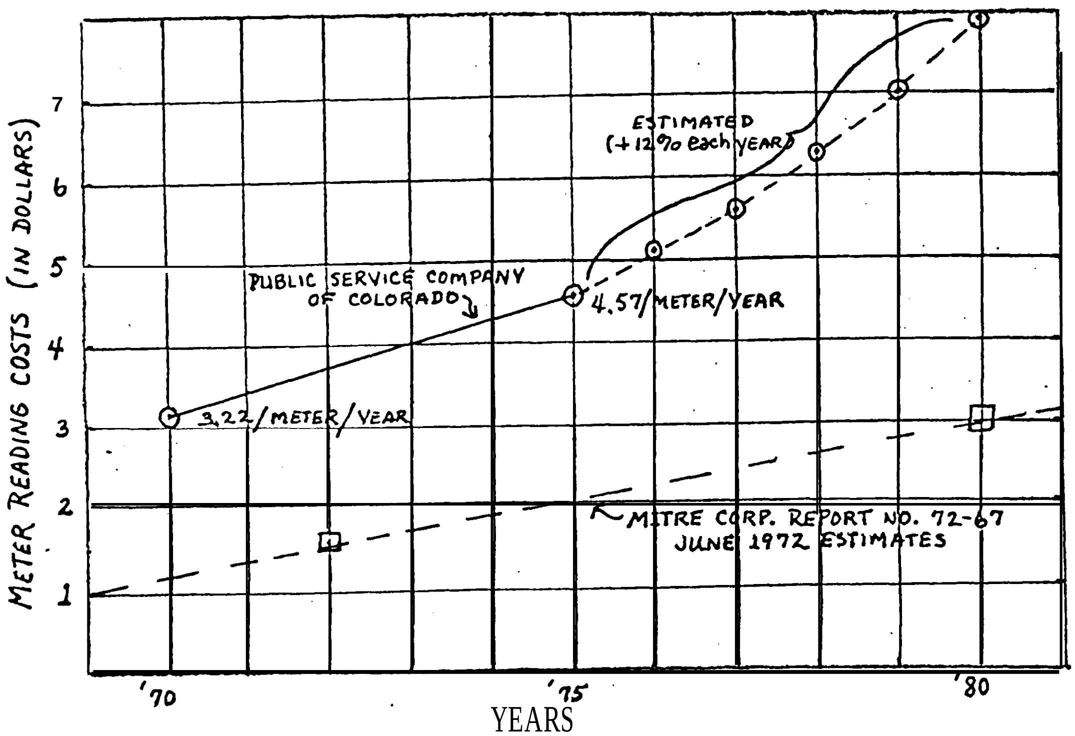
Recently , the Bankers Trust Company of New York began using the excess capacity of a cable television system operated by Manhattan Cable Television. The bank found the cable system to be a practical medium for transmitting the massive amounts of data that must be interchanged between their central office and their many branch offices.

Both the Chase Manhattan Bank and the First National City Bank in New York also are seriously exploring the Manhattan Cable network for transmitting data. To date, however, Bankers Trust appears to be the only business activity using an existing cable television network for data transmission. It is being used to update savings, demand-deposit and installment loan accounts; transmit data between the data center and the operations center; and transmit documents via high-speed facsimile equipment. Manhattan Cable has arranged a fee schedule for this service which is dependent on the amount of data that is transmitted rather than the the distance over which it is transmitted.

Rural applications. Rural banks must also convey large volumes of information to their branches and to other banks. Thus, this application is potentially attractive in rural areas. In addition, it should be noted that the approach reflected in the Bankers Trust application, that is using the full capabilities of a system to generate revenue, is precisely what is needed if broadband systems are to be economically feasible in low density rural areas. As with some of the other services discussed earlier, this application may be a good candidate for consideration in the system approach described in Chapter IV.

Automatic meter reading: rural needs. Since their inception water, gas and electric utilities have depended on manual meter reading to determine the consumption of their customers. This has been especially difficult and costly in rural communities because of the great distances between households and the large areas to cover. Automatic remote meter reading, long discussed but never implemented by utility companies, is being looked at anew because of the sharply increasing costs of manual reading as illustrated in the chart Further impetus comes from the recent and growing interest in management of electrical demand as a means of conserving energy and resources. Such management will require far more frequent reading of meters than is possible by manual methods.

TRENDS IN MANUAL ***METER READING COSTS***



Traditional on-site measurement systems have a number of disadvantages that have continued to plague the utilities. These include:

- Skipped readings - when no one is at home to allow access to the meter(s);
- Adverse weather conditions;
- Need for a large fleet of vehicles;
- Vicious dog problems;
- Need for a large, attrition-prone work-force;
- Reading inaccuracies;
- Need to estimate billing because of skips and reading errors; and
- Effects of company holidays on reading and billing cycles (65).

For these reasons, consideration has been given to remote and automatic meter reading techniques using:

- Telephone distribution networks and automatic interrogation during off-peak hours;
- Cable television distribution networks and automatic interrogation, but not necessarily during off-peak hours;

- Electric power lines as a transmission medium; and

- Completely different schemes such as having the measurement instrument radiate signals which can be picked up by a utility truck passing by the house.

Potential benefits of using automatic systems include:

- Load studies -- to assure that pressure levels and voltages are maintained within the prescribed standards;

- Detection of service failures -- to determine the location of service outages after storms, earthquakes, etc.;

- Continuous operation -- readings can be taken 7 days per week, automatically addressing the problem of company holidays on reading and billing cycles;

- Elimination of skipped readings -- covering problems related to lack of *access*, adverse weather, viscious dogs, etc.;

- Fewer vehicles -- size of fleets could be substantially reduced;

- Reduced personnel problems -- related to hiring, training, and terminating personnel;

- Fixed costs -- automatic systems should be less sensitive to inflationary pressures;

- Increased reading accuracies -- reduction of questionable readings, skips, errors, etc.; and

- Other utility services -- such as turn-on and turn-off of valves, switches, etc. (65).

Over the years, a number of tests have been conducted using the telephone network for automatic meter reading; none of these resulted in an operational system. Today one of the most active companies promoting automatic meter reading via telephone is Darco Telemetering Systems, Omaha, Nebraska. In 1973 Darco, together with United Telecommunications and Iowa Power and Light Company conducted field tests in Avoca, Iowa. Those results prompted the Omaha Public Power District, People's Natural Gas Company and the Lincoln Telephone and Telegraph Company to initiate large scale tests, using the Darco system, in Ashland, Nebraska. One thousand houses will be wired to provide automatic and remote reading of electric, gas and water meters. Modification costs and telephone charges are tabulated below.

Cost Elements, Ashland Test. (In dollars)

	Costs/Household	Total (1000 Households)
Equipment Costs:		
Remote Unit	84.	84,000
Conversion Kit (3/house @ 1.50 ea.)	4.50	4,500
Control Console	3.82 (prorated)	3,824
Total Equipment costs	92.32	92,324
Labor Costs:		
Installation and equipment costs shared by three utilities @ $40,918 each.	30.43	30,430
TOTAL	122.75	122,754
Telephone Charges:		
Per Reading/Location	.025	25
Lease Line Charges		2.25/month
Central Office Charges		14/month

In conjunction with the Ashland test it should be noted that (73):

- Special rates were developed by the telephone company for this service;
- Lines were connected to those houses that have no telephone service to provide 100 percent penetration;
- No protective coupler was used to interconnect to the telephone lines;
- The electric utility is collecting all of the data and transferring gas and water information to the respective utilities for billing
- The gas company has a control console which they use to interrogate industrial accounts;
- Present manual meter reading costs are between $4.25 and $4.60/meter/year; and
- Savings of 53.7 percent for residential accounts, and close to 100 percent for industrial accounts, are anticipated.

Although the DARCO tests used telephone lines for transmission, the use of cable for this purpose has been the subject of some examination. The Mitre Corporation study (65) compares costs of manual and automatic meter reading via telephone and cable. The study indicates that manual meter reading costs will double from early in 1970 to late in the same

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decade, primarily because of labor costs, whereas automatic meter reading costs will remain essentially the same. The study further indicates that using the telephone will be approximately twice as costly as using cable and that manual costs will be higher than automatic meter reading via cable by the end of the decade.

Tests of automatic meter reading were to be undertaken in 1974 on systems in Orlando, Florida and Irving, Texas, in conjunction with tests of two-way cable systems in general. Although the principals still express interest, lack of interest among potential subscribers and lack of adequate funding has forced the discontinuance of both of these tests.

The Darco system discussed earlier is adaptable to cable transmission systems. A primary concern of utility companies with regard to automatic meter reading and cable television distribution systems is the level of penetration. Unless close to 100 percent penetration can be achieved, cost savings and other benefits will be minimal.

The growing interest in energy conservation, and the potential of load management as a conservation technique, may prompt renewed interest in automatic meter reading. Effective load management programs may require "time-of-day" metering, demand metering, interruptable monitoring, and automatic usage control. Time-of-day metering would allow a rate structure which would vary according to varying energy demands and thereby encourage consumers to adjust usage schedules. Hourly measurements may be needed to effectively control such a rate system. A Canadian firm, Delta-Benco-Cascade, Ltd., of Rexdale, Ontario, has submitted a proposal to the U.S. Energy Research and Development Administration concerning the use of coaxial cable for these purposes.

Rural applications. Concerning the specific application of these systems in low density rural areas, it is unlikely that coaxial cable, installed solely for this purpose, could be cost competitive with existing telephone lines. Whether the charges for this service by a full service broadband system with a broad revenue base might be sufficiently low as to be economically attractive cannot be known in the absence of hard financial data, but it does seem that this possibility warrants further consideration.

Pay Television

Rural needs. In spite of the ubiquity of television, there are still many households in the United States which are beyond the reach of broadband reception -- either directly from the originating stations or relayed through the medium of translators or cable systems. More than one million households do not have access to any service; nearly six million do not receive adequate service on at least three channels and approximately 22 million do not receive adequate service on at least five channels. Most of these households are scattered among farms, ranches and small communities in rural America (71).

While there first has to be an existing broadband system before pay television can have any relevance to the above communities, still, as will be discussed below under the heading "Rural Applications", it is possible that pay television -- as a revenue source in broadband systems in low density rural areas -- might permit the opening up of some of these areas to television entertainment, as well as to the public service applications and commercial uses described earlier.

Pay-TV services. Since the beginning of television, the potential of supplying special program material on a pay-per-program basis has been the dream of entrepreneurs. Subscription television, or Pay-TV, was first seriously proposed in 1950 by the Zenith Corporation, whose first over-the-air pay-TV system, called Phonevision, was tested in Chicago in 1951. Opponents, however initiated a series of court battles which lasted into the early 1970's (72-8).

Recently, interest in pay-TV has been rekindled. Among the reasons are the now sizable and still growing television audience and the motion picture industry's search for new markets for its productions.

Technology is available either to distribute pay-TV programming over-the-air or by cable television systems. One of the proponents of over-the-air pay-TV has been Blonder-Tongue Laboratories, Inc., Old Bridge, New Jersey. Blonder-Tongue is a major manufacturer of components and systems for the television industry. In the late 1960's the company introduced a system which would allow broadcasters to provide over-the-air pay-per-program television. The system employs an encoder ("scrambler") which suppresses the horizontal and alters the vertical synchronization pulses causing the picture to appear seriously distorted. The sound is also interrupted. When the home subscriber desires a specific program he activates a decoder ("descrambler"). The home subscriber can purchase the decoder for $130 and then pays a specified amount for each program (68). The company has also developed a system for flat rate payment by the month. In this case the home decoder costs the subscriber $70, with the monthly rate to be determined by the broadcaster. To date, however, over-the-air pay-TV has attracted only limited interest.

Within the cable television industry there also has been a continuing interest in finding away of exploiting the profit potential of pay-TV. Of all of the broadband services discussed in this Chapter, pay-TV is seen by those in the cable television industry as having the greatest immediate potential of generating additional revenue.

Although pay-TV by cable did not achieve rapid growth until late in 1972, the demand has already far exceeded the expectation of the industry and almost exceeded its ability to supply such services (69-9). Today nearly 400,000 subscribers have paid $10 to have the necessary equipment installed and are paying a monthly fee of $6-9 to receive this service. The needed equipment is essentially a filtering device which will allow the transmission of the pay-TV programming when activated and "trap" the signals when deactivated. In most cases the hardware is installed in the subscriber household, but in some cases it is located externally where the subscriber drop is tapped into the feeder cable.

On September 30, 1975 Home Box Office (HBO), a subsidiary of Time Incorporated, began its service of delivering pay television programming by satellite with live coverage of the Ali-Frazier fight from Manila. The fight was seen in 25,000 homes via cable television. Receive-only earth stations are now available for approximately $65,000-75,000, making it possible for most of the larger cable operators to become part of the pay-TV network and receive special events programming .

It has been predicted that there will be 2 million subscribers for pay-TV in 1980 (69-9). At the present time, the operator is expected to purchase the earth receiving station and in addition to pay HBO approximately 50 percent of the revenue collected from subscribers. HBO prepares the programming and is responsible for transmitting the program material via satellite. Although the subscriber now pays a flat monthly fee, it is anticipated that programming will ultimately be sold on a per-program basis.

Rural applications. Providing pay-TV to rural areas may require different approaches than in more densely settled areas. For example, the cost of an earth station, not out of reach for the cable operator who has subscribers numbering in the tens of thousands, may be out of the question for a system with subscribers numbering in the hundreds. It has been suggested in the literature that smaller operators could form "cooperatives" to share the costs of the earth station among a number of cable systems (70-20). The concept of cable systems working together financially and technically is not a new one. Many existing community antenna relay installations are jointly owned but used by separate operators (71-33 ff.).

Other modes of supplying pay-TV in smaller rural areas are also available. Tapes might be leased by the cable system operator and played on a video tape recorder over the system. Another option is to lease channel space to and provide collection service for a pay-TV company for agreed upon rates. Finally, pay-TV might be distributed over-the-air using translators. [1]

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1 Because translators broadcast signals over the air, the signals can be picked up by any set. To ensure payment, either the community can designate a special taxing district or the signal can be scrambled and individual subscribers pay for use of decoding equipment. However, the last technique would require changing FCC regulations (72).

Since pay-TV, like the information services discussed earlier, delivers "canned programs", the only barrier to its adoption by rural systems of the type contemplated in this report is one of economics (sufficient market and revenue when related to costs). Unlike the rest of broadband services discussed in this Chapter, no effort is required on the part of the system operator or his consultants to devise program content and tailor it to the customers intended. Pay-TV represents the older, "conventional" purposes to which broadband might be put. However, pay–TV might serve the further function of providing sufficient additional revenue to help make a rural system economically feasible.

Summary And Discussion

Actual and potential uses of broadband communications to meet rural needs in the public service areas of health, education, law enforcement and government/administration were examined in this Chapter. Potential commercial uses of broadband systems for security, information services, data transmission and pay-TV were also reviewed.

Public Service Applications

In both health and education, rural needs derive from shortages and inadequacies of facilities and personnel, as well as from the many factors that make access difficult, such as distances to be travelled. Principal factors contributing to shortages and inadequacy of personnel in the health area include isolation from peers, from specialists and from health care facilities. In both the health and education areas, it is difficult for remotely located personnel to maintain currency in their fields and to continue their training. Financial resources, that is, lower incomes than in urban areas, the fact that fewer rural residents are insured for health care, and the generally smaller tax base available to support facilities also contribute to the reduced opportunity for health care and education in rural areas.

In health, a vigorous experimental program conducted over the last twelve years has demonstrated the feasibility of using broadband communications to meet rural needs in five basic areas of health care; namely, consultation, supervision, direct patient care, administration and management, and education and training. Patient acceptance is high and it has been demonstrated that telemedicine can increase the adequacy of health care by providing access to services which were not available before or which were available only to a minimal extent. For health manpower personnel, some problems remain such as ensuring privacy and confidentiality in the doctor-patient relationship, the possibility of increased workloads, and a feeling that supervision of nurse practitioners and physician assistants is sometimes excessive. Otherwise, attitudes of medical personnel involved generally have been found to be favorable. However, if these services are to be widely used, change in some state laws will be required.

Major unknowns requiring further research include comparisons between the relative costs of video vs. non-video systems, and the best ways to combine manpower and technology for total health care delivery systems that can be self-supporting financially.

Fewer experiments using two-way communications have been conducted in education, especially in rural areas. Nevertheless the technical feasibility of meeting many educational needs of rural areas has been demonstrated. There is, however, a lack of information concerning the particular technical capabilities needed to support educational uses, as well as concerning the relative effectiveness of education using communications when compared to the traditional classroom. Educational programs adapted to broadband use and/or guidelines for their development are also needed. Generally, little hard data are available on the cost-effectiveness of using broadband communications for education.

For both health and education, it should be noted that cost-effectiveness should not be considered as the sole criterion for use of broadband communications. This is because use of broadband may be the only alternative available. Nevertheless, further experiments should include evaluation of effectiveness, collection of cost data, and alternatives analysis as an intergral part of the study design.

Rural needs in law enforcement derive from the large distances involved and the time consumed in travel to and from the central station, which reduces the time available for assigned duties. In some rural areas, it is estimated that up to one-fourth of the working day of a law enforcement officer is devoted solely to traveling back and forth to central headquarters. In this connection, broadband communications could be used to televise roll calls and briefing sessions, transmit fingerprints and related documents, and conduct some pre-trial arraignment procedures. An innovative experiment in the city of Philadelphia will test some of these concepts, which might be of value in some rural areas.

Government and administrative uses are also potential areas of application. For example, where processing of claims and applications requires more than one agency, broadband communications might reduce requirements for travel and processing time, thereby reducing costs to local governments. An experiment underway in Spartanburg, South Carolina, will provide data on the effectiveness and costs of using broadband communications for this purpose.

Commercial Applications

Four classes of potential commercial applications were examined. These were: security systems, information services, data transmission, and pay-television.

Rural needs for security services include detection of fire and unlawful entry. Fire losses on farms in 1970 totaled $242 million and insurance premiums paid by farmers to cover fire and wind damage totaled $441 million. As for crime, one category in particular, unlawful entry, has increased in rural areas at a rate nearly double that in cities and four times that in Standard Metropolitan Statistical Areas.

A rural broadband system could assist in reducing these losses by permitting continuous monitoring of isolated building from a central location. The firm of TOCOM, Inc. of Irving, Texas, has developed such a system, and it is commercially available. In addition to centrally-monitored smoke, fire and intrusion detectors, the TOCOM system can also be used for opinion polling and meter reading. So far, the primary market for TOCOM's system has been new communities where wiring and installation of detection devices is accomplished during construction and paid for by the builder. The homeowner pays a monthly subscriber fee; however, as a result of the features of this system, insurance companies have offered discounts that offset much of the amount of the subscriber's fees. Although the economic viability of these systems in rural areas remains to be tested, they represent a potential component of rural broadband systems.

In the area of information, services are available which provide stock and commodities' prices, round-the-clock news and other business data. These services are presently available, if the necessary market exists, and could be readily provided on rural broadband systems.

In the area of business uses of broadband systems, the following applications were considered: 1) high volume data transmission; and 2) automatic meter reading. Communications of large amounts of data between headquarters and branch offices is required by many institutions and can be accomplished by transmission on a broadband system. One example is the Bankers Trust Company on New York which uses the excess channels of a local cable television system for transmitting the massive amounts of information that must be interchanged between the central office and their many branches. The system is used to update savings, demand-deposit and installment loan accounts; transmit data between the data center and operations center; and transmit documents via high-speed facsimile equipment. The bank pays a fee to the cable company for use of the system. Although this service has not been tested in a rural area, it shows how a broadband system can be employed to generate revenue from institutional users.

The potential for automatic meter reading arises from the fact that manual reading of meters for water, gas and electricity is especially costly in rural areas because of the long distances involved. Estimated costs for manual meter reading are projected to approximately double between 1975 and 1980, primarily due to increased labor costs. While meter reading does not require a broadband system and can be accomplished over telephone lines, a recent study indicates that using telephone will be about twice as costly as using cable and that manual costs will be higher than automatic meter reading via cable by the end of the decade. In addition, automatic meter reading, since it can be done as often as necessary, permits management of electricity load, which is a potential energy management technique. These factors suggest that utilities might find automatic meter reading attractive in rural areas, thereby providing additional revenue to support a community broadband system.

The final commercial application reviewed was pay-TV for which subscribers pay a fee to obtain special programs and sports events. This service, increasingly available in urban areas, could also be made available in rural areas. In the context of this report, the value of pay-TV lies in its potential for generating additional revenues to support a multiservice broadband communication system.

Discussion

This Chapter has shown that there are many areas where broadband communications could be used to meet rural needs. A variety of public services can be provided and there are a number of uses which are potentially attractive to commercial institutions.

A major characteristic of many experiments in the public service sector is that they have been directed at demonstrating technical capability. Economic feasibility and the design of economically viable systems have received less attention. When cost-effectiveness has been considered, it has been limited to the use of technology to provide a single service. Detailed consideration of a system approach to broadband communications in which costs are shared by public service users, commercial users and subscriber-supported entertainment fees, has not been attempted. However, such a *systems* approach may be the key to a broadband system serving an entire rural community.

All the public service and commercial uses described in this Chapter have potential for inclusion in a rural broadband communications system. The particular public service and commercial uses included will vary according to the characteristics of each rural area. Selection for a specific rural community should be based on a comprehensive needs analysis.

CHAPTER 11

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