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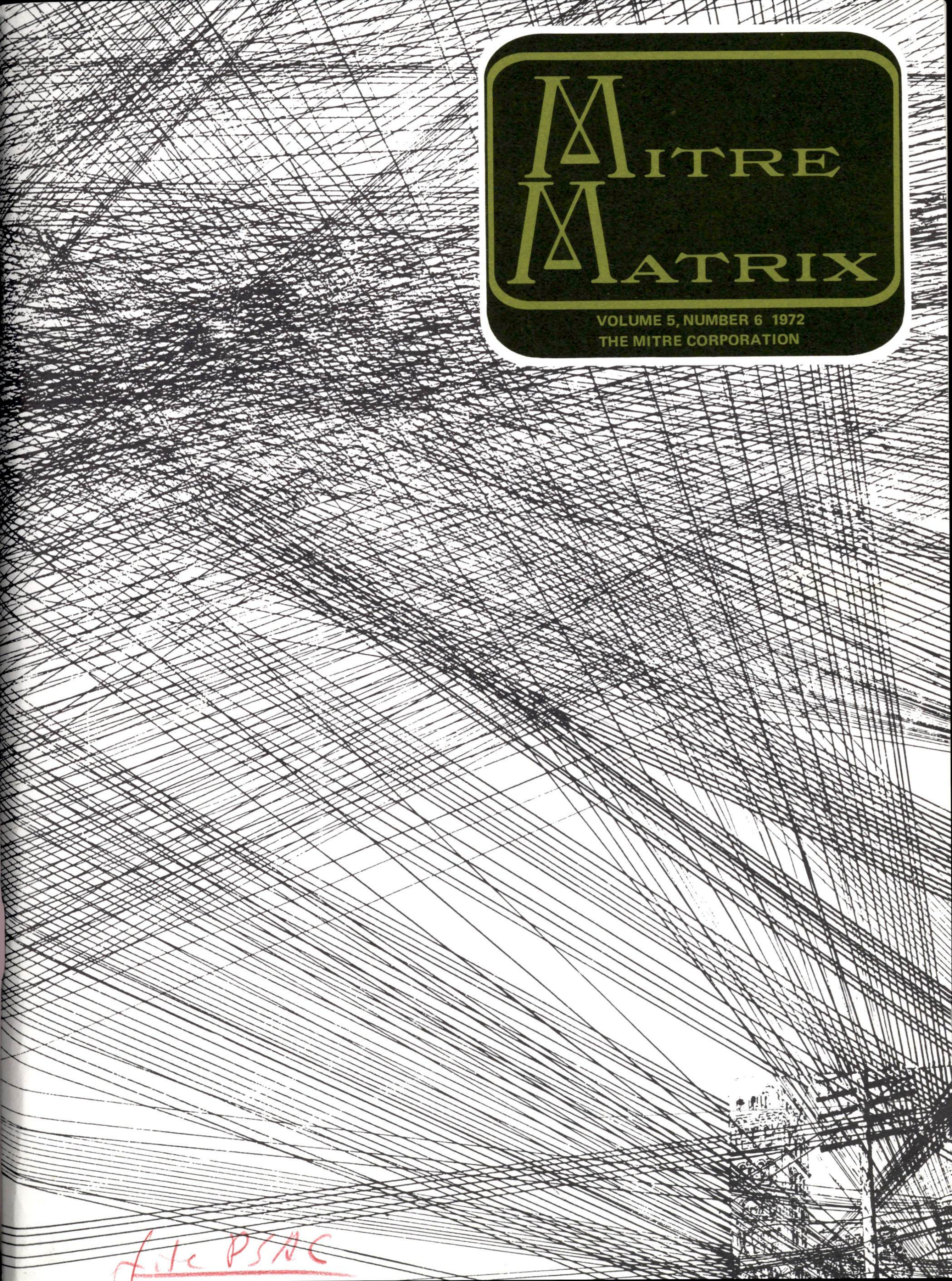

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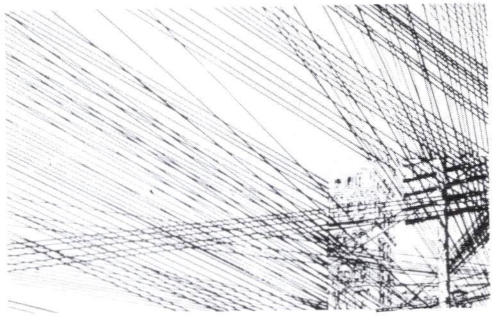
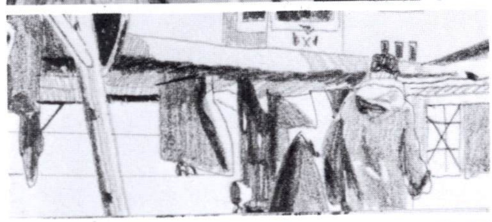
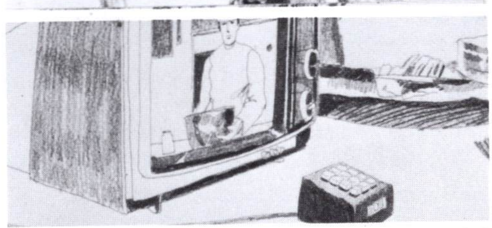
THE COVER: The skein of wires on our cover graphically represents the pervasiveness of electronic communications. In this issue, MATRIX describes some of MITRE's work in cable telecommunications and its implications for the future.

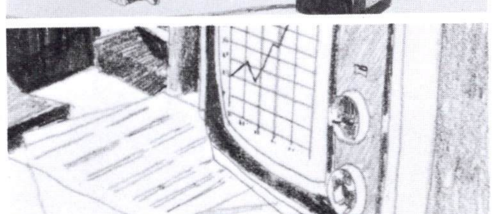


TOWARD THE WIRED CITY: TELECOMMUNICATIONS AT MITRE

by Robert Coltman







FOREWORD

In the past few years, speculation has run high about the array of new services to be offered by cable telecommunications. While it is probably safe to say that no medium can meet every one of the expectations advanced by enthusiastic prophets, the fact remains that cable telecommunications do hold significant promise. Inescapably, they will have considerable impact on our society and the lives of each of us. The anticipated move of the base system – cable television – into urban areas brings the first wave of this impact quite close in time.

Beginning with self-funded independent research programs several years ago, MITRE has become increasingly involved in cable telecommunications planning, design and development. The reason is quite simple and straightforward: any technology as powerful as this requires sensible, knowledgeable guidance and direction. This must include keen technological awareness and a great deal of down-to-earth engineering. It must also embrace broad understanding of social priorities and an ability to draw together the many impinging interests to work toward rationally chosen, beneficial applications of the new medium.

In this issue you will find discussion of the general background of the cable telecommunications field, and of the programs underway at MITRE which contribute to it. Investigating cable telecommunications from many viewpoints – technological, economic, social – MITRE's scientists and engineers have steadily built up a fund of expertise as a basis for assisting in decisions about cable applications, designing and engineering cable systems, and improving and extending the medium's potential. At a time when development is rapid – sometimes precipitate – it is no small contribution to bring to the field a blend of experience, judgment and freedom from commercial bias as a basis for balanced progress.

The first limited cable telecommunications systems are already making their appearance among us. Within the next decade or two they and their descendants, the fully interactive systems, will be a familiar presence in our society. As indicated in what follows, MITRE is working to help ensure that they will be the best systems – from all viewpoints – that we can possibly create.

Robert R. Everett
President

CABLE, THE UNCOMMON CARRIER

It sometimes seems as if the stock materials of yesterday's science fiction are taking tangible shape everywhere we look. Cable telecommunications are no exception, promising to improve working productivity while offering unprecedented services in the home. Cable-borne video and its complementary services are just around the corner – and their influence will be profound.

"Cable system technology, with its broadband, low-cost, widely distributed capacity, creates opportunities for whole new classes of service," says Lewis Billig. As Technical Director of MITRE's Communication Systems Division, he has headed one of three MITRE organizations working on cable programs. "Some are obvious now. Others – probably most – will arise from innovations by those who will use the new systems."

Charles A. Zraket, Senior Vice President for MITRE's Washington Operations, says: "As cable moves into the urban setting it will transform many features of urban life – but only if it transforms itself to include a wide range of broadband, two-way communications services that can help fulfill the social, cultural, civic, educational, governmental, business and commercial needs of the city. Introducing this new form of communications into the mainstream of American society so as neither to abridge nor underplay its promise is one of the most important and complex tasks of the 1970s."

William Mason, Technical Director of the Systems Development Division at MITRE-Washington, sums up: "Cable will introduce a revolution in human interchange, especially in urban areas, and other wideband technologies will complete it."

Picture a community in which homes, businesses and governments have all-purpose terminals in which videotelephone, high-speed facsimile, recording services, printout and other data exchange and display devices are at your personal service as the telephone is today – bringing in such diverse services as mail, professional advice, computational assistance, cashless transactions, educational and emergency assistance. A few years ago these would have seemed "blue sky" impracticalities. Yet such services have been demonstrated, and are now part of plans for development in cable systems across the country. Certainly some of them will arrive sooner than others, and some – electronic mail, for instance – are still far off. But the *idea* of the wired city has arrived, and it is bringing the reality closer every day.

Coalescence

A word of caution, though, before we begin. It is easy to oversell the promise of the wired city; some prophets, encouraged by the things that are technically feasible even today, have done so. Enormous changes are possible, however, and we will cite some of them, for they are legitimate options.

But a host of unanswered questions stands between us and the wired city. Mostly these are human rather than technical questions – questions of politics, economic appeal, and desirability. These, as they coalesce in the prospective cable market and audience, will decisively influence wired city trends.

Accordingly, the vision of the wired city we present is a prospectus, not a prediction. It discusses what *can* be done, and how our society might do it, if it chooses. And it covers a time span from the near to the very far term. It is extremely unlikely that the technology now developing will go unused; technology rarely does. But its introduction will most likely be cautious, uneven – harnessed, sometimes stalled, by economic and other human realities.

It is therefore all the more important to make sure that the planning for the wired city is as rational and coherent as possible.

Threefold Approach

This issue describes three MITRE programs which focus on varying aspects of the services that already can be provided to complement video on the cable networks or will soon be installed. We begin with a specific community application of the wired city: the UNIBAC program, which seeks to create a modern telecommunications environment on a military base. This sets the stage for the next account: the story of the interactive television (called TICCIT) family of programs being carried out at MITRE's Washington Operations, which is working to meet the challenge of cabling civilian communities. The third program, MITRIX, now in experimental use at MITRE's Bedford facility, is a new departure in cable technology which is already demonstrating the flexibility needed for wired city use.

All three programs stem from MITRE's independent research work; two have now resulted in Federal investment to test their feasibility. They are closely interrelated: the TICCIT programs emphasize service over one-way and limited two-way cable links; MITRIX creates the capability for full two-way operation; and UNIBAC seeks to put these and other capabilities to use in a military setting.

The technical products of these programs are not primarily specific design solutions, but rather are broad frameworks within which specific innovation in cable telecommunications can take place. UNIBAC, TICCIT and MITRIX all represent advances in themselves, but MITRE stresses across-the-board improvement in cable system design and use. Cable, unquestionably one of the most important developments of our time, is beginning to find its direction; it is through hard-won knowledge and ability in the field that MITRE can make its most useful contribution – helping cable customers choose and develop the best, most flexible systems to meet their wired city needs.

Open-Ended Concept

Just what *is* the wired city? Basically it consists of a flexible, accessible network offering two-way communications of unprecedented variety to its customers. Technologically it is not especially complex; it uses simpler control concepts, for example, than the telephone system does today, and needs little or no technology that is not already in hand. Its complexity lies in its social impacts: cost, desirability, and political feasibility. Precisely because it is such an open-ended concept, the wired city has the potential to be a "man Friday" that will greatly change the way people do things. It will bring a much wider, much more personal choice of services and information to its customers. Its effects must be studied with particular care because they are likely to be so far-reaching.

The idea of the wired city began gathering steam when cable television was recognized as more than just a medium for carrying commercial TV signals into weak-reception areas. Clearly, once you have a system for carrying TV signals on wires, you are no longer in the same ball game as you were with broadcast TV. Signals can travel in the opposite direction without the complex transmitters which broadcast TV requires. The resultant two-way communications yield a service as individual as, and potentially far more flexible than, the telephone. With the capacity and adaptability of cable links, the subscriber obtains more control over resources whose nature he can select – even perhaps help determine – for himself.

In fact, an increasingly popular view holds that one element has been missing from today's communications picture: the locally responsive all-purpose network with which the sub-

scriber can *interact.* Capacity limitations have till now enforced centralized control and restricted use. But cable's wealth of capacity, in the form of bandwidth, will deliver access and control at least partly into the subscriber's hands – working a change as profound as the introduction of the automobile into a society whose non-local travel was based on railroads.

Interest in cable has mushroomed since the Federal Communications Commission (FCC) freeze on community antenna television (CATV)[1] began to thaw in 1971. While CATV is only part of the cable telecommunications picture, it is the top of the iceberg, and as CATV has gone, in terms of public awareness, so has the rest of the field. The critical development came when the FCC made room for CATV expansion into urban areas on a trial basis. This was greeted as a boon for CATV, which now serves some 10% of the nation's households (roughly 5½ million subscribers) at an average use fee of $5 a month. Enthusiasm has now progressed to the extent that the United States' potential as a "wired nation" is even coming in for animated discussion.[2]

Since the first flush of excitement at the tentative opening of the urban market, cooler heads have pointed out the complex questions that remain to be resolved. Copyright and control over program material are obvious areas of competition. The FCC is already addressing the issue of appropriate computer-communication integration. The monopoly question is sure to arise.

Coherent Policy

Eventual cooperation among CATV, broadcast TV, radio, telephone, telegraph and other carriers will be the only workable long-term answer. Each can supply a portion of the communications jigsaw puzzle that the others lack. But because entrepreneurs , entranced by the money to be made in the CATV entertainment market are snapping up franchises, coherent national policy will be needed to avert deadlocks.

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[1] *To define our terms: CATV is the dominant subset of cable television; for our purposes the two terms may be regarded as synonymous. "Cable telecommunications" in our context signify the aspect of cable services complementary to conventional-type television programming. "Wire" and "cable" are often used synonymously, but since wires can imply the use of telephone networks (a legitimate candidate for at least some wired city applications), "cable" will be used herein except in the case of the generic term "wired city" itself.*

[2] *Some say that wiring the USA could be a $123 billion job, but nobody really knows at what point in the process the job could be considered complete. According to William Mason, "When urban centers are cabled and interconnections among urban cable systems have been established by satellite and microwave links, the wired nation will become a reality.*

Further, will the sudden demand for cable services be backed up by adequate economic support? The U.S. Office of Telecommunications Policy, the voice of the White House in these matters, has yet to find backing for a pilot two-way demonstration system in a city the size of Akron or San Jose, for example. The first wave of privately-sponsored demonstrations of new services has not attracted cable operators' commitment. Businesses and other potential customers hesitate, waiting for the industry to prove itself. While scientists and engineers are busy charting the fulfillment of CATV's promise, buoyed by strong public interest, advertisers are hanging back, not sure there will really be an important CATV market for the next five to ten years.

Perhaps there won't be. But the cable revolution seems to have come to stay. David Willard, who heads MITRE's MITRIX project, says: "There are now over 2,700 cable systems operating in this country. Unless Federal authority decrees otherwise, they'll tend to tie together. CATV owners and operators tend to be interested only in entertainment, but the FCC has ordered them to make cable circuits available for lease. So the facilities for the new kinds of services *will* be available." He adds: "Pretty certainly government and big business will be the first widespread users, as they have been in the computer field. Home use will come later."

Prime movers in MITRE's cable television efforts – (L to R) William Mason, John Monahan and Robert Labonte – at the Northeast Electronics Research and Engineering Meeting in Boston last November. All three men participated in a panel session on "Developing the Wired Nation."

Predictions subscribed to by MITRE and others who have studied the field indicate that within the next decade an interconnected national network of cable systems will bring up to 40 channels into over 40% of America's homes. This may have to be brought about in part by a determined effort to sell to the public – but that effort will surely be made. John O'Neill, Associate Head of the Telecommunications Systems Department at MITRE's Washington Operations, concludes that to attain the necessary "critical mass" of public acceptability cable may have to cut subscriber fees – perhaps even below the profit level to begin with – and provide special services appealing to the lucrative non-household market. He speaks persuasively for substantial initial outlay to have cable facilities ready and waiting for subscribers as telephone facilities now are, giving cable a working foothold with its potential customers.

But here and there about the landscape are the forerunner systems – like the system now being constructed in South Orange, New Jersey by Video Information of New York City. Scheduled to begin operation in 1973, this limited two-way system will enable some 2,000 to 4,000 subscribers to shop, be polled and make pay-TV selections over a link to a central computer by means of a six-button control unit. The system will also sound alarms at fire and police headquarters in case of emergency on subscribers' premises – a prime selling point in a community increasingly worried about crime.

Uncharted Territory

Some people – Motorola Chairman Robert Galvin is one – believe that all broadcast TV must eventually be phased over onto cable. But even if this doesn't happen, says Jack Shay, Head of MITRE's Airborne Surveillance and Control Systems Department, cable is fairly sure to be the next emerging "big industry." It was Shay who sparked MITRE's move into the field at its Bedford Operations, complementing the work already in progress at MITRE-Washington, which took the first plunge based on its pioneering TICCIT interactive television concept.

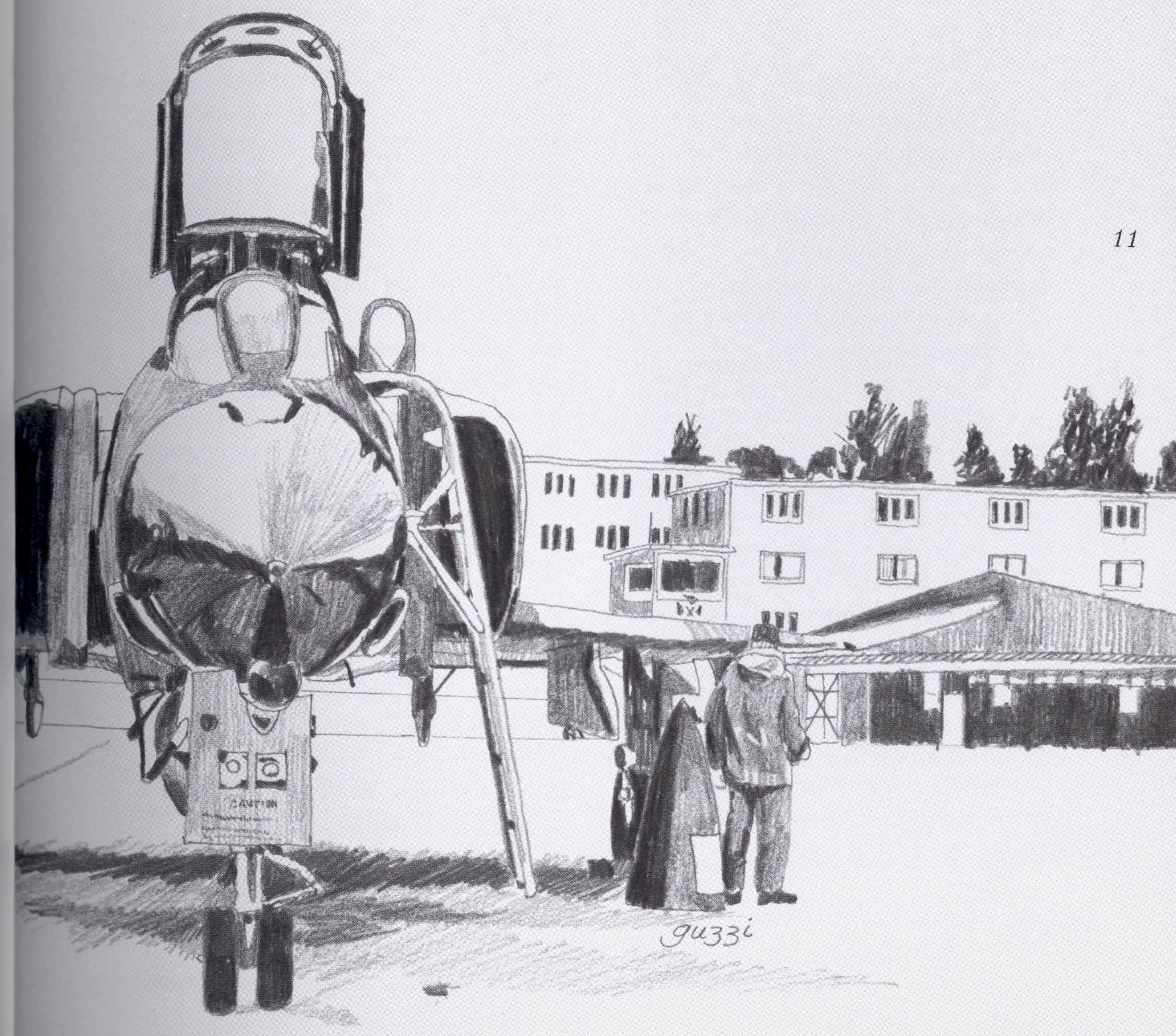
From a regulatory point of view, the time is ripe; the official attitude runs along laissez-faire lines for the first time in cable's brief history. FCC Chairman Dean Burch announced in March 1972 that the FCC will "step out of the way and let the cable TV industry see if they can make CATV work . . . there is plenty of channel space for all." Envisioning a future in which broadcast and cable TV will be "more complementary" (and thus by implication less competitive) than they are today, Burch concluded: "CATV is now an uncommon carrier, but no one yet knows if that is the proper evolution for the industry." The implication: CATV will have its chance to prove itself.

The some 44 channels that can be provided within a single cable's bandwidth[3] are uncharted commercial territory, of course – cable is expected to be a multibillion-dollar industry – and the rush to exploit this territory is just beginning. The chance to shape this new medium wisely must be seized soon, or it will vanish as the industry "hardens." The cable communications of the future are already taking shape, in the form of localized, limited experimental systems tied to computers and using digital technology to squeeze the greatest possible capacity from communications resources.

"These systems and services truly represent new ways of doing things," says John Monahan, who as Technical Director of MITRE's Tactical and Digital Systems Division oversees the MITRIX project. "We owe it to society to tread carefully. The best contribution we can possibly make is to learn everything we can about cable's potential and implications – come to an unbiased conclusion about the merits of the competing technologies, including our own – and then try to project ourselves as far into the future as we can, to work out where we think this technology is going, how we propose to get it there, and what effects we think it will – and should – have. The MITRE programs are different in emphasis, but in combination they have given us a basis of experience and skill across the board in the cable field. Society is going to have cable, willy-nilly. What we want to do is make certain cable does its best for people – that both economically and socially it will be beneficial."

[3]Roughly between 40 and 300 MHz, although the upper and lower limits vary somewhat among systems.

UNIBAC: Cabling a Military Base



Among the most important considerations in wired-city development is an appropriate "testbed" – an environment within which a cable telecommunications system can be proved out. Such an environment should be reasonably circumscribed, reasonably distinct from its surroundings – a self-contained community such as a hospital, a government bureau, a school system or a small town.

One community which has varied, well-defined communications requirements is a military base. In fact, a base is just about ideal. It runs the gamut of individual and community needs, yet has a far more tightly defined range of economic factors and variations in test configurations than a less structured setting has.

MITRE's Communication Systems Division, actively studying the wired city concept, has a military base close at hand: L. G. Hanscom Field, site of MITRE's chief sponsor, the Electronic Systems Division of the Air Force Systems Command. Hanscom meets the testbed requirement especially well. It houses a highly technical business operation, ESD. It has just about everything a small city has: education, administration, entertainment, housing, domestic services, public safety – even commerce, in the form of a gas station, the commissary, the PX and the post laundry. All of these are candidates for wired city applications.

And, as UNIBAC (Universal Intra-Base Communications) project leader Richard Witt says, "Once cable telecommunications are established, the Armed Forces will likely be among the first and biggest users. A great deal needs to be learned in a fairly short time about the effects of this medium on the military environment: the services it can provide, its costs and its benefits. Hanscom may not turn out to be the first implementation base. But it has served us as an environment within which we have been learning what can be done."

Configuration Concept

UNIBAC began as part of MITRE's independent research program when MITRE secured Air Force permission to study Hanscom and two other bases to evaluate the value of wired city services to the Air Force as a whole. Now a full-fledged Air Force program, UNIBAC is a system – but not in the usual engineering sense. It is a configuration concept, a carefully evaluated framework within which communications technology can be put to work.

"We're not limiting ourselves to any one class of hardware," Witt explains. "The wired city in military base terms will probably be an amalgam of the best modes for the mix of applications. The telephone system is a point-to-point service designed to handle voice and digital data. Cable TV is a broadcast service transmitting audio and video. Remote computer terminal networks have the many-to-one connectivity we call polling. We want to combine them into a single multimode system that will use all three kinds of connectivity inexpensively, reliably, simultaneously and independently."

The goal of the project is to show how military base operations can be improved, and money saved, through use of local video, audio and data distribution over a CATV-type network. "If information can be exchanged faster and more readily via cable telecommunications," says Lewis Billig, "as well as retrieved more easily and provided in more combinations and formats on a truly interactive basis, then the work of a military installation is going to be easier and less expensive to do. This will mean better conduct of business and less time spent on routine, repetitive tasks whose error rate is comparatively high because they're boring."

Significant Assistance

What could this mean in terms of services at a base like Hanscom? Larry Stine, who led the UNIBAC project during its research stage, says: "Face-to-face video conferencing will probably be of high interest, since it will allow people to confer on facsimile-borne documentation. Remote library access, training and improvement in data transmission and display are some of the aids UNIBAC could provide to many base functions. Really there are few areas where UNIBAC would *not* be of significant assistance."

Information moving over a base-wide network, emerging in video, audio, facsimile, printout and other forms almost instantaneously following transmission, can in Stine's view expedite functions like payroll, supply, records, and base maintenance and policing. It can accelerate memoranda, speed up file referencing, and help beat the workload which seems never to diminish.

Suppose you are a base duty officer with UNIBAC at your elbow. Locator services, alarm systems, patrols, records, transient and housekeeping information could all be displayed for your reference. Data a battery of clerks might need a day to get out of the files would be yours in

Operations of this control tower at L.G. Hanscom Field would benefit markedly from a tie-in with a UNIBAC-type capability which can instantaneously exchange information with maintenance, scheduling, and other flight-related departments.

a breath, formatted the way you need it. In such an electronically integrated data exchange environment, you would be "tuned in" to all sorts of resources you never had before – resources enabling you to do your job better, as well as resources for education and even off-duty recreation.

It was toward this end that the UNIBAC staff obtained the Base Commander's permission to survey Hanscom's military and civilian personnel to elicit needs. They found that the new telecommunications services they proposed had potential application in just about any area where information is gathered, processed, coordinated or moved in any way.

"For initial focus," Stine says, "we looked for the areas where UNIBAC can make the biggest difference. Some of these were personnel training, maintenance of crew flight time records, the base message center, and the update, coordination and transfer of the base's forms, records, manuals and regulations. At low incremental cost we can add time savings in dispensary and dental clinic operations, more up-to-date and efficient base locator and phone books services, and shorter checkout lines and better inventory control at the commissary and base exchange."

An especially promising application is the work of the Electronic System Division's many System Program Offices – the units responsible for managing acquisition of ESD systems. The SPOs generate, process and coordinate vast amounts of paperwork. Timeshared video display via cable would place current contract files, manuals, regulations, engineering drawings and project history at the disposal of each Program Officer, permitting faster, more accurate preparation of work statements and specifications. Instantaneous message exchange would eliminate legwork and abolish delays. The result: shortened lead time for system procurement.

The staff has also devoted much study to documentation, one of ESD's heaviest, and sometimes most frustrating, responsibilities. Hypothesizing a 100-page report, Witt and his colleagues simulated its production cycle and found that a computer-driven typewriter controlled through UNIBAC could yield significant savings for an organization producing ESD's volume of reports. Text editing using the system's data storage and manipulation potential would save even more. "Wired-city-type telecommunications," Witt summarizes, "have it in their power to enhance the performance of Air Force business to a striking degree."

Two Other Bases

Because of ESD's presence, Hanscom may not be typical of Air Force bases. So two additional bases were studied: Keesler, a technical training base at Biloxi, Mississippi, and a mission command base, Dover Air Force Base in Delaware. Keesler, with its flight and survival training and its 350-bed hospital, proves highly adaptable to cable telecommunications aid – in fact, the Air Training Command is now working on a plan for an instruction program based on the TICCIT concept described in the following section. The UNIBAC staff included in its recommendations complementary training applications and medical information system uses.

Dover, by contrast, is characterized by extensive flight activities. For this urgent, dynamic environment UNIBAC recommendations pertained to functions including flight scheduling and planning – together, of course, with the streamlining of housekeeping and other functions common to any base.

"We're counseling caution in adopting UNIBAC-type changes," says Witt, "because of their great significance. First a prototype system should be set up on a base to check out the new services in operation on a modest scale." It wouldn't be reasonable, he stresses, to look for visible time savings and performance improvements immediately. But with familiarization and adjustment, he expects operations to speed up, fewer mistakes to be made and over-all performance of UNIBAC-equipped offices to improve.

"A UNIBAC user," he adds, "will find it as strange as a jet plane would be to the ordinary driver, at first. But these facilities are coming fast and inevitably, and past the break-in period should be easy to adjust to, as training of eighth-graders on computer terminals attests. Our planned testbed will not only permit equipment evaluation – it will explore the whole area of user familiarization and acceptance."

Different Approaches

Technologically, there are two families of systems evolving to make the wired city go. One is the "hub," epitomized by the telephone network – a highly centralized, switched, point-to-point resource. The other is known to communications engineers as the "tree" – the decentralized subscriber-controlled CATV-style network modified for two-way communications. Stine stresses that from a performance standpoint there is little difference between the two. But there

Hanscom Field base library's indexes and files can be entered into a computer data base available through a UNIBAC-type system to anyone on the base or even another base in a multibase cable communication system.

are important behind-the-scenes factors: geographical distribution of subscribers, service mixes, dynamic costs. In areas like these there *are* important differences between tree and hub, and these will influence system choices for particular bases. Indeed, any given base may combine both.

The UNIBAC staff is now trying to keep its planning flexible enough to accommodate the widest range of possibilities. Different bases may benefit from different configurations, according to the nature of their missions. Perhaps most important of all the many influences on the direction of the project is an Air Force mission analysis begun at MITRE in August, which is studying base communications and the base operations most intimately tied to them. The ESD study is considering video techniques, computers, digital communications, large-scale integration and other equipment and methods which could modernize Air Force base communications, projecting its conclusions against anticipated needs of the 1985 time period. When completed in early 1973, the study will recommend a base communications goal and identify programs and concepts which best lead to it.

The Air Force planners will be deciding whether to follow through on a conventional design using a centralized telephone system style network, or whether to go along with current trends toward the wired city and the services it will provide. Among other things they will be evaluating UNIBAC's plans for a laboratory mini-prototype to be set up during fiscal 1973, a hybrid tree-hub configuration. "The hub is most economical in the dense base operations area," Witt explains, "while the tree's flexibility and adaptability to growth is important at the base periphery. We envision using the MITRIX system in the hub case.

"We plan to set up a computer with several demonstration terminals to prove out UNIBAC's service delivery – followed by establishment of a full prototype at an Air Force base some time the following year. But we won't begin the testbed work till we know what the conclusions of the mission analysis are."

If the wired city is chosen as the desirable trend of Air Force base communications, then UNIBAC may be a prime candidate for implementation in the near term. "UNIBAC is a 1975-era effort," Witt says, "ten years closer-in than the Air Force's goal. Yet it does provide a significantly modernized capability.

"In my opinion UNIBAC will

Flight planning would also benefit from a UNIBAC-type system which would provide up-to-date information such as flight-line status, aircraft availability, crew and load status, and weather data.

Surrounded by a video camera, television monitor and other evidence of their cable system planning, Larry Stine and Dick Witt discuss a fine point.

answer many of the Air Force's needs. I don't think its benefits will stop with improvement in working efficiency and reduction in operations and maintenance costs. It should also reduce manpower requirements by expediting Air Force work. And it should enhance the quality of life on a base, by eliminating much repetitious work, providing better entertainment

and cultural outlets and making available 'mind-expanding' facilities such as educational courses. Thus it could serve as a twofold approach to the problem posed by volunteer force proposals, which almost certainly mean that the Armed Forces will have to get along with fewer people."

Planned Evolution

UNIBAC is being subjected to high-level scrutiny, earlier in its life cycle than the average project. Is the wired city approach valid for Air Force bases? If so, is this version of it cost-effective, feasible and acceptable? The mission analysis planners will have to decide. Witt feels UNIBAC's flexibility, its openness to growth and its economy are all persuasive. He feels the variety of uses it offers will lower incremental costs sufficiently to support still more operations – thus quickly repaying the initial investment in terms of time and cost savings. Equipment costs are not unreasonable, and are likely to drop further as volume production increases, refinements are introduced and operating experience lengthens.

"We're particularly flexible," he adds, "in the degree to which we can add or drop services as we learn through prototype experience how useful they are. We think UNIBAC is second to no other system in its ability to be responsive to the actual needs of the community it will serve."

Cable planners here and elsewhere are increasingly taking the view that the wired city is with us to stay – that it is not a question whether we shall have it, but merely how we shall decide to put it to use. Accordingly Witt and his colleagues are strongly recommending adoption of a wired-city-style base communications goal by the mission analysis group.

"With its responsibility for electronic systems," Witt says, "ESD – and therefore Hanscom Field itself – can't help but be affected by the new medium as time goes on. The same, however, is true of other bases which are already heavy users of electronic systems for numerous purposes, and which are finding some of their biggest bottlenecks in the communications area. We're sure that Air Force base communications will evolve into the wired city era, either piecemeal and accidentally, or as a planned, directed effort. By exercising firm guidance now, the Air Force can avoid false starts and misguided commitments, and make sure that Hanscom and other military bases have their chance to reap the full benefits of this new technology."

TICCIT AND BEYOND

Reston, Virginia owns a nationwide reputation entirely out of proportion to its modest size. The reason, of course, is that it is one of the "new towns" – a community planned and structured from concept to completion. For the cable communicator, Reston has one feature of consuming interest: every new home built there is wired for cable television as a matter of course.

Some 3,000 Reston homes now contain full cable TV facilities, carrying seven Washington stations, three from Baltimore and three local-programming channels plus 14 FM stations. The local programs include round-the-clock time and weather; a combination newswire, stock market and local announcement channel; and a local service producing several hours' programming twice weekly. And since summer 1971 the Reston cable system has also carried the signals of TICCIT – an experimental timeshared interactive computer-controlled information television system designed by MITRE's Washington staff which is making a notable contribution to the concepts and technology of the wired city. Charles Zraket, MITRE Senior Vice President for Washington Operations, calls TICCIT "remarkable," its development "especially dramatic in view of the relatively small effort of a year ago."

TICCIT[4] began as a corporate-sponsored program to apply interactive television to computer-aided instruction (CAI). As its name change suggests (it is now known as "information television," TICCIT, rather than "educational television," TICCET), its world of discourse has markedly broadened since 1969. To begin with, under Kenneth Stetten (now head of the MITRE Systems Development Division's Computer Systems Department), Conrad Nuthmann and their colleagues, TICCIT fused timeshared television with minicomputers and high-speed disk storage devices to drive toward an economical CAI system. TICCIT provided independent material to different students within the "same" time period from an extensive data base, using continually refreshed video stillframes, and for the first time brought CAI down to economy size, reducing operating costs from $3-10 per terminal hour to about 50¢. The system was highly interactive, allowing a pupil to type in responses which either generated new lessons or, in the case of a wrong answer, triggered remedial frames leading the student to correct his own error.

[4]Whose early development was reported three years ago in MATRIX. See "Just the TICCET: Computer-Aided Instruction Where It Is Needed Most," MITRE MATRIX, Vol. 2 No. 2, March-April 1969, p. 10.

Vigorous Concept

The TICCIT program succeeded in its initial purpose of routine instruction and drill, but it also showed the kind of vigor and irrepressibility really basic concepts tend to have. Just as the modern computer evolved in part from attempts to build a universal aircraft simulator,[5] so TICCIT has proved to be much more than just a CAI system. "We realized," says William Mason, "that in TICCIT we had a concept and hardware potentially applicable to a great many uses, and hence likely to have considerable impact on people's lives."

The hardware Mason cites is a low-cost, MITRE-designed home terminal prototype whose projected use has spawned studies ranging from evaluations of CAI use to a full-scale design for a city-wide cable system. In its first version, a videotape recorder with its motion inhibited acted as refresh memory, controlled by a specially designed coupler-decoder[6] which screened incoming messages and accepted those with its own address pattern. Accepted material was displayed on an ordinary TV set, and could be recorded and played back using the recorder. Once switched from broadcast to interactive mode, the system activated 512 channels of video information for 30,000 subscribers.

Feasibility

In summer 1971, with the permission of Reston's developers, MITRE began demonstrating TICCIT over a 12-mile microwave link with Reston, where it was received on the prototype home terminals in selected homes and offices. Test subscribers used their pushbutton telephones to request specific information from the MITRE computer. The result was to show that ordinary home TV receivers could be used as remote computer-driven displays for information distribution.

"We sacrificed the apparent motion of standard TV," explains Computer Systems Associate Department Head John Volk, "transmitting pictures only once each second rather than at the standard 30-per-second rate. The coupler-decoder played them back 30 times a second to refresh the TV picture; users simply called our computer, read off a list of services from their home screens and pressed the telephone pushbutton corresponding to the class of information they wanted. The computer re-

[5]For an account of this absorbing episode in computer history, see "WHIRLWIND: A Harbinger of the Computer Age," MITRE MATRIX, Vol. 4 No. 1, January-February 1971, p. 2.

[6]Patent applied for.

sponded by generating more specific sets of questions leading them to the information they were after."

For the demonstration a modest "software package" was prepared, consisting of interactive educational and community service material. The educational material offered two varieties of CAI – one teaching addition, the other a five-day drill and practice course with pre- and post-test evaluations.

The community service material was designed to show how responsive such a system might be to a given community's interests. It included a simulated ski report, baseball scores, weather, racing forms from Pimlico and Shenandoah Downs, stock quotations and a local fishing report. Information on demand included classified advertisements for jobs, apartments, merchandise, pets and the like; the Reston telephone directory; a weekly events calendar and a TV guide. Simulated services included checkless banking, emergency medical information and income tax computation assistance. In practice, of course, the range of such material is virtually endless.

Cable Capacity

As the fusion of TICCIT with cable is demonstrating, mass home use

The city of Reston, Virginia exemplifies the application of future community concepts, including cable television. Around the shores of this man-made lake lie the cables through which MITRE's cable feasibility work is being done.

of this kind of system demands the kind of channel capacity only cable can supply – while at the same time it is opening the way for cable's economic success. Indeed, Zraket asserts, mere traditional cable services will not succeed in an urban market. "Even if subscriber fees are cut below what most companies charge," he says, "only one-fourth of all households might be expected to subscribe if all that's offered is distant broadcast signals, and no urban system could make it on those terms. We believe we are the first in this country to design a system whose principal sales appeal and economic success will be based on special programming – community and public service and other imaginative two-way services. We think bold steps should be taken now to bring such a system into being."

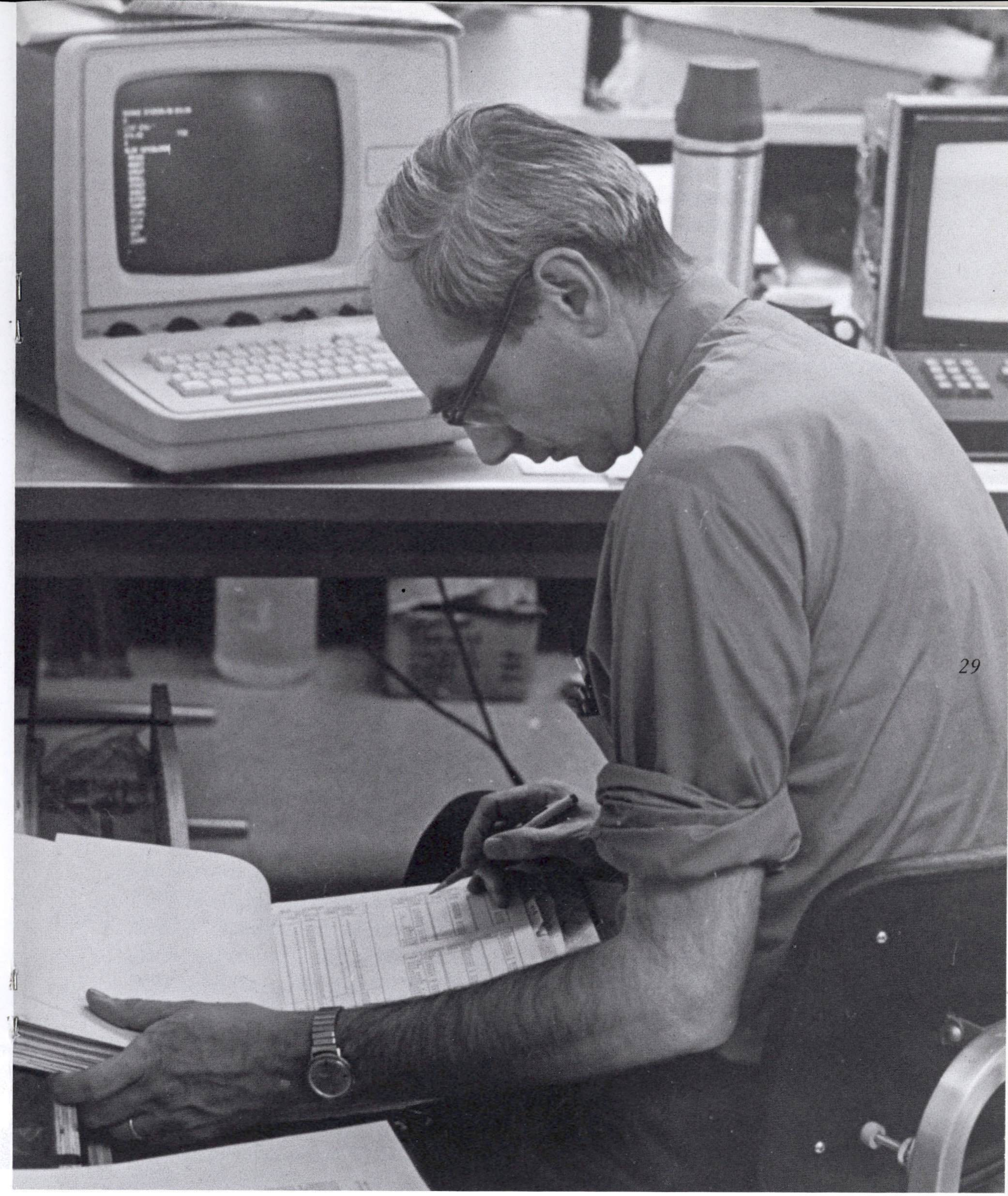
"TICCIT-style systems will be an attractive revenue-producing item for cable TV operators, too," says Mason. "The equipment for the home terminal isn't cheap, but the most expensive item, the device used to refresh the image, is coming down in price, and we've come up with some techniques that could create market success even now for a large-scale operation. Even with the home service package we've been using at Reston, it appears that TICCIT on cable would be a significant drawing card to attract subscribers to cable TV."

Beyond the Reston experiment (now expanded to include color capability and a new type of refresher device), Mason and his colleagues hope to catalyze development of this kind of system by cable TV interests and equipment manufacturers, and to interest city, state and Federal planners in its educational, informational and cultural potential. Cable theorists have vied to outdo each other in enumerating services cable TV could perform; Mason states categorically that the TICCIT-type terminal could provide just about all of them.

There are five fundamental classes of service: *conventional one-way broadcasting*; *special one-way broadcasting* (such as dedicated nets or pay-TV); *discrete addressing* (electronic mail, library service); *limited two-way communication* (home shopping, tax filing); and finally *full two-way communication*. The Reston feasibility system provides services chiefly in the limited two-way class. More sophisticated services will cost more – in the thousand-dollar-per-home category for face-to-face conversation.

Dollars to Doughnuts

Cost, of course, is the ultimate question. Enthusiasm about technological developments is all very well,



Ansel Gould of MITRE prepares a new demonstration program for the prototype TICCIT system.

but it takes an appeal to our economic instincts to make us take out our wallets – or, if you will, to persuade us to push the button on our home terminal that debits our bank accounts for the amount of the purchase. The question is, quite plainly: how many people are going to want what service, and at what price?

From the beginning the TICCIT staff has asked hundreds of visitors to the Reston demonstrations to respond to questions about what they'd pay for this kind of service at home. They are hardly a typical urban population sample – they have tended to be manufacturers, cable operators, officials, educators and social scientists from around the world. But their views provided a start. Better than nine out of ten indicated interest in CAI at $1.35 per terminal hour. Three quarters would pay an average $1.74 per month for one-way services such as stocks, ski reports, daily ads and school lunch menus and 69¢ for a home calculator service. This degree of initial acceptance was pleasing considering that what the visitors saw gave only a modest indication of the extent to which a working full-scale system could be tailored to the needs of specific urban subpopulations.

One such subpopulation showed especially keen enthusiasm: school children. Given simple instructions, the pupils worked quickly and easily with the CAI mode, showing a high rate of retention. Project personnel fondly recall their animated interaction with the terminal – talking back to the computer, laughing at it and at themselves, and frequently sharing terminals informally.

To Cable the District

In the meantime, a MITRE study sponsored by the Markle Foundation resulted in a mid-1972 report[7] on the potential benefits and problems of outfitting the nation's capital with an interactive, two-way cable telecommunications system. The report, already a "best seller," exhaustively details the facilities and financial and institutional arrangements needed to implement a WCS – a Washington Cable System.

The report, which has excited considerable interest and speculation with its far-ranging analysis of what is involved in cabling a major city, stresses that the new family of TV-related services that could be provided to every home could help alleviate many of the traditional communications problems of municipalities while supporting public, social and commercial service functions. It supports the intent of the Federal Communications Act, which seeks to redirect television toward diversity, social usefulness, local expression, and access that is both inexpensive and widely receptive to all comers – rich and poor, black and white, urban and rural.

Using Washington as an example of a large urban area fitted out as a "wired city," the MITRE report postulates a two-cable, 30-channel expandable system providing local programming of community events in nine different areas of the city; special-interest programming on sports, hobbies, travel, investments and the like; instructional programming for preschoolers, visitors and minorities; channels for rent to private groups for marketing or opinion; point-to-point channels for government, hospital, school or other closed-circuit communication; and public information channels carrying everything from drug rehabilitation information to coverage of Boy Scout troop meetings. Using financial, demand and sensitivity analyses including a community market survey conducted under a subcontract to Howard University, MITRE concluded that almost 80% of D.C. households might be expected to subscribe to one-way and subscriber-response services, and almost 50% to electronic information handling if the program is sufficiently inexpensive and attractive.

Calling television "the most pervasive information and communication medium in our society," the report outlines specific means of providing greatly expanded services whose costs will be cheaper and access extended through provision of many new channels. Means and varieties of programming for particular audiences are addressed, and potential programs and services are illustrated.

Responsiveness

From a variety of sources, including a landmark University of Michigan study of ghetto attitudes toward television, the MITRE report finds abundant evidence to substantiate present hopes for programming and services that are truly responsive to the needs and resources of urban subcultures which today are excluded from the communications mainstream. In its view, cable can do much to counter alienating trends at work there today. The Sloan Commission on Cable Telecommunications compares cable to the printing press in its democratizing influence on communications; MITRE sees the nation's urban centers, with

[7] *William F. Mason et al, URBAN CABLE SYSTEMS, M72-57, The MITRE Corporation, McLean, Virginia, May 1972.*

their varied demography, as the places where this can most clearly be demonstrated.

MITRE's WCS concept incorporates 1,076 street-miles of cable, passing all of the 263,000 households in the District. It would provide 30 one-way video channels initially with provision for 34 more, expandable to two-way operation. It would include independent programming from local studios, and promises two-way communications on a demonstration business in the first year of operation. To be installed over five years, it would cost about $30 million, with fees at $3.50 per month for one-way service. Two-way subscriber-response operation would cost $3 more, and electronic information handling an additional $8.50 to $15.50 – not unreasonable compared to present-day phone bills.

"Because we're emphasizing high subscriber penetration and low subscriber costs," says Zraket, "we believe our system can be financially viable and socially useful. The attraction of this service, aside from its economy, is plain. Much current broadcast programming, setting aside aesthetic questions, is simply irrelevant to viewers' needs. Specialized, tailorable, participative programming is going to have broad appeal. We intend to test this appeal in large-scale demonstrations accompanied by market surveys."

The WCS plan is generic enough to apply to any large city, providing a technical framework within which impinging political, economic and social considerations are fully explored and legal, regulatory and public interest factors are dealt with. A parametric set of system options is now being designed for practical implementation, and follow-on work, including informal contact with leaders of other cities, is now underway to extend the plan's relevance to specific municipal needs.

Washington is seriously considering wiring itself; Mayor Walter Washington's Economic Development Commission favors the idea. Washington's many Federal agencies stand to benefit from the availability of a city-wide cable system. How soon Washington will be cabled is still uncertain, of course; the question of public versus private ownership, for one, is not yet resolved. But an occasion offers itself – one that's only four years away. "The Bicentennial Celebration in 1976," Mason says, "is an attractive target date. A WCS could show other cities how an urban cable system providing better and more responsive telecommunications can improve a city's quality of life."

Brass Tacks

Meanwhile, the Markle-supported analyses and the Reston demonstrations have spun off hardheaded use studies designed to put TICCIT-style CAI in reach within a few years. "CAI has been a commercial failure till now," says Kenneth Stetten, project leader of MITRE's National Science Foundation-funded studies aimed at catalyzing CAI's mass dissemination. "Yet the need was never greater, school systems never had larger budgets, and the technology's effectiveness is demonstrated. The Foundation wants us to make a market, to convince schools of CAI's validity as a reasonable, cost-effective approach to supporting individualized instruction."

Two junior colleges were chosen to prove the market because of their rapid growth, receptivity to innovation and emphasis on educational effectiveness. TICCIT systems are being developed for demonstration use in these colleges, in an attractive size and price range. "Courseware" – educational material – is being developed under subcontracts to the University of Texas and Brigham Young University in four high-exposure freshman and remedial math and English courses. Emphasizing the student's control over his own work habits and pacing, the system strives to develop good learning strategies in the student while accompanying him through the course material.

The modular, 128-terminal systems, including audio response, color displays, minicomputers and cable capability, are expected to cost less than $250,000, and less than one dollar per terminal hour. "The Foundation wants to stimulate a major CAI market in five years," Stetten says. "We think we can do it. The real selling of CAI will be done by the students and teachers who use it and the administrators who oversee its operation. If their own experience shows that it can help them, CAI will be on its way."

Assessments

The MITRE-Washington effort is moving rapidly on a number of fronts. Stetten and his staff are awaiting Air Force approval of plans to implement a TICCIT system for computer-managed instruction in the electronic technician training program at Keesler Air Force Base. And under a different National Science Foundation contract, MITRE is studying the technical and economic aspects of home delivery of instruction and other socially related services via interactive cable television. What is afoot is a full-scale

assessment of the implications of the new medium, with special emphasis on the critical question of acceptability. The newest phase of the Reston demonstrations is making a contribution here, driving toward implementation of complete interactive services on a Reston-type link. In-depth acceptance surveys will be conducted among users of expandable educational, informational and recreational service packages, and technical features such as character size and style, color and definition will be tested for viewer reaction.

Once the facts are in, criteria will be defined for selecting a demonstration city where the feasibility model will get its first large-scale public

Children at the Reston, Virginia Day Care Learning Center (above) display their talents during a TICCIT demonstration. At left, a visitor to MITRE-Washington tries out the prototype student terminal, part of the computer-assisted system being developed under National Science Foundation sponsorship.

Ken Stetten (R) fields questions following a demonstration of the TICCIT system at MITRE's cable conference last October.

tryout. From studies like these, the National Science Foundation hopes to find an effective way to shape the introduction of two-way interactive cable telecommunications services with high social impact – cushioning adverse reaction, identifying advantages, and finding the market the entire field is so restlessly seeking.

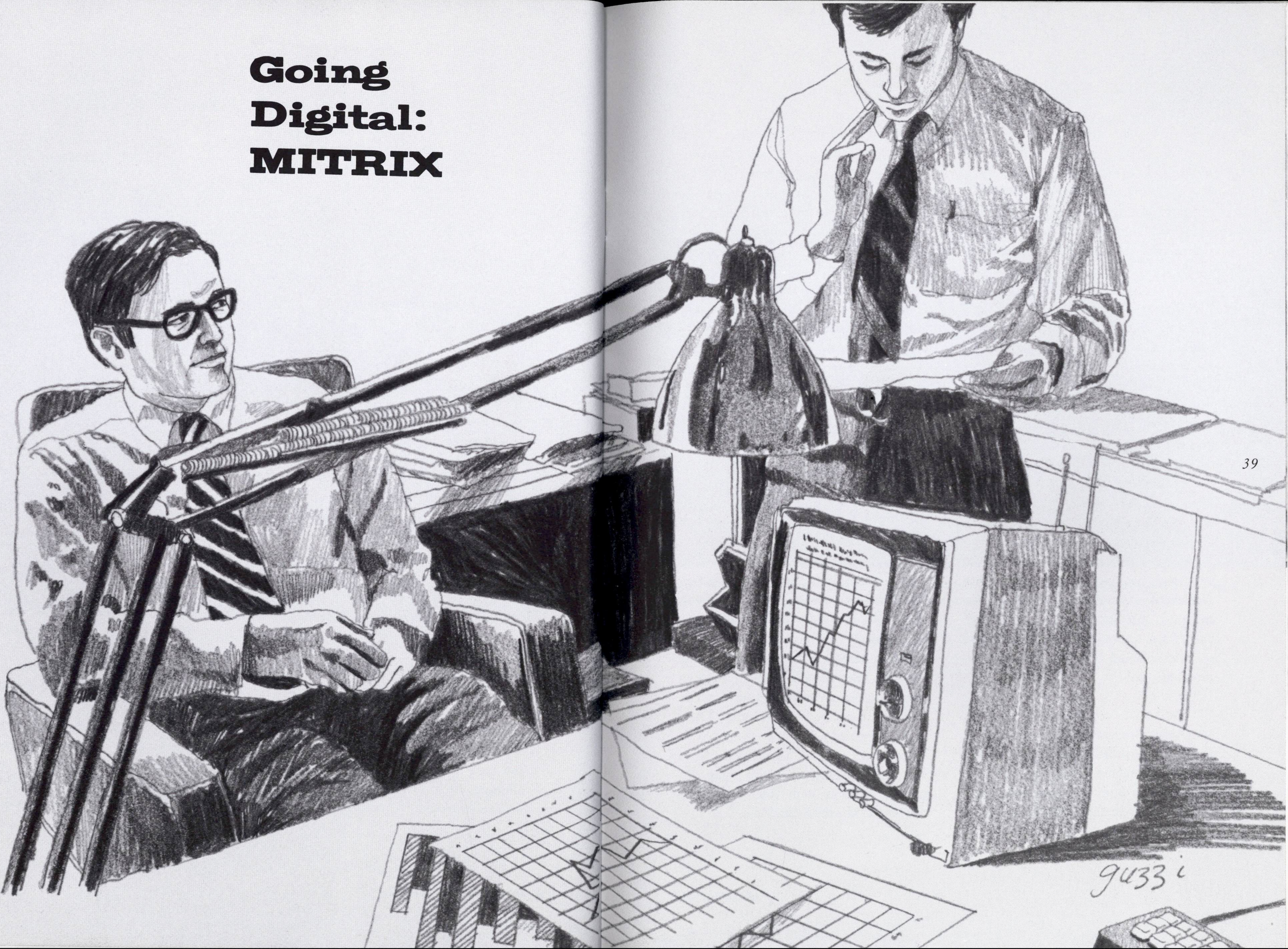
The Ultimate Audience

With this in mind, MITRE convened in June an advisory panel of experts from the Markle Foundation, the New York City Rand Institute, the Cable Television Information Center and other organizations in the field to discuss means of reaching cable's ultimate audience. They discussed desirable alternatives for initial programming efforts, and analyzed methods of selecting a population sample that would be representative of the U.S. population at large. Needs and possible applications in education and community relations were evaluated, and the panel members huddled to identify requirements. They decided it is clearly important to minimize complex or expensive software, to incorporate community groups in planning experiments, and to provide people who are encountering the system for the first time with a bridge that will alleviate their uncertainty about the new technology.

This was only the first of such gap-bridging efforts. Shortly before this issue went to press, MITRE and the Cable Television Information Center co-sponsored a symposium at MITRE's Washington facility on urban cable television. The meeting covered issues ranging from needed institutions to fee structures and system ownership. Attracting municipal officials from the 100 largest CATV markets, industry, the government and the academic community, it contributed needed perspective about realistic means of achieving cable's tremendous potential.

"There are three primary barriers to rapid introduction of new types of cable services," says Mason, "system cost, the costs of preparing two-way programming, and uncertainty in the marketplace. A start has been made on all three, and we believe these barriers will fall quickly as people see the new services demonstrated. Television itself, to begin with, was seen as an expensive luxury, yet today few households are without a TV set. Cable telecommunications appear to promise a similar revolution in a relatively short time. And the TICCIT concept, with its multiple potentialities for education and information exchange, is unquestionably one of the most vital parts of the cable telecommunications picture today."

Going Digital: MITRIX

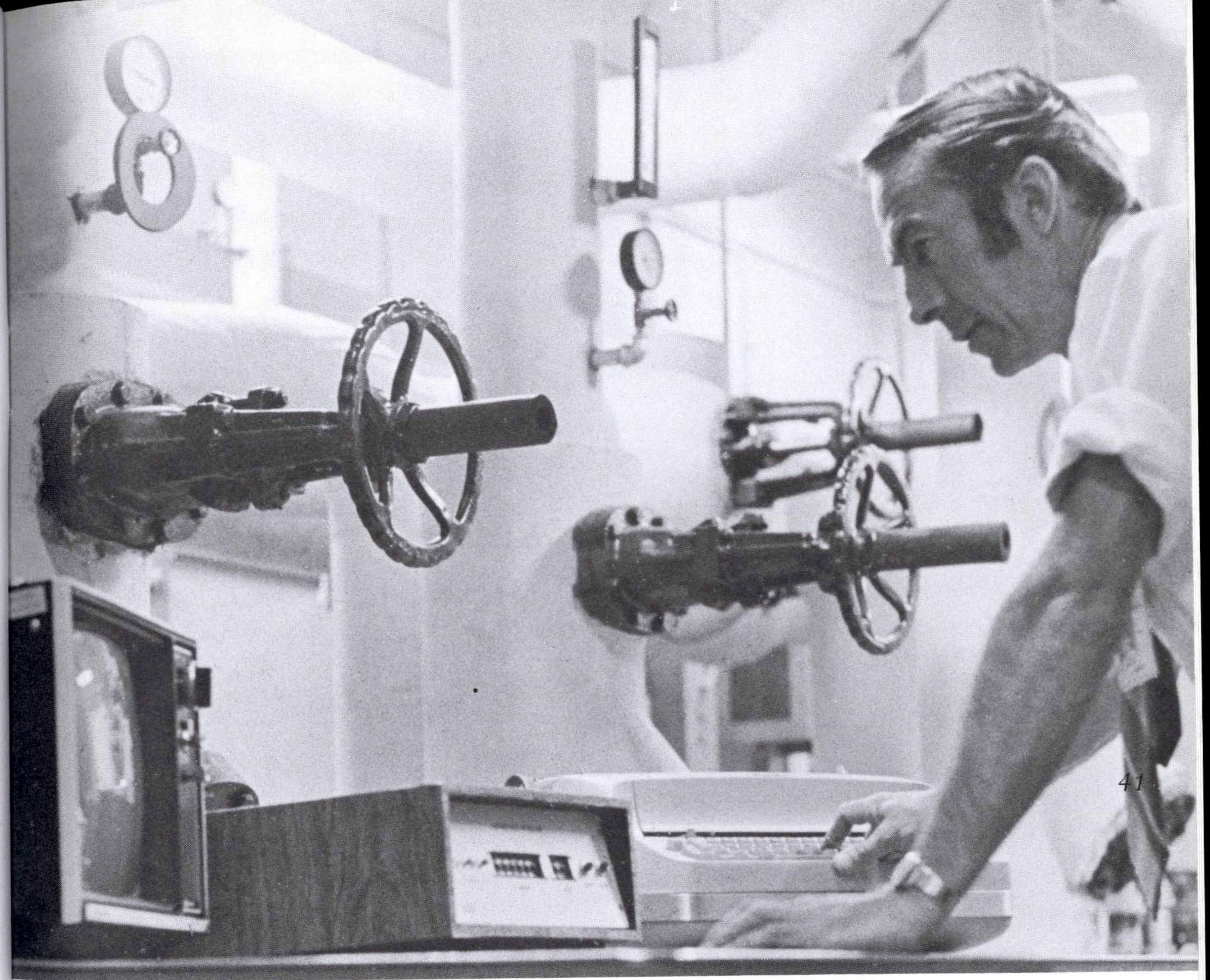


"It's axiomatic by now that the expansion of cable telecommunications is going to come out of the bandwidth CATV doesn't use. Well, just as the whole rationale behind current development lies in using that untapped vein, the rationale behind our project lies in finding the best *way* to use it."

David Willard of MITRE's Tactical and Digital Systems Division is talking about a new approach to communicating by cable. Project Leader Willard and his colleague Michael Cogan concentrated on a search for the best possible cable communications technology as a way of enhancing MITRE's effectiveness as a cable system designer and developer. The result was MITRIX, a time-division multiple-access digital communications system intended to exploit the potential of the medium to its fullest. A year of evaluation has given them a wealth of experience in cable system design – and has convinced them that they have uncovered one of the keys to the future of cable telecommunications.

MITRIX is housed within MITRE's Bedford Operations, on a three-quarter-mile cable loop which includes standard CATV facilities as well as some auxiliary equipment one wouldn't ordinarily associate with cable systems. On this testbed, MITRIX is undergoing continual test and refinement, to the point that it is now regarded as sufficiently established and sufficiently promising to be a candidate for the military base communications application discussed in the UNIBAC section earlier. MITRIX is also carrying a number of services within the Bedford complex itself – among them on-line editing and computer-aided typing – which are contributing to MITRE's day-to-day operations while they demonstrate the system's viability in the business environment. Technologically, MITRE is finding MITRIX most promising as a vehicle for the kind of cable telecommunications system development it seeks to do.

"The experience we're obtaining with MITRIX is a cornerstone of our approach to cable system work," comments Technical Director Monahan. "Systems like it can serve as the basis for cable facilities that are far more economical, flexible and capable than today's. Needless to say, any cable task we take on will present its own demands and problems, so we don't in any way restrict ourselves to MITRIX as an approach. But it does appear to be a better way of handling many of the kinds of services now being discussed, and as such has brought us nearer to the wired city."



Robert LaFleur of MITRE shows how a plant monitoring system might be supported by a capability like MITRIX: data is requested via the keyboard, and readout appears on the video screen, with MITRIX handling the communications.

The uses of a really flexible cable telecommunications system are many: credit card validation, automatically tabulated transactions, and cashless purchases, for instance.

Wide-Open Communication

The MITRIX staff sees the new system as an ingredient which can help lift many of the limitations of present capabilities, turning the medium into an all-purpose pipeline for communications whose nature and form will be almost entirely up to the subscriber. Jack Shay, who oversees the project, considers it a distinctly new capability, "well ahead of its field. It appears to be the best choice for really wide-open communication by cable."

Staff member Charles Dolberg, who has been studying the economic implications, adds one more point of special significance. "Cost is often a sour note when people start talking about really versatile two-way interaction. But we believe we've established that the MITRIX kind of capability can be mass-produced inexpensively enough to permit such services to develop on an economical basis."

At the beginning of the project Willard and Cogan studied available and projected systems elsewhere and found that while flexibility was on the tip of everyone's tongue, most systems actually offered anything but. "We found most people wanted quick one-time access for a variety of uses," says Willard. "But outside MITRE, few people seemed to be developing technological approaches which would take advantage of cable's practically unlimited potential for data exchange. Instead, we found dedicated full-time systems being designed to do only a few limited jobs: reading meters, ringing alarms, making pay-TV selections and so on."

Keystone System

Willard and Cogan contended that any company in the business of engineering effective cable systems ought to be able to offer its clients a system which can handle virtually any communications task. So they set out to create a system which would not be limited by its design. It had to be a communications pipeline on which MITRE as a cable system designer and engineer could base a full-scale system with confidence that it would not be outgrown by future needs.

They came up with MITRIX, a keystone system whose versatility brings cable's broad potential into sharp focus. It consists of two main elements – a series of terminals called Subscriber Digital Interface Units (SDIUs), and a network control center. The SDIUs are the user's key to the system, achieving flexibility and economy because they are not tied to a hard-wired set of uses. They are detachable from the "end instruments" which are their means of expression: cathode ray tube displays, facsimile devices, keyboards and so on, which create information throughput in the form needed for a given use but do not restrict the system's formatting and carrying capability. Use of digital communications and easy access through timesharing add to the user's freedom.

"We call this a 'transparent' system," Cogan says, "because MITRIX is indifferent to the type and variety of communications you use it for. Just as glass passes light, MITRIX passes digitized information, without distortion or restriction. Thus we've skirted the problem of commonality that always afflicts early designs in a new field. And we have a very powerful communications utility adaptable to many uses in many different kinds of cable systems."

MITRIX is one of the many MITRE programs which have converted and adapted to societal benefit concepts originally designed for military use. In this case, time-division distributed communications, with which MITRE has gained extensive experience in the PLRACTA[8] and other military programs, have served as a catalyst to give MITRIX increased flexibility. The staffers redeveloped the distributed communications concept in terms of the problems presented by cable, and in doing so arrived at a technique as strikingly new and different for civilian communications as PLRACTA has been in the military sphere.

[8]*See "PLRACTA: A New Approach to Tactical Communications," MITRE MATRIX, Vol. 3 No. 5, September-October 1970, p. 2, and "Anticipating Tomorrow: PLRACTA" in MITRE MATRIX, Vol. 5 No. 3, June 1972, p. 33.*

Undivided Attention?

Technically, MITRIX operates rather like the average timeshared terminal, the difference being in its provision of all three classic communications modes: broadcast, one-to-one, and polling (many-to-one). On notification (within 0.1 to 2.6 seconds, depending on the access time you want to pay for), the system assigns a customer time slots. A message, repeated by the control center, moves to the subscriber(s) addressed, and is recognized by the terminal whose address matches that accompanying the message. Over 8,000 minimum-rate users can be accommodated at any instant in a full-scale two-way system of this kind, with a total network size of 131,072 individual terminals. And each network can be interconnected with others to form the hierarchical configuration of the wired city – or, for that matter, the wired nation.

Information reaches you in whatever form your end instruments allow: display via CRT or television screen, printout on teletype or computer-driven typewriter, reproduction in facsimile. One application now being evolved connects a Braille embosser[9] to MITRIX to create a communications system for the blind. MITRIX data exchange is complemented, of course, by cable-borne audio and video. And timesharing produces the by now familiar illusion that you have the system's undivided attention – whereas in fact it is taking care of many other users "simultaneously."

As a whole, this digital-based information capability gives its user an uncommon degree of communicating power. Whether you want to scan printed information remotely, carry on a three- or four-way discussion of the fine points of documentation reproduced by facsimile at all callers' locations, send an all-points bulletin, monitor a remote meter, automatically credit or debit a budget account merely by registering a purchase, take a poll, maintain an up-to-the-minute listing of dynamically changing resources such as equipment inventories – think of your own information application – MITRIX, according to its designers, can use a combination of its resources to accommodate you.

[9]*See "Braille Translation: The Computer Aids the Blind," MITRE MATRIX, Vol. 5 No. 2, April 1972, p. 22.*

"We've done what many developers of new systems don't do," Willard points out. "We've investigated thoroughly what kind of distribution system the wired city really needs in order to meet its communications requirements – and used that as a specification for building our system. I think MITRIX has benefited from this order of events, and we've gained the kind of experience we need to be effective in designing analogous systems which really respond to the requirements of specific wired city installations."

Jack of All Trades

The "transparency" of the MITRIX concept of communications makes it a kind of input-output matrix which can create its own network according to need. Marrying cable TV and digital two-way communications as an integrated facility on the same cable system is of course a prerequisite for the wired city; MITRIX provides a communications channel accessible and powerful enough to create an *environment* within which the wired city services can be supplied without stint.

Willard sees considerable promise, for instance, in the use of systems

The flexible capacity of MITRIX has ample room for a monitoring capability such as at this guard station.

based on a MITRIX-like capability for high-data-rate tasks in conjunction with Air Force systems. Apart from its candidacy for use in UNIBAC, MITRIX appears to have potential as an expediting element to enhance the capability of quick-response command and control systems. It can act as a channel for computer-to-computer data exchange, data storage and retrieval, and so could conceivably be applied to military data management and real-time planning operations, whose needs seem constantly to outstrip the available technical and fiscal resources. Light, compact MITRIX-type equipment could enhance tactical communications flexibility in a theater or deployed field headquarters operation.

On the civilian side, many large organizations with formidable data-handling problems, from the New York Off-Track Betting System to the United Nations, are now being cabled – as are, of course, many communities across the nation. "But what they're buying," Willard points out, "is limited capability, because the structure of their links and nets, and of their access instruments, permits them relatively little latitude in operation. If they're going to want to extend their resources later, as it seems certain they will, they'd benefit from the kind of flexibility our cable system engineering experience and MITRIX technique could offer them now at reasonable cost."

Conceptual Prototype

Willard and his colleagues have already begun investigating applications for which the MITRIX design may serve as the conceptual prototype. Discussions have been held, for example, with the Massachusetts arm of a national organization which funds police improvements. "In times of message overload – just when they're needed most," says Dolberg, "police communications can bog down badly.[10] We see a way to fit distributed communications into a city police network, adding low-power mobile transmitters on a local basis to free up the city-wide frequencies."

Electronic mail is another field with great potential, although much auxiliary equipment must be developed before it can become a reality. A channel like MITRIX could be used to send facsimiles of letters; encoded for privacy, these could be automatically decoded and inserted in envelopes at the receiving end without being seen by human eyes, cutting days of mailing time down to a few hours.

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[10] *See "Crime, Communications and the Massachusetts State Police," MITRE MATRIX, Vol. 5 No. 5, October 1972, p. 38.*

"Scrambled" channels could be used for other purposes too: pay-TV; surgical consultation for hospitals; secure file access for organizations like the FBI. Computer-to-computer "conversation" for credit card validation or auto registration checking, inventory control or accounting; remote social service counseling; vastly improved employment referral service; home computation; shopping-from-home; political and local event coverage with viewer participation – the full list of cable telecommunications services is within the reach of this new dimension of communications.

Paperless Office

MITRIX-style concepts have considerable impact in the business environment as well. The "paperless office," in which functions now performed on paper are handled instead by electronic files and transactions, has been a favorite theme of technological forecasters for over a decade. But little has been done to make it a reality, despite the volume of complaints about "paper pollution." Whether bureaucracies will or can yield to such a trend is of course uncertain, but as Willard points out, the new capability does offer the necessary technology coupled with the required simplicity and reliability of operation. And it is already operating at MITRE-Bedford on a small scale to prove out concepts like the following.

Suppose that, instead of a memo to all personnel, a large corporation sends out a message to terminals in all departments, to be printed out only where required. Communications time would be saved; so would worker time for coordination, printing and mailing.

Or this kind of flexible cable system could reduce skill requirements for typists by using computer-driven terminal typewriters to final-type drafts – edited on the system – of everything from cafeteria menus to finished reports on mats ready for printing. Time sheets and purchase orders could be tabulated and abstracted in any form desired, using an on-line computer for data manipulation. Digital communication and interactive video create the basis for employee training, product marketing and other face-to-face interactions. Project funding – reports on which commonly lag weeks behind actual expenditures – could be monitored on an up-to-the-minute basis with itemization to order.

The men behind MITRIX: from left, Michael Cogan, David Willard, Project Leader, and Paul Gill. Under Cogan's left arm is the new Subscriber's Interface Digital Unit, the miniaturized version of the large unit in the foreground.

"Of course, all these applications require full-scale development," Willard warns. "What seems most important to us is that we have come far enough to be able to act with confidence as a designer along these lines. We know now that specific questions of service delivery application within particular systems can be dealt with."

Pay for What You Use

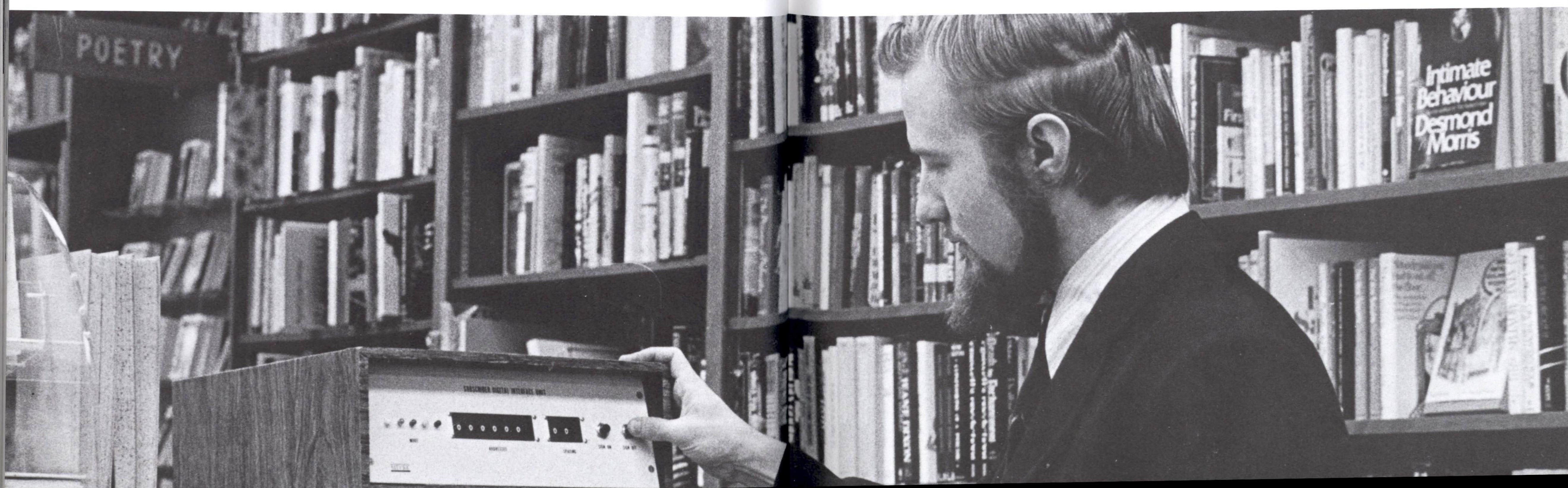
Chief among the variables in any cable telecommunications installation are effectiveness and economy. Dolberg estimates that the present yard-high experimental SDIU can be miniaturized into a piece of desk-top equipment about the size of the average hi-fi amplifier to sell for something like $500, or to be leased as the telephone now is. Over and above a base charge, the subscriber need only be billed for the actual time during which, and rate at which, he is actively using the system.

Paul Gill, creator of much of the MITRIX hardware, explains: "With phone lines today you only get really high data rates by renting a full-time dedicated line. We can provide the same high rates in small time increments without giving up timesharing – that's a substantial saving. Yet we can interface with phone lines, microwave or satellite links without significant loss in quality." Modularity is another important plus; with detachable end instruments, MITRIX is maximally tailorable, and it need not even piggyback on a CATV circuit.

MITRIX, with a maximum service rate of over 300,000 information bits per second, offers a wide range of data and use rates, including those now used with phone lines. Its flexibility is readily apparent as the staff puts it through a rapid series of demonstrations – accessing and answering a questionnaire using the CRT and keyboard, ordering and obtaining facsimile information in about one eighth the time it takes by telephone, obtaining printout of displayed material, reading a water meter a quarter mile away (8,000 such meters can be read off in five seconds – and at virtually any distance – by this means).

Monahan stresses that MITRIX is an approach rather than a solution. "The system works well," he says, "and is a significant step forward in communicating by cable. But MITRE is a system designer and engineer, not an industrial production firm. The chief value of MITRIX is the way in which it has advanced our knowledge and our ability to benefit people who

Another communications benefit of the future – pushbutton inventory control, with the computer serving as stockbook.



seek our help in setting up cable systems that won't cramp them."

All Manner of Interactions

The men responsible for cable system development at MITRE see the way open ahead, technologically speaking, for wired city development, in part because of such innovations as MITRIX. As Monahan says, "There are many communications tasks we can visualize but can't do today. The new capabilities now coming along will make all manner of interactions possible. And our own experience with them has taught us much about the right ways to design cable systems."

But of course there are further considerations – among them the caveats we mentioned to begin with. Public response to cable will be far from unanimous; regulatory and market barriers will make its introduction uneven. Robert LaBonté, subdepartment head for the project, comments: "I think it's a mistake to believe that the 'wired home' will enter the picture very soon. But public use of cable is going to grow rapidly, starting right now. As an indication of the intensity of the demand, government and commercial high-speed data transfer accounts for about three percent of American Telephone and Telegraph revenues today. But by 1975 – only three years from now – AT&T estimates this amount will increase three to five times. Cable technology in some form will unquestionably be called upon to meet a good part of this added demand. We'd like to help make certain that the cable technology that is there to do the job is the kind that will do it best."

LaBonté's concerns typify those of many cable planners throughout the country – fear lest too little planning will be done, too little advantage taken of truly capable technologies and techniques, before the industry "hardens," bringing on service limitations and eventually a wasteful retooling comparable to the conversion to integrated VHF-UHF television a few years ago. "In a sense we're in a race against time," Jack Shay sums up, "trying to make sure that quality and flexibility are in the design from the outset. Concepts like MITRIX, and our experience with them, give us a chance to help build systems that look ahead, not just to the needs of next year, but to the needs of the years to come."

THE TIN LIZZY QUESTION

As so often nowadays, we find ourselves standing on another threshold, trying to see what lies beyond it. It's instructive to remember that in the early days of the automobile, when everyone was saying it wouldn't work, wouldn't be cheap enough or reliable enough or popular enough, Henry Ford put money, gumption and faith behind something called the Tin Lizzy. Is what we have under our hands today the Tin Lizzy of cable telecommunications? We can come within an ace of being certain. But there are enough imponderables so that we can never be quite sure unless we try it.

One thing *is* certain: cable technology is too powerful, too far-reaching in its impact, to be left simply to grow on its own. The big questions must be answered. What about the vast sums and efforts required for programming, for example? It is conceivable that this could become one of America's largest industries. Public demand is small today, but as broadcast television did, cable telecommunications will sooner or later capture the public's fancy. Cable had better be prepared to meet the boom intelligently.

What about the depersonalization some suppose will accompany the tighter integration of communities by cable? What, indeed, will cable's effect be on our way of life? On the quality of our lives? There are promising remedies underway for the controversial privacy issue. Frank Eldridge of MITRE's Washington staff, for example, has proposed a composite channel selection and address gating system that does much to resolve the problem from a technical standpoint. But the effectiveness of such devices rests to a great extent on the degree to which their use is governed, and on the power and goodwill of their governors – and privacy is only the most obvious of this class of questions.

Indeed, do we really *want* to live in the wired nation? Can we counter the deluge of information with improved selectivity? What will the information we entrust to the system be used for, and can we control it personally? And, in the long term, what might life be like in a society in which a great many people don't have to leave home very often because they do their work and obtain their services remotely via their home terminals?

Helping Find Answers

We are just beginning to learn how many such questions, great and small, there are. There will be many more. They will test the faculties of a society whose policy-making wisdom has not invariably kept pace with its technological know-how. It is the business of organizations like MITRE to try to evaluate questions like these, to analyze and present clear, unbiased alternatives, and to help society find answers before the questions turn into quandaries.

Resources will continue to be in short supply. Paradoxically, the FCC rulings that liberated cable TV have had an adverse effect on funding for cable research and development, because the cable crunch is gobbling up available money for construction. So there will be very little elbow room for the kinds of mistakes that naturally attend the infancy of any major technological development.

All the more important, therefore, is the kind of program MITRE has set for itself – a program marked by cautious exploration, modest expenditure and careful assessment of technical and economic feasibility on several fronts and in a series of graduated steps marked by keen understanding of social priorities. How will people react to the new services? Will professionals accept them? Will they harm existing services? Each such question must be carefully weighed, and answered *before* its effects become inevitable.

The MITRE testbed environment presents an opportunity to evaluate cable telecommunications research and applications without the cost in money, and possible premature user rejection, of a public pilot program. It prepares the groundwork for the time – and it will be soon – when communities and corporations, schools and service agencies, armies and governments and hospitals and eventually homes will all be using this new medium. While UNIBAC seeks to provide military base communications of unprecedented power and variety, the projects associated with MITRE-Washington's revolutionary TICCIT concept lay the foundation for the wired city. The MITRIX system seeks to refine and redirect the technology and techniques of cable telecommunication itself. And MITRE planners strive to relate these programs most closely to the trends of the industry and the tide of public interest, and to evolve more coherent, more reliable bases for cable system design, development and engineering.

"Government, business and public demand for advanced communications services is already on the upswing," says Charles Dolberg. "It's vital to ensure orderly, economical transition into the wired city environment."

To see how profound are the implications for American life in the near future, we have only to think of the acceleration of social change attendant on the introduction of the automobile, the computer and television. These have irreversibly changed American family life, politics, commerce and industry, war, trade – and the face of the land. What changes will cable telecommunications bring?

This question cannot be evaded or turned aside. It can only be met as best we know how. This is what MITRE is preparing to do.

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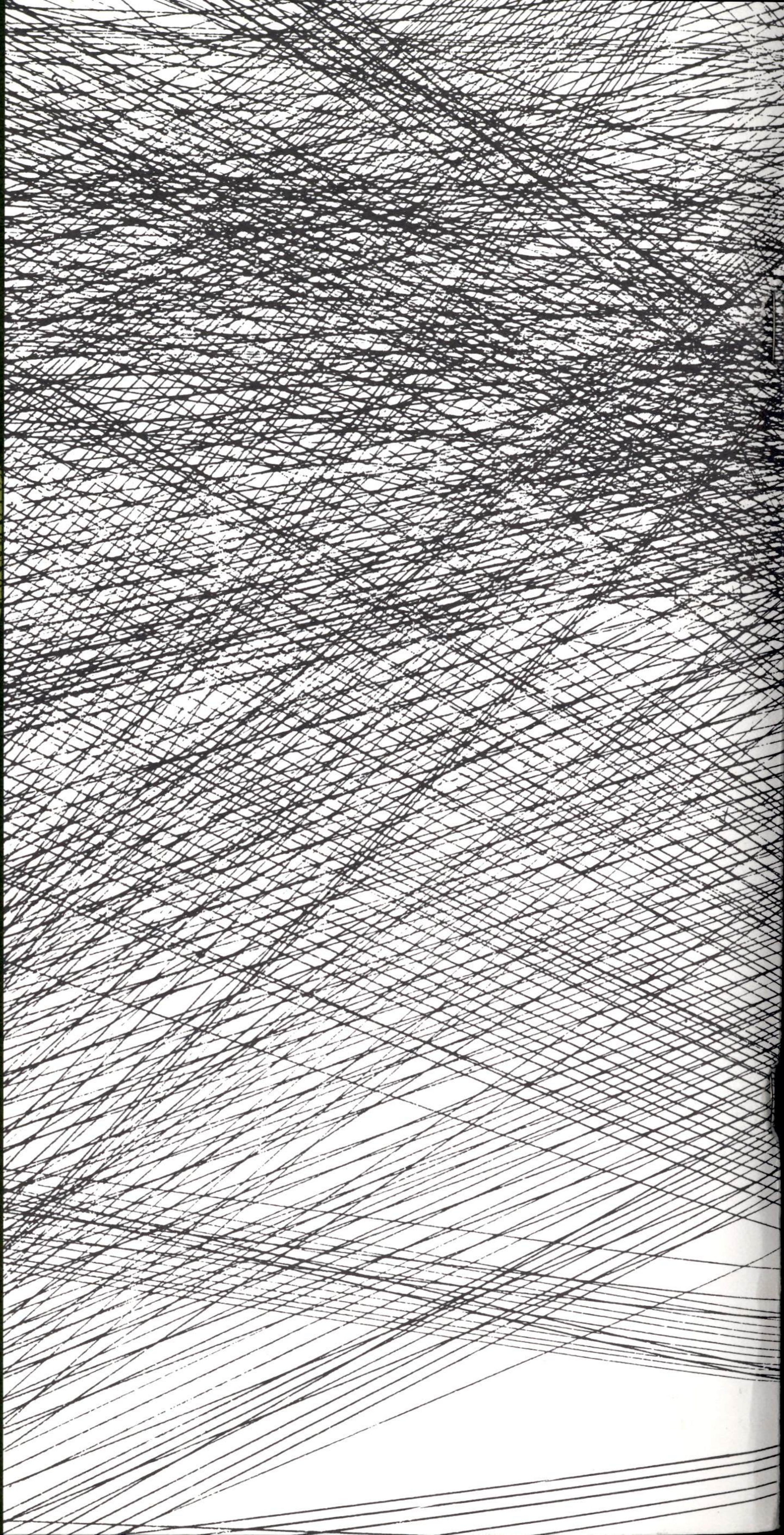

OCT 22 1971

THE MITRE CORPORATION
WESTGATE RESEARCH PARK
McLEAN, VIRGINIA 22101

T. F. ROGERS
VICE PRESIDENT
URBAN AFFAIRS

October 19, 1971

Mr. Kenneth H. Olsen
President
Digital Equipment Corporation
Maynard, Mass. 01754

Dear Mr. Olsen:

In the light of that part of our Sunday's discussion prompted, particularly, by Henri Busignies observations and questions, I have asked our Bedford office to forward to you a copy of the Mitre report entitled "Local Distribution of Telecommunications, A Perspective".

I would draw your attention, particularly, to Sections II and III and most particularly to Figures 1 and 2.

I trust that you will find the report helpful.

Sincerely,

T. F. Rogers

TFR:mc

OCT 19 1971

THE MITRE CORPORATION

BEDFORD, MASSACHUSETTS

18 October 1971 D93-608

Mr. Kenneth H. Olsen
President
Digital Equipment Corporation
Maynard, Massachusetts 01754

Dear Mr. Olsen:

I am sending this report to you at the request of Thomas F. Rogers, Vice President, Urban Affairs.

Cordially,

Laurie Amato

Laurie F. Amato
Network Engineering & Analysis

lfa
Enclosure

M71-91

LOCAL DISTRIBUTION OF TELECOMMUNICATIONS
A PERSPECTIVE

L.L. Stine
C.M. Plummer
M.A. Lambert

August 1971

THE MITRE CORPORATION
BOX 208
BEDFORD, MASSACHUSETTS

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ABSTRACT

There is a great deal of speculation about the new services (videotelephone, dozens of TV channels, computer access from the home) and systems (broadcast satellites, CATV) which will bring about the "wired city" and "information revolution." This paper contains a survey and analysis of commercial telecommunications from a broad technological viewpoint. A method is developed to define and classify the various services and to compare the capabilities of the new and established telecommunications systems to provide them.

This approach then permits the identification of possible future policy issues involving competitive and cooperative relationships among the various evolving systems.

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SECTION I

INTRODUCTION, REPORT STRUCTURE AND SUMMARY

1.1 INTRODUCTION

Civil telecommunications is one of the nation's largest, most rapidly growing, fundamentally important, and relatively sophisticated industries. However, public demand for improvements in the nation's present telecommunications services has become more widespread, articulate and persuasive in recent years, and there is a growing interest in new services--the economic support for which, however, remains to be determined.

To sustain this growth, to improve today's services and to address new apparent needs, a large number of technological innovations are being looked to that now are in various stages of development. Some are still in the laboratory; some are now experiencing their first introduction to the commercial and general public: videotelephone, domestic satellite repeaters, millimeter and optical wavelength line-of-sight radio circuits, waveguides and optical fibers, coaxial cable, time-shared computers, data transmission circuits, home video recording and playback, more flexible mobile communications, mini-computers, and digital technology. All of these will bring about the "wired city" and the "information revolution" which is the subject of much speculation.

During the past few years these dissatisfactions, expectations, and innovations all began to have their influence felt throughout the telecommunications industry and the institutions that serve it, those that it serves, and those that regulate its operation and growth. Rarely (perhaps even never before) has the telecommunications field been faced with such great concerns, opportunities, and dynamic change.

Since its inception, The MITRE Corporation has been concerned with the design, development, procurement, and use of large and sophisticated telecommunications systems--initially with defense systems, and now with civil systems as well. It appreciates, full well, the great public interest in a healthy, vigorous, and responsive telecommunications industry, and it is committed to assisting in its sound progress.

In this general context, late last year it appeared that a study of present and planned local telecommunications distribution services, and the technical capabilities of established and potentially new telecommunications services designed to meet them, could be quite useful--especially if the study results illuminated important potential policy and regulatory issues and did so in such a form as to be of utility to those institutions concerned directly with such issues.

This is a report of the highlights of our study.

1.2 STRUCTURE

The study has looked at local distribution of telecommunications services from a broad technologically oriented perspective, with the objective of anticipating future related public policy issues. The report is a logical presentation of telecommunications services (Section II), the capabilities of four types of fixed distribution systems to provide these services (Section III) and, since the capabilities overlap and supplement each other, the competitive and cooperative relationships that exist or could evolve between the systems (Section IV).

Section II develops generic classifications of the various services. The capabilities of each system to provide these services are assessed in Section III. The four systems examined are the telephone and telegraph

carriers, coaxial cable television (CATV*), the over-the-air broadcasters, and the recently licensed specialized carriers (DATRAN, MCI, etc.).** Their directions of technological development are identified.

Section IV discusses competitive and cooperative relationships among the systems. A significant cooperative relationship among all of the systems involves the generation of technical standards, discussed in Section 4.2. The remaining paragraphs discuss relationships between pairs of systems: (1) the over-the-air broadcasters and CATV, (2) the over-the-air broadcasters and the telephone and telegraph carriers, (3) the telephone and telegraph carriers and CATV, (4) the telephone and telegraph carriers and the specialized carriers, and (5) the specialized carriers and CATV.

Appendix A is a summary of an investigation into the cost aspects of the CATV systems and the local distribution facilities of the telephone system.

1.3 SUMMARY OF THE REPORT

In order to conduct the study, it was necessary to have a method for comparing the system capabilities. This was done by developing a means of classifying the various telecommunications services and then assessing the capabilities of each distribution system to provide the different classes of service.

* The term CATV is used throughout this report to identify both those present systems which distribute television signals primarily over coaxial cable, and those future coaxial cable systems which are expected to evolve and to provide many different additional services.

** Mobile radio systems are not included since they serve a special class of users. Their relationship with the fixed systems in sharing the frequency spectrum is recognized, however.

The initial classification scheme that was explored is one based upon the division of signals into three types: data, audio, and image, and the specification of transmission performance requirements for each of these types. While this approach was found to be useful with reference to the technical standards area, it was not found suitable for comparing the distribution systems.

A better classification method is one that is based upon two parameters: (1) how information is distributed, and (2) the rate at which it is transmitted. Using this method, three broad classes of distribution are defined: BROADCAST (point-to-multipoint), POINT-TO-POINT, and GATHERED (multipoint-to-point). Within each distribution class, information can be transmitted at different rates.

The four transmission systems--telephone and telegraph carriers, broadband coaxial cable (CATV) systems, over-the-air broadcast stations, and the recently licensed specialized carriers--are compared within the context of this classification method.

It is seen that the telephone and telegraph carriers provide, or can provide, all POINT-TO-POINT services and low-rate BROADCAST services (news teletype services). Some of these carriers are experimenting with some low-information-rate GATHERED services (e.g., meter reading).

CATV systems provide certain audio and video BROADCAST services (e.g., high-quality audio and standard television) and, inherently, should be able to provide others as well. The provision of some very low-rate GATHERED services and POINT-TO-POINT services is being investigated on an experimental basis by some broadband coaxial cable (CATV) systems, and if offered commercially, they could compete with the telephone and telegraph carriers. In fact, it is possible (in a technical sense) for such

broadband coaxial cable (CATV) systems to offer all of the POINT-TO-POINT services now provided by the telephone and telegraph carriers. If current technological trends continue, it may be possible (in an economic sense) to provide such services.

Over-the-air broadcast stations can provide a variety of BROADCAST services, but only up to the practical information-rate limits imposed by the spectral width of their channels; also, it is difficult for them to provide the other two classes of services. Thus, they may not be able to carry such signals as television with line resolutions greater than today's commercial standard, or new broadcast-related services such as the gathering of large-scale viewer response data. These signals may be carried by CATV systems, however.

The special carriers (DATRAN, MCI, perhaps one or more domestic satellite systems, etc.) intend to provide most POINT-TO-POINT services in competition with the telephone and telegraph carriers. For local distribution they can build their own facilities, interconnect with the local carrier(s), or establish a cooperative relationship with a CATV system operator. This last option may become especially desirable if technological advances permit economical full-duplex, POINT-TO-POINT transmission via CATV systems (and current trends indicate this as a strong possibility) and if such systems are able to expand into the major urban markets.

There are two general findings contained in the report, and a number of specific potential issues have been identified:

(a) Findings

1. It is possible and analytically useful to develop generic descriptions of telecommunication services based on (a) method of distribution and (b) the information rate. Their use should

ease the burden of analyzing each application for a new service as a completely separate entity and should facilitate the evaluation and comparison of various telecommunication system capabilities.

2. The sophisticated systems that are expected to evolve from today's broadband coaxial cable CATV systems have the potential, technically, to provide all of the telecommunications services in a given local area. The application of digital technology, the reduced cost of this technology, and the development of new services will be important factors in making this possible. Whether or not they will do so depends, of course, upon important economic and regulatory considerations.

(b) Potential Issues

1. If CATV systems successfully expand into the larger cities and are able economically to provide POINT-TO-POINT transmission, they could compete with the telephone and telegraph carriers in providing local distribution facilities for the specialized carriers.

2. Many of the new services rely on the use of a low-rate data transmission device in the home or office. This terminal may become as ubiquitous as the telephone--indeed, it often may be the telephone--and also may have to be as standardized. Although not discussed in the report, this suggests a corollary issue; that is, ownership of the terminal and interconnection with the local distribution system (CATV, telephone), just as is now being considered for the telephone system alone.

3. New television programming and advertising offered by CATV systems will use a data entry terminal and the associated transmission system to achieve rapid large-scale viewer responses. If the telephone companies do not also provide such a capability the CATV systems will have a monopoly, and over-the-air broadcasters may be at a competitive disadvantage in offering similar programs.

4. Much of the information collected and disseminated in the provision of certain new services (meter reading, viewer response, data bank access) will be processed by computers. These computers could be owned by the telecommunications system operators. This could lead to new regulatory issues related to the integration of computers and communications--issues analogous to those which recently were the subject of an FCC inquiry and ruling.

5. Digital technology is expected to be applied to all aspects of telecommunications, including the many new services. Many digital standards are being developed which sometimes are compatible with each other--sometimes not; sometimes they anticipate new technological developments and can be applied to them, --often they do not. In view of this rapid technological change and the more complex industrial structure caused by the entry of new systems into the telecommunications area, there may be a need for a more coordinated, far-seeing, national approach to the development of standards for equipment and systems interface, particularly in the digital area.

6. Expanded local and national BROADCAST services (such as many commercial and educational television channels) can be provided to rural areas by a variety of techniques: direct broadcast satellites, regional terrestrial radio stations, and wire or coaxial cable. A wire or coaxial cable system is the most economical way to provide access to both BROADCAST and POINT-TO-POINT broadband services for many rural subscribers. To do so, however, may require a cooperative effort on the part of both the telephone and telegraph carriers and the CATV system operators.

SECTION II

CLASSIFICATION OF TELECOMMUNICATION SERVICES

2.1 APPROACH

When telecommunication services of the future are mentioned, one hears phrases such as "newspaper by wire," "voting," "dial-a-program," and "the checkless, cashless society"; the list seems endless. For the purposes of this paper, a generic classification of such applications has been developed. The three main technical parameters that describe the services are (1) information type (data, audio, image), (2) transmission rate (bandwidth or bit rate), and (3) distribution method (broadcast, store and forward, half-duplex, etc.). Interrelationships among these parameters specify other factors. The nature of the information to be transferred and its rate and accuracy are the major technical determinants of the transmission performance required from the telecommunications system. However, in the interest of simplicity and clarity, distribution method and transmission rate are the parameters used in this report to assess the comparative capabilities of the telecommunications systems to provide the services.

2.2 INFORMATION TYPE AND TRANSMISSION PERFORMANCE

Telecommunications signals can be classified in several different ways. Here, the usefulness of classifying them according to the signal source and the ultimate reception point is explored. Three types are identified: data, audio, and image. Data signals are continuous or discrete waveforms that are objectively and exactly interpreted. They include bilevels (which describe on/off or open/closed events), sensor outputs with a time base and one-dimensional amplitude (such as electrocardiograms or temperatures), and alphanumeric symbols such as might be generated by a teletypewriter. Audio and image signals are generally subjectively interpreted. Audio signals are usually meant to be received by the human ear. Speech generated by the human vocal system and music are the most common examples of this type. Image signals are meant for interpretation by the human eye and are generated by a line-scanning process. Imagery information is displayed in a two- or three-dimensional presentation.

Figure 1 presents some representative examples of transmission performance requirements of the three information types. The examples within each of the three categories are listed in order of increasing bandwidth if they are in the form of an analog signal, and increasing bit rate if they are in digital form.

It is apparent that the transmission requirements vary widely for the various signals, both between and within the same type. For example, the required signal-to-noise ratios for videotelephone and studio television are quite similar. However, the same parameter for telephone (intelligible voice) and AM radio (5kHz) and FM radio (15 kHz) are quite different. Also, maximum allowable transmission delays vary for the different applications. Therefore, it would be difficult to develop generic classifications of services based on this approach.

This viewpoint is useful, however, in developing technical standards for the performance of transmission systems and terminal devices. Such standards are an important part of current FCC inquiries into CATV transmission performance, direct interconnection of non-carrier-provided

		Analog		Digital	
Information Type	Performance	Information Bandwidth	Signal-to Noise Ratio (dB)	Uncompressed Bit Rate	Nominal Maximum Error Rate
DATA	Alarm Bilevel	5 Hz	6	5bps	10^{-2}
	Teletype				
	English			> 45 bps	10^{-3}
	Alphanumeric			> 45 bps	10^{-5}
	Computer-to-Computer			> 75 kbps	10^{-7}
	Electrocardiogram	1 kHz	20		
AUDIO	Tone				
	Intelligible Speech	3 kHz	Not specified per se	>48 kbps	10^{-3}
	AM station music	5 kHz	> 50		
	Stereo music	15 kHz per channel	> 55		
	Quadrophonic music				
IMAGE	Bilevel Fax	1800 Hz	26		
	Video Telephone	1 MHz	52	6 Mbps	10^{-6}
	Studio Television	4.5 MHz	53	> 50 Mbps	10^{-6}
	High-Resolution Television		53		
	Three-Dimensional Television				

Notes

- Values shown are typical and provide acceptable levels of performance.
- The service request and transmission delays required of the telecommunications system depend on the application; for example:

Application	Service Time	Transmission Delay
Telephone	< 20 seconds	1/4 second
Computer-to-computer	Less than three seconds	Depends on data rate and error rate
One-way television	--	Many Seconds

- Blank entries appear where the specifications are not pertinent or not available at the time this table was composed.
- Many other parameters such as delay distortion, tone interference level, impulse noise, and cross-talk must also be included to completely specify levels of performance.

Figure 1. Examples of Information Classified According to Type and Transmission Performance Requirement

terminals with the public telephone network, and radio frequency interference. They are important in the consideration of future standards development in areas such as digital telecommunications, high-resolution television and facsimile, and systems interconnection. However, in order to compare systems from a total viewpoint another approach should be used.

2.3 DISTRIBUTION MODE AND TRANSMISSION RATE

This other approach that may be used to compare the capabilities of telecommunications systems is to classify the services according to their information rate and mode of distribution as shown in Figure 2. Information rate is expressed in terms of the analog bandwidth or the digital bit rate that can be carried by the system.* Since there is no one-for-one linear correspondence between bandwidth and bit rate, both are used in the assessment. Three basic distribution modes are identified: BROADCAST (point-to-multipoint), POINT-TO-POINT, and GATHERED (multipoint-to-point). Each service represents an intersection of the distribution mode (horizontal axis) and the bandwidth (vertical axis).

Real-time broadcast is the widespread transmission of a signal where the information rate is independent of the number of receivers. In store-and-forward distribution one receiving station at a time is accessed. Thus, the transmission time depends upon the number of receivers. If one

*Actually, in mathematical terms, the information rate capacity is expressed in terms of both bandwidth and signal-to-noise ratio. This level of sophistication is not necessary for this classification approach and is, in a sense, implicit in the system information rate capability.

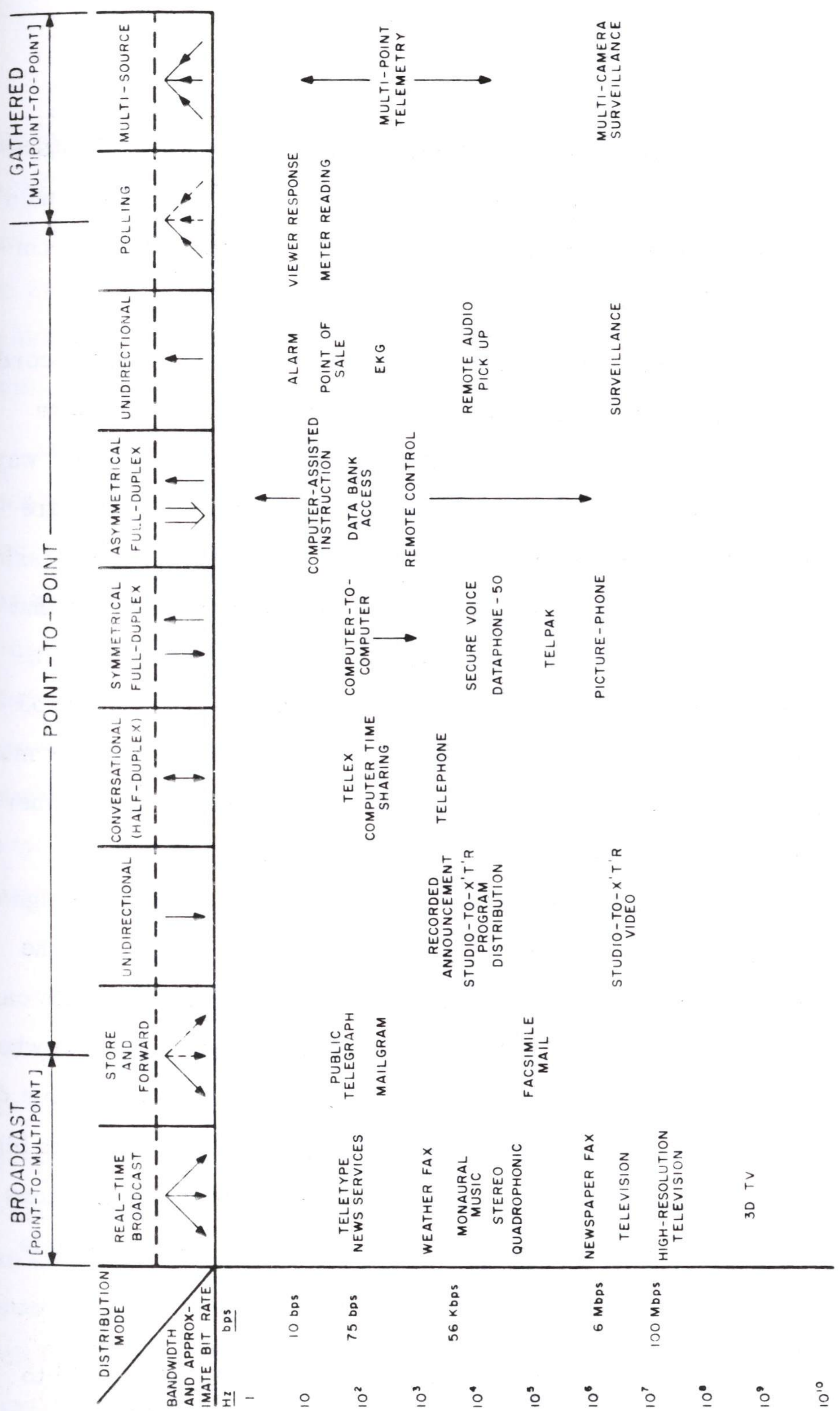

Figure 2. Telecommunications Services Classified According to Distribution Mode and Information Rate

station at a time receives the same message, it is a BROADCAST store-and-forward system. The store-and-forward processor can also send a unique message to a single station, in which case the distribution is considered to be POINT-TO-POINT.

The POINT-TO-POINT modes of distribution are classified according to the direction of information flow. Unidirectional is the case where information (with or without return control signals) always flows one way. Services which are conversational (simplex, half-duplex) in nature are those in which the two end stations generally share the same transmission medium (a radio frequency or pair of wires) and with the limitation that both stations do not transmit at the same time. An equal amount of information is expected to flow both ways.* Telephone service is a good example of this type. Full-duplex distribution is provided when information flows in both directions at once. Computers are generally tied together this way. Digital voice systems must be full duplex because, even if information is not being passed simultaneously, synchronization signals are. If an equal rate of information is expected to flow both ways, the circuits are symmetrical; if unequal rates are expected, the circuits can be asymmetrical. Asymmetrical services generally are of the type where manually generated alphanumeric symbols are sent from a station to a data base such as a computer complex. The data base then responds with high-speed data, audio, or video signals. Many remote-control applications are also included in this classification. For example, a space vehicle

*Sometimes a conversational line is used to provide control signals to activate a unidirectional service such as the dial-up of a recorded announcement or to poll a meter and activate its readout signal.

sends to earth large quantities of information and receives a few command signals. The unidirectional classification with the flow direction reversed is included for the sake of balance. It includes services where data flows from a sensor to a processor (e.g., a remote television camera) rather than the other way around (e.g., a video signal sent from a studio to a remote monitor).

The transition from POINT-TO-POINT to GATHERED service depends upon whether the information coming from a station is of a unique character (e.g., a teletype message) or is to be treated like information from the other stations (e.g., a vote is conducted). Polling systems, which are one type of GATHERED distribution, are like store-and-forward systems in that one circuit at a time is active. Another type of GATHERED service is one where all stations are assigned transmission capacity simultaneously, regardless of whether information is being generated or not. Services of this type would include pollution monitors, multi-sensor alarm systems and other real-time multi-source monitoring systems.

2.4 CONCLUSION

Telecommunications services are frequently examined in terms of their technical characteristics (i.e., bandwidth, noise level, distortion). This viewpoint is useful for system engineering and standards development. However, in order to compare the capabilities of different telecommunications systems to provide these services, a more manageable and simpler approach is to look at the way these signals are distributed and the rate at which the information is transmitted. In Section III, each system is described using this classification method and graphically illustrated according to the format of Figure 2. The present capabilities of the systems and their ability to expand into providing other services are assessed. For example, the illustration of the ability of CATV to evolve from a BROADCAST system to also providing GATHERED services and then POINT-TO-POINT is an example of the use of this viewpoint.

SECTION III

DISTRIBUTION SYSTEM CAPABILITIES AND FUTURE DEVELOPMENTS

3.1 GENERAL DESCRIPTION

This section of the report briefly describes the four local area telecommunication distribution systems (telephone and telegraph, CATV, broadcast stations, special carriers) and assesses their present and future capability to provide the various services. The general classification presentation developed in Section II is used to illustrate the system capabilities.

3.2 TELEPHONE AND TELEGRAPH CARRIERS

The telephone and telegraph common carriers constitute the major existing telecommunication system in the United States. The following paragraphs discuss the present configuration and future trends for this system and assess its capabilities.

3.2.1 System Description

The local distribution system of the telephone and telegraph plant basically consists of cabled pairs of copper wires. Until recently these wires were limited to teletype, voice bandwidth (3.4 kHz) and high-speed data rates (2.4 kbps). The cost of a typical system is presented in Appendix A. With the addition of special amplifiers and conditioning, a pair of wires will pass up to 1 MHz of bandwidth, which is sufficient for program audio, broadband data (0.5 - 6.0 Mbps), and videotelephone. Carriage of standard television requires the use of special video wire pairs, coaxial cable or microwave links and, when provided by the telephone company, is found on a limited basis, usually in support of television studios.

Figure 3 shows the present capabilities of this system to provide the various services. The existing capability is shown by the hatched area. Within this area are shown those categories of services where switching is provided; otherwise the service is available on a dedicated private line basis only. The dotted areas include services that can currently be supported on a dedicated basis by a proper configuration of the wire pairs. These presently untariffed services include all broadcast and unidirectional transmission to a limited number of subscribers, asymmetrical duplex services at bandwidths less than PICTUREPHONE and multi-source gathering services at bandwidths less than 1 MHz. Polling and store-and-forward services are

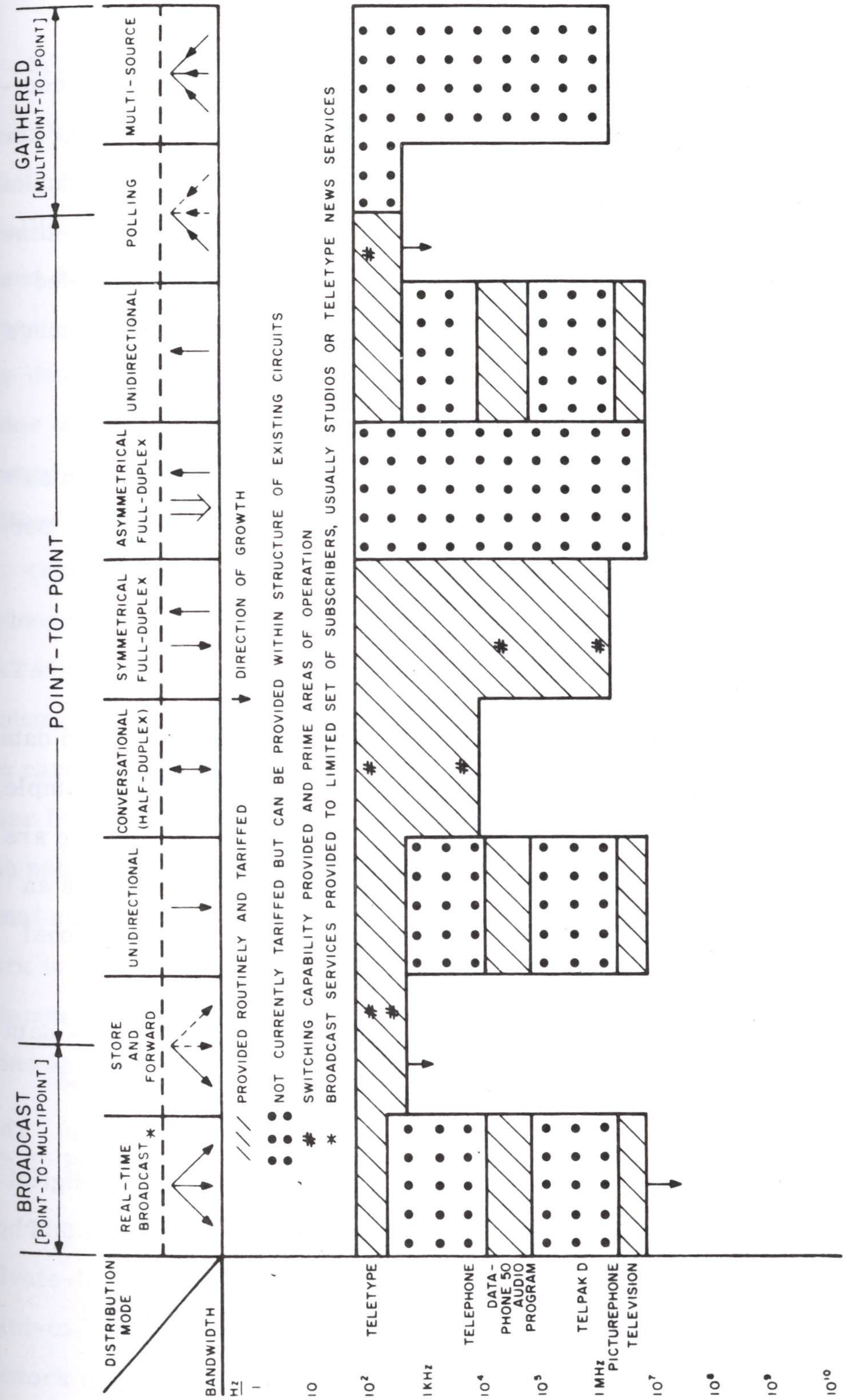

Figure 3. Telecommunications Services Provided by Telephone and Telegraph Carriers

limited to low data rates because of current processing speeds of the computers and switches and also because no demand for transferring other kinds of information in this way has developed. The wide-bandwidth, half-duplex services also reflect the absence of demand. Finally, unlimited real-time broadcast services, other than teletype news services, are not provided within their service areas by the telephone and telegraph carriers because of FCC regulations.

The Western Union Telegraph Company (Western Union) and the American Telephone and Telegraph Company and its affiliated companies (the Bell System) are representative of companies providing the above services. Their specific areas of activity are presented below.

3.2.1.1 Western Union

Western Union's prime areas of activity include all the low-speed data services represented by the horizontal top area of Figure 3. For example, the public telegraph network and the experimental MAILGRAM service are examples of store-and-forward data services. The TELEX system is an example of switched, conversational, low-speed service. Unidirectional and polled teletype configurations are also offered.

Western Union also provides high-speed and wideband full-duplex data services. They offer TELPAK C (48 kHz), TELPAK D (240 kHz), and conditioned voice bandwidth circuits (series 4000) for private line use. They have a switched broadband (48 kHz) exchange service and a new all-digital Time Division Network that carries data rates from low-speed up to 56 kbps.

3.2.1.2 The Bell System

The Bell System's prime services are provided by the telephone network, which is a switched, conversational voice bandwidth system. Besides intelligible speech signals, the network can also carry low-speed and high-speed data, as well as facsimile signals. The polling of utility meters is a recent experimental application of the network capabilities to provide a low-data-rate GATHERED service. The time to poll each terminal is on the order of seconds, because of the modulation method and the speed of the central office switch. The system would have to be modified to increase the polling rate.

Other switched networks include various special teletype offerings (but no longer TWX, which was sold to Western Union), the experimental DATAPHONE 50 service which is similar to Western Union's broadband exchange, and the PICTUREPHONE network. The PICTUREPHONE network can carry not only a 250-line, 30-frame-per-second video signal, but also other broadband signals that can be accommodated by the 1 MHz bandwidth. The network is composed of the full-duplex video circuit and the conversational audio circuit with TOUCHTONE signaling. One application of the network is to use the TOUCHTONE terminal to manually enter data into a computer, which responds with up to 400 characters displayed on the 5-inch video screen.

3.2.2 Future Developments

The Bell System recently announced its intention to offer an all-digital, private-line, data network to provide synchronous, symmetrical, full-duplex point-to-point transmission at 2.4, 4.8, 9.6 and 56 kbps. Eventually this network may also be expanded to provide switching and lower speed and higher speed features as well.

Many of the asymmetrical full-duplex services include the use of a manually keyed data entry device at the station location and a broadband return. The PICTUREPHONE network can be used for this application by providing symmetrical full-duplex broadband capability and a telephone line with a TOUCHTONE terminal. This is efficient for videotelephone service, but not necessarily efficient for the asymmetrical data service. What may be needed for the latter is a low-speed unidirectional line (driven perhaps by an ASCII keyboard) and a unidirectional broadband return.

The TOUCHTONE terminal is required to control the switch. Used as a data-entry terminal, the present TOUCHTONE set, although it is inexpensive, has the disadvantage of not providing all of the symbols needed. As will be shown in the next section, cable television systems may have an advantage in providing these asymmetrical services.

Two new technological developments that could significantly affect local distribution by telephone and telegraph companies are the use of broadband transmission media and digital technology. The broadband media provide an alternative to the present almost exclusive reliance on copper wire. Digital technology is generally used with these new media, and promises to lower costs as well.

3.2.2.1 Broadband Transmission Media

Two new broadband media that could be extensively used for local distribution are (1) highly directional microwave links operating in the frequency range above 10 GHz and (2) optical fibers. The former is in the prototype stage of development, while the latter is in the early experimental state. Optical fibers can carry enormous information rates, are independent of atmospheric effects, and their physical size is comparable to that of

present wire strands. Both types of links can carry signals with bandwidths much greater than 1 MHz and could thus carry many videotelephone signals.

3.2.2.2 Digital Technology

The use of digital technology in the telephone system is becoming more widespread, especially in the interexchange plant. Currently, T-type (digital) trunk equipment is approximately half the cost of N-type (analog) equipment. Technical as well as economic considerations will accelerate the use of digital technology. Long-haul PICTUREPHONE transmission will be digital. New short-haul interexchange trunking circuits use digital transmission. In addition, the new waveguide and optical media will use digital transmission.

It is not clear yet how rapidly digital transmission will be used in local distribution. It is expected that operation of the Bell System's and Western Union's new all-digital data transmission networks will accelerate the use of digital technology in the local distribution plant. Also, new digital station-carrier systems can provide up to 96 telephone circuits on two wire pairs. Station-carrier equipment multiplexes several telephone signals into one composite broadband signal for transmission over a set of lines which, before conditioning, normally carry just one telephone signal. This additional per-line capacity represents significant cost savings for subscriber loops over five miles in length, or where additional loops cannot be added at reasonable costs because of installation problems. The use of digital technology and station-carrier concepts offers two advantages. Digital station-carrier equipment is often attractive for upgrading the capacity of installed wire cable, and it is an inexpensive way to support rural subscribers, especially if they are highly clustered. Furthermore, the cost of such equipment is rapidly decreasing.

As digital technology becomes less costly, the present approach of providing all multiplexing and switching at the central office could become one of both centralized and distributed switching and multiplexing. This concept is already being implemented in rural telephone systems and, because of rapidly decreasing cost, is becoming attractive for urban use as well. This may offer a means of providing multiple home terminals that can be simultaneously in use without requiring either the installation of more telephone cables or the routing of all traffic through the same central office switch.

3.2.3 Summary

Telephone and telegraph systems can supply all POINT-TO-POINT and GATHERED services up to the bandwidth limitations of twisted wire pairs. The PICTUREPHONE signal is probably this upper limit. The small-gauge wire plant used for local distribution may eventually be supplemented by video wire cable, microwave, coaxial cable and optical fibers. The first three already are used to a limited extent to provide unidirectional video distribution. These new media would permit services with bandwidths of more than 1 MHz and could probably provide more efficient ways of providing services with smaller bandwidths.

3.3 COAXIAL CABLE TELEVISION (CATV)

When the "wired city" telecommunication services are discussed, the distribution system specified is usually the broadband CATV cable. This section of the report describes the present capability of CATV systems and how they can evolve from providing only BROADCAST signals to achieving the capability to provide GATHERED and POINT-TO-POINT services--perhaps to the extent of including all of those services now provided by the telephone and telegraph carriers. Some preliminary economic comparisons between the telephone system and the CATV system indicate the potential for this happening.

3.3.1 System Description

As shown in Figure 4, the cable television (CATV) companies presently provide BROADCAST distribution of FM radio and television signals. The local distribution system of CATV companies primarily uses coaxial cable with repeaters periodically spaced to compensate for transmission losses. One-way microwave links are sometimes used to replace main trunk sections of the cable. The CATV systems also provide their own remote studio-to-headend unidirectional transmission. (See Figure 4.)

The usual CATV distribution network is constructed like a "tree," with all of the signals from the headend being made available to each subscriber. This system can broadcast all kinds of narrowband and wideband information, including video signals with bandwidths greater than present commercial television. This is illustrated in Figure 4, which shows that CATV systems presently provide television and high fidelity audio signals and also have the capability to broadcast other kinds of signals as well. These signals could include higher resolution television, "facsimile newspapers," quadrophonic

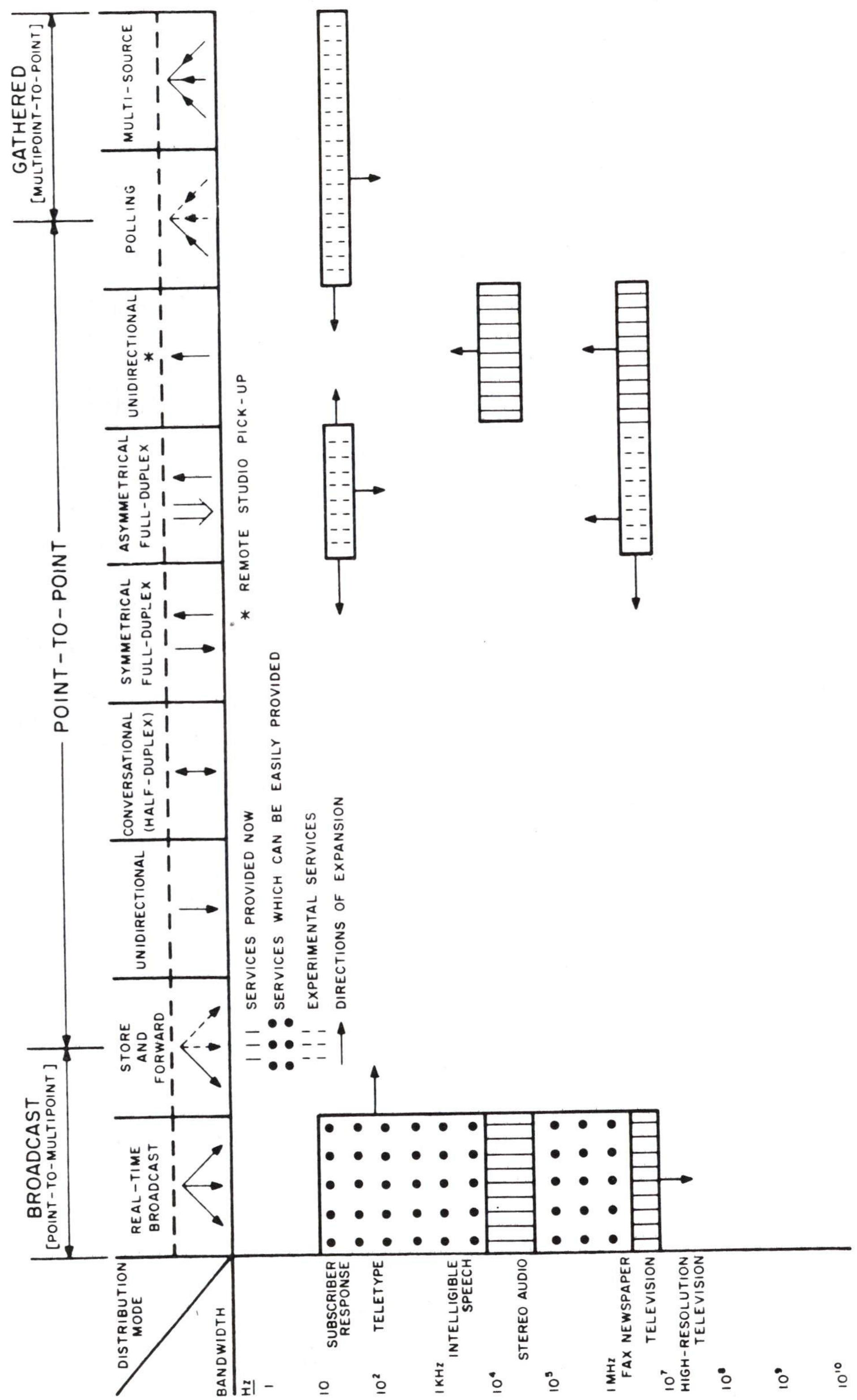

Figure 4. Telecommunications Services Provided by CATV Systems

music, and teletype news services. All that is needed is to make available in the broad bandwidth of the cable a channel sufficient to carry the service without degrading the other services and to provide a suitable terminal at the subscriber location. It is shown in the Appendix that these systems generally exhibit economies of scale in a sort of "step" function (see Figure 5), and that extra capacity can sometimes be achieved at low incremental cost. Thus a great number of television channels can be economically provided or the bandwidth can be used to carry other signals.

Not all CATV systems have the tree configuration where all signals are transmitted on a signal cable and made available to every subscriber. The DISCADE and Rediffusion systems have a "star" configuration. Each subscriber has a dedicated cable to a concentration of switching crosspoints. All the signals are available at the input to the switch, and the subscriber chooses which one to bring to his location. The DISCADE switches are scattered throughout the distribution area and fed by a trunk system. One-way coaxial cable runs between the switch and the individual subscriber. The Rediffusion system has the switch located at the headend, although there could be many switches distributed in the same way as in the DISCADE system. Rediffusion connects the switch and the subscriber with four 26-gauge wires--two carrying the selected video signal and the other two carrying the selection signal but with the potential to carry return video.

It should be noted that the cost of the "tree" configuration is more sensitive to the number of channels than is the case with either "star" configuration. For low-capacity systems, as is the case in the majority of present systems, "tree" configurations normally have significantly lower costs. However, as channel requirements increase, "star" configurations become more competitive. In general, "star" configurations should be

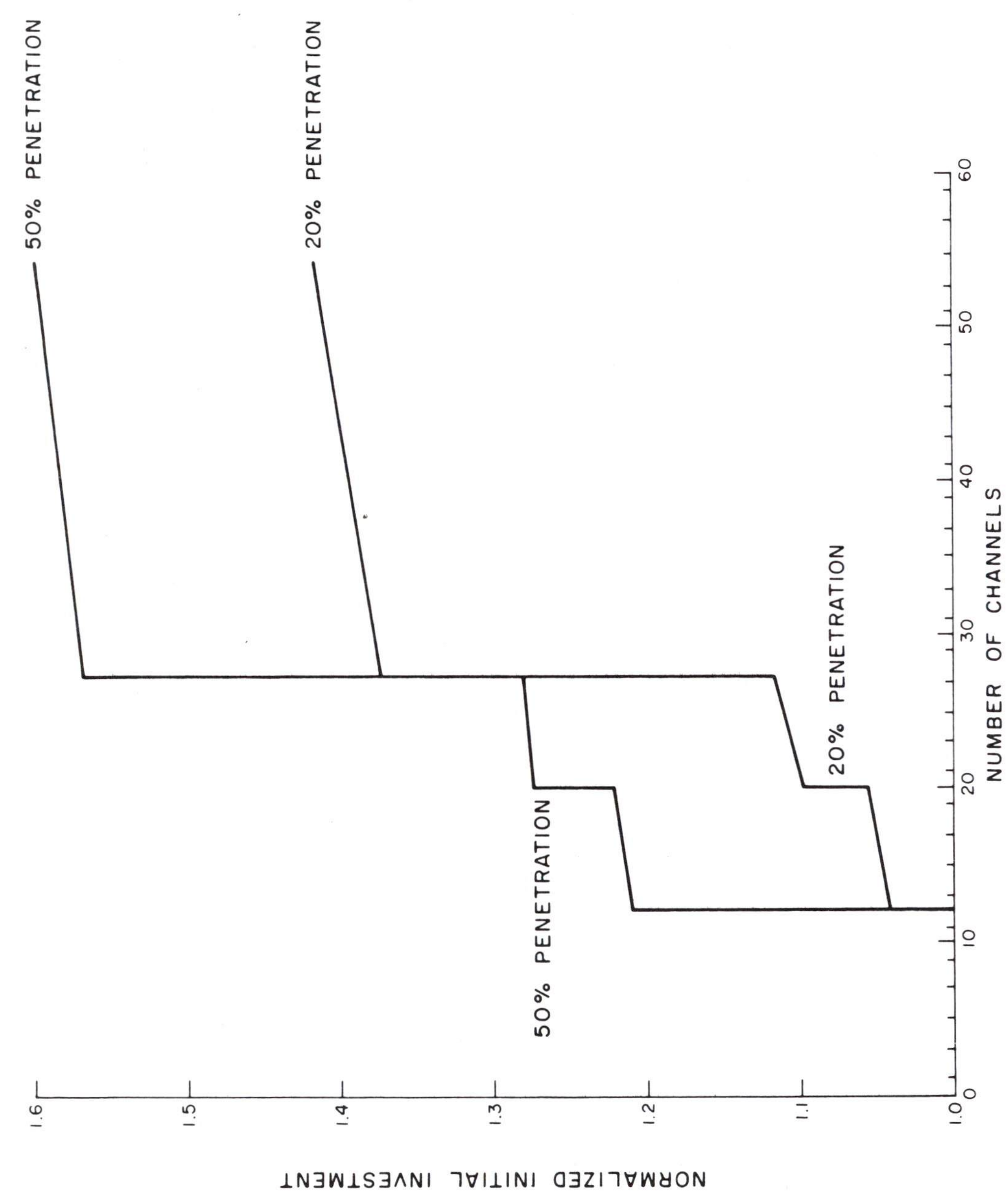

Figure 5. Normalized Cost of a Large Urban CATV System versus the Number of TV Channels

considered as another solution to the same problem of providing a given service. The selected configuration depends upon the local service area, cost at the time of construction, and the mix of signals to be transmitted. (See Appendix A.)

3.3.2 Future Developments

The subject of much of the speculation about the future of CATV or, more properly, broadband coaxial cable systems, is its potential capability to provide GATHERED and one-way and two-way POINT-TO-POINT services. As shown in Figure 4, a few experimental CATV systems are being constructed to demonstrate the feasibility of providing rapid, large-scale, low-data-rate GATHERED services. These services include alarm systems, viewer polling, monitoring of the channels to which subscribers are tuned, and taking of sales orders in response to a broadcast advertisement.

This kind of capability could be provided by installing two-way amplifiers in the "tree" configuration and by the use of economical subscriber terminals which successively transmit in an ordered sequence upon reception of an addressed command from the headend. A computer at the headend would provide system control and could also tabulate and summarize the results.

The broadband downstream and low-data-rate upstream capability of CATV systems makes possible the provision of POINT-TO-POINT asymmetrical duplex services. Such services include data bank access and computer-assisted instruction. Again, the use of CATV for such services is still in the experimental state, and the current configurations are rather inefficient for this purpose since the downstream signal is sent throughout the entire system. However, it could be feasible if the extra capacity is sufficiently economical or available at off-peak broadcast periods. Also, a more efficient configuration could be easily implemented using extra capacity only in the trunk. Then, at feeder junction points, signals could be picked off and routed to the subscribers attached to that feeder. Considering the step-like function in CATV costs (see the Appendix), an additional channel quite often can be supplied at very little expense. Another system for two-way transmission may be the "ring" or "loop" configuration where all transmission is one-way and signals are inserted and taken off as required. This configuration is analogous to the way network television is presently distributed around the nation.

Regardless of whether a "tree" or "star" or "ring" configuration is used, the key to providing GATHERED or POINT-TO-POINT services is how the signals are processed at junction points. For example, at each junction of a feeder with a trunk, upstream and downstream multiplexers and possibly even switches could be provided. Signals would be routed to make the most efficient use of the system capacity. In Section 3.2.2., which described current technological developments for the telephone and telegraph carriers, the trend to install station-carrier systems which make use of distributed multiplexing and switching was identified. Also, the rapid growth and decreasing cost of digital technology and its compatibility with distributed multiplexing and switching was discussed. Through exploitation of these technological trends, CATV systems have the potential not only to compete with the telephone and telegraph carriers in providing GATHERED services, but in providing all dedicated and switched POINT-TO-POINT services, as well. In the case of switched video many techniques are feasible to provide such a switching capability. However, the additional cost of such a capability must be acceptable in the light of the demand for and revenue from such a service.

3.3.3 Summary

The application of the technology (two-way amplifiers, digital techniques, distributed multiplexing) and system configurations which could enable CATV systems to provide services other than BROADCAST is still in the early experimental stages. The rate and extent to which CATV systems can economically provide these services depends upon the cost of this technology and regulatory policy. Some of these aspects have been explored in this section and are also explored in Section IV.

The new BROADCAST services such as facsimile newspapers could be easily provided on CATV systems. The first "upstream" services will probably be large-scale, low-data-rate GATHERED services such as viewer polling and the reading of meters and other low-bandwidth sensors. This will lead into POINT-TO-POINT asymmetrical services such as computer-assisted instruction and access to computer data bases. Finally, symmetrical full-duplex and half-duplex services such as computer-to-computer data transmission, videotelephone, and conversational services may also be provided if current trends in multiplexing technology continue.

3.4 OVER-THE-AIR BROADCASTING

The over-the-air broadcasters are operators of stations that radiate AM and FM audio and VHF and UHF video signals. Their present capabilities and future potential are discussed in the following paragraphs.

3.4.1 System Description

The capabilities of radio broadcasting systems are constrained primarily by the necessity to regulate the use of the limited resource of the frequency spectrum. Thus, as shown in Figure 6, the present radio systems are limited to providing BROADCAST services that can be accommodated in the bandwidths allowed by the FCC.* For example, FM broadcasters can provide not only monaural and stereo music but quadrophonic music and narrowband facsimile. They could also broadcast low-speed and high-speed data signals. Under present FCC standards for facsimile newspaper service the FM broadcasters probably cannot provide facsimile newspaper service. However, if the total bandwidth (75-kHz base bandwidth) were used, a small newspaper could be transmitted.

Compared to the 75-kHz base bandwidth of the FM broadcasters, television broadcasters have a 4.5-MHz base bandwidth. When they are not transmitting television signals, television stations could send other kinds of broadcast services, including facsimile newspapers and magazines.

The broadcasters are also granted allocations in the frequency spectrum for POINT-TO-POINT services which relate to broadcast operations. These

* POINT-TO-POINT communications provided by radio systems fall under the realm of FIXED and MOBILE radio services, which compete with the broadcasters for room in the frequency spectrum.

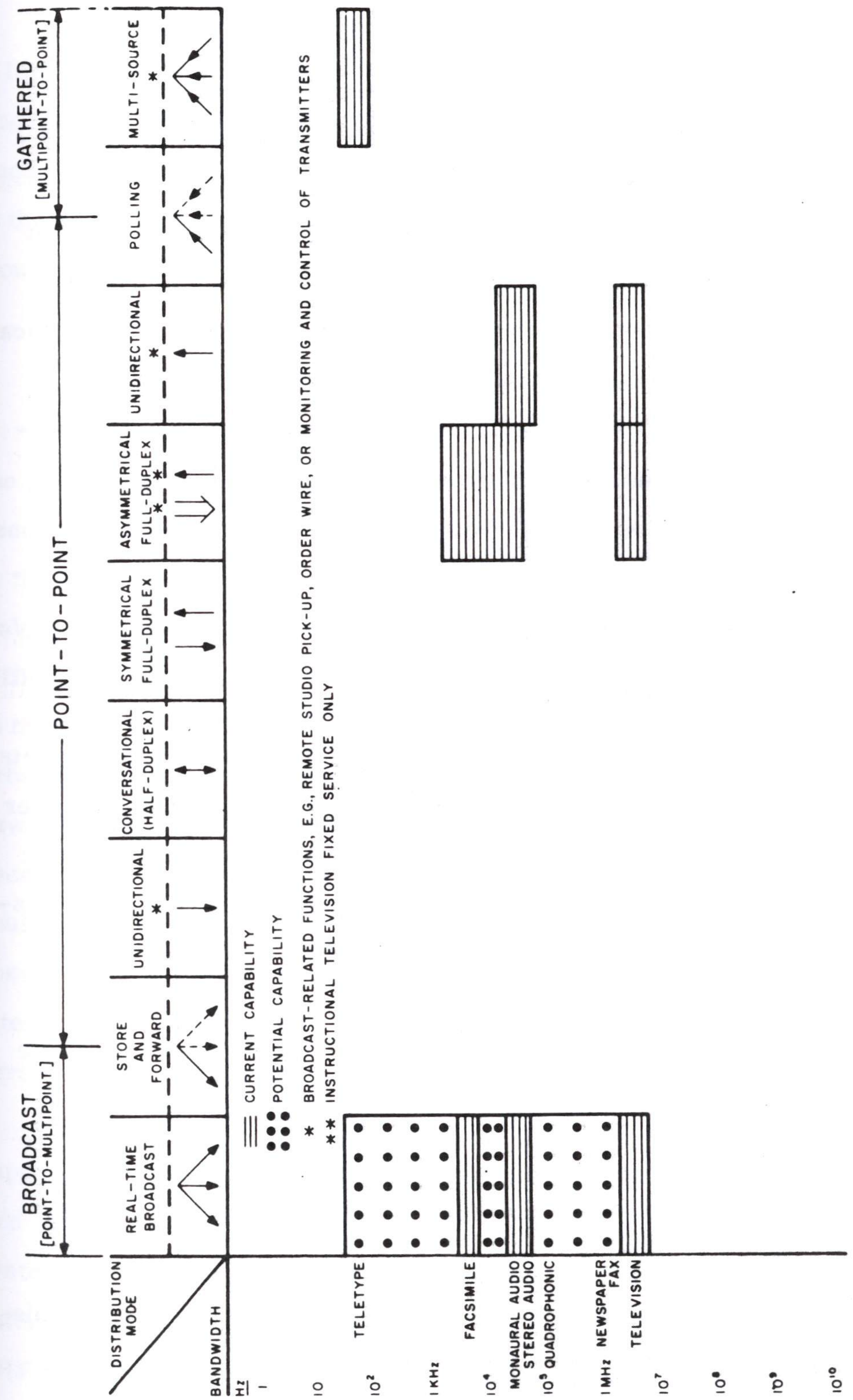

Figure 6. Services Provided By Over-The-Air Broadcast Systems

services include remote pickup of broadcast signals, studio-to-transmitter links, monitoring of transmitter status, and order wire communications for two-way coordination between the studio and transmitter.

A service that employs a distribution system with more flexibility (but uncommonly found and with limited range) is the Instructional Television Fixed Service (ITFS). The system provides both broadcast and asymmetrical two-way transmission. The studio broadcasts up to four video channels to selected nearby classrooms with the classrooms having the option of directional radio links back to the studio to carry voice and high-speed data signals.

3.4.2 Future Developments

3.4.2.1 High-Resolution Television

Television signals with higher resolution due to more lines and elements per frame would present a better picture on today's large screens. Whether such a new signal and resulting new standard is required would probably be the subject of FCC hearings. However, if such signals are ever to be transmitted over the air, the broadcasters will require that more bandwidth be made available. This would require substantial changes in the Table of Channel Assignments. Because of the highly structured nature of the Table and the limited availability of unassigned frequencies, such changes would probably be difficult to effect.

3.4.2.2 Viewer Participation

Other new programming that could be offered would involve large-scale viewer participation such as preference polling or advertising responses. Presently, the over-the-air broadcasters use the telephone system to obtain

a limited degree of communication with the viewers. The difficulty of finding room in the frequency spectrum and the expense of using radio systems for such a capability would preclude an approach using over-the-air propagation. If the radio broadcasting system wished to obtain such a capability, they would have to rely on the CATV systems or an augmented telephone system.

3.4.2.3 Satellite Broadcasting

The difficulty of changing the Table of Channel Allocations also limits the possibility of broadcasting from satellites directly to the home. This was recognized by the FCC in the Report and Order (Docket No. 18294) relating to the U.S. position at the World Administrative Radio Conference for Space Telecommunications in June of this year. For the United States, it would be difficult to provide an exclusive frequency allocation for space broadcasting in the 88-108 MHz FM band and 614-890 MHz UHF television band. Also, in urban areas man-made noise is at a high level. Shared frequencies would have zones where neither the space signal nor the terrestrial signal could be received. There may be some areas, however, where direct broadcasting could be usefully applied. The United States, therefore, proposes that possible systems can be accommodated by footnote modifications in the International Table, permitting space broadcasting in these bands subject to agreement among the administrations concerned.

Direct space broadcasting also would compete with indirect systems in supporting fixed users. Several indirect systems are now under consideration (FCC Docket 16495 concerning Domestic Satellites). These indirect systems have highly directional, ground-based, community receive-only antennas which pick up the satellite-relayed signals for distribution by local UHF or VHF broadcast systems or by cable systems. These satellite systems are economical even for small isolated communities of between 500 to 1000 population (such as might be found in Alaska), and are also compatible with the policy of local control of program content and local origination of programming. In some circumstances (e.g., Alaska), the satellites and small earth stations will also be useful in providing two-way POINT-TO-POINT services.

3.4.3 Summary

Over-the-air FM radio and UHF and VHF television stations can provide a variety of BROADCAST services that are compatible with their assignments in the frequency spectrum. Broadcast signals with wider bandwidths such as would provide a higher resolution television picture are currently excluded. Also, programming that entails large-scale viewer or listener participation will require the cooperation of the CATV or telephone systems. In the near future, satellite systems will most likely continue to operate only in an indirect way to distribute broadcast programming to the local systems and carry two-way POINT-TO-POINT communications.

3.5 THE SPECIAL CARRIERS

The special carriers are primarily those recently licensed under FCC Docket 18920. In addition, special carriers include those applicants for a domestic satellite system (Docket 16495) who are not established, general-purpose, common carriers within the contiguous 48 states (i.e., Western Tele-Communications, Inc., RCA, MCI Lockheed) and who wish to provide a variety of telecommunication services incorporating satellite technology.

3.5.1 System Description

As shown in Figure 7, these carriers would primarily supply leased POINT-TO-POINT services and, in the case of RCA and DATRAN, switched full-duplex data transmission services. Applications have not yet been made to provide store-and-forward and polling services, although this capability could easily be provided using full-duplex circuits.

DATRAN has described their proposed local distribution system in more detail than have most of the other special carriers. The proposed DATRAN local distribution network uses distributed multiplexing to make optimum use of the various possible links. One switch will serve each local area and connect subscribers into the long-haul transmission system. The degree to which DATRAN will be compatible with other switched all-digital systems and will be able to interconnect with these other systems is not yet known.

3.5.2 Future Developments

For local distribution, these prospective carriers will interconnect with any local telephone-telegraph carrier or cable system. They also

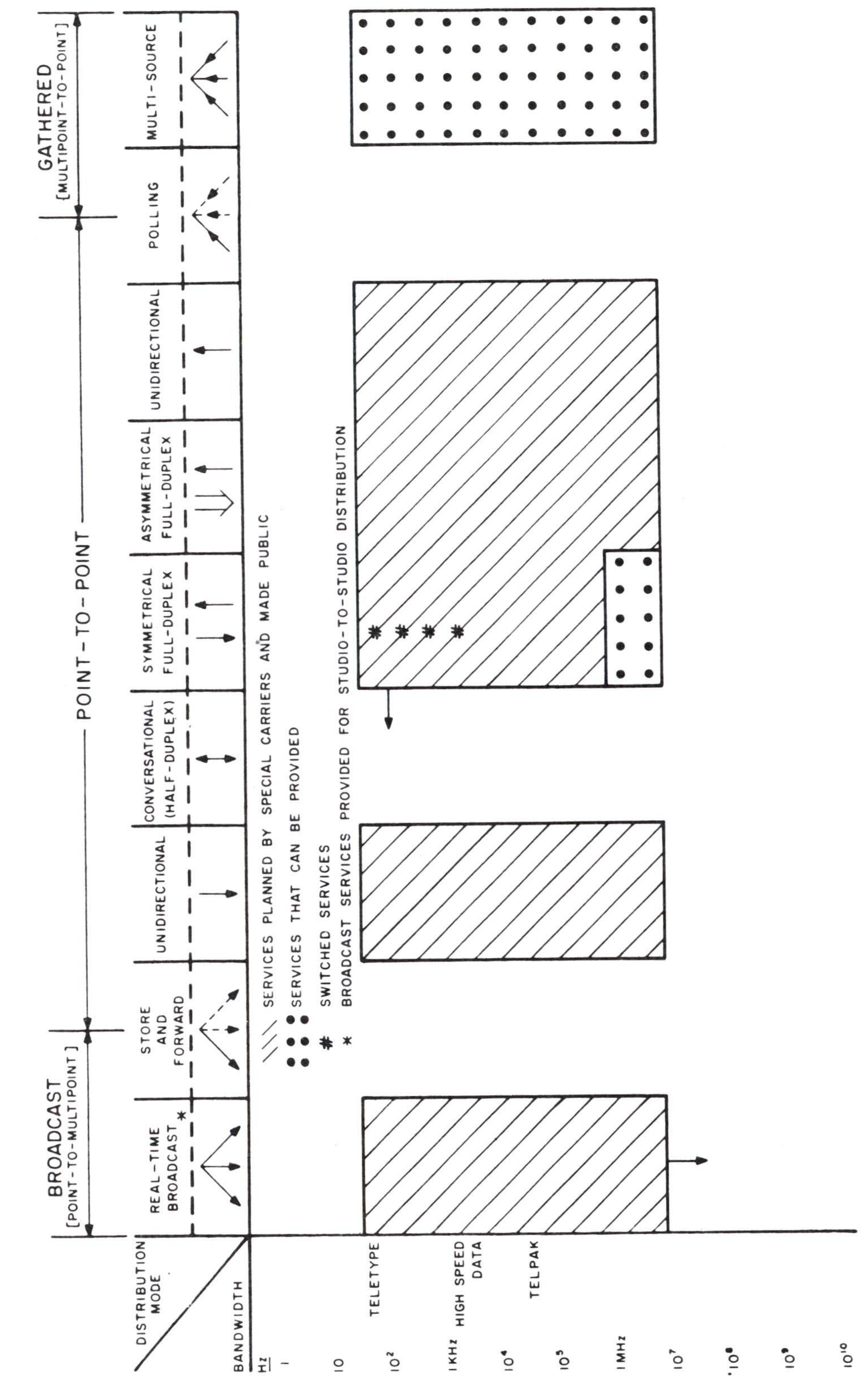

Figure 7. Telecommunications Services Provided By the Special Carriers, Including Special Satellite Systems

intend to use microwave, millimeter wave, and optical links. The performance of these links is limited, owing to atmospheric effects and interference and safety considerations. All of these transmission media offer viable alternatives, and the proper mix depends upon local geography and climate, customer distributions, and cost. Each local situation will be different.

Where these new carriers are not able to install their own wire-pair cables, or are not provided adequate service from other local carriers, the special carriers might not be able to meet their reliability specifications in all local areas by depending upon line-of-sight radio and optical links. This is because these links can be overcome by local weather conditions. In addition, links of this type may not always be economically attractive. However, if cable television companies were present in the area, they could provide an additional means for local distribution. This potential relationship between the special carriers and CATV systems is explored in Section IV.

3.5.3 Summary

It is too early in the operational cycle of the specialized carriers to determine their trends of expansion. Initially, they are expected to provide dedicated POINT-TO-POINT services with some switching capability in the low- and high-speed data area. After they establish their intercity capability, the next growth phase will probably be to lessen their dependence on the local telephone company. This will involve the construction of their own complete local distribution system consisting of wire, microwave, optical links, and the use of CATV facilities.

3.6 REVIEW OF SYSTEM CAPABILITIES

The established telecommunications systems provide services that generally do not overlap. The over-the-air radio and television stations broadcast high-quality audio and standard television signals. The telephone and telegraph carriers provide most one-way and two-way symmetrical POINT-TO-POINT services up to the capabilities of their present wire plant. This plant is expanding to incorporate the higher bandwidths of private line data and videotelephone. The new systems, CATV and the special carriers, have generally overlapped these service areas. CATV companies carry the same BROADCAST signals as the over-the-air stations. The special carriers are expected to provide POINT-TO-POINT services, although generally on a leased rather than a switched basis. DATRAN and RCA (through its pending domestic satellite application) are exceptions and expect to provide switched full-duplex data service up to 64 kbps.

The future potential areas of conflict between these systems will involve new services (high-resolution television, computer-assisted instruction, viewer polling, sensor monitoring) and expansion of present services into new market areas, particularly the residence (data base access, videotelephone, teletype). It is difficult to forecast when and how these issues will arise until the specific situation occurs. However, in view of the general trends of each of the systems discussed in this section, some potential issues can be predicted. The next section of the report compares the systems, one against another, to identify possible future policy issues.

SECTION IV

INTER-SYSTEM RELATIONSHIPS AND POTENTIAL ISSUES

4.1 OVERVIEW

The previous sections in this report described the ability, at least technically, of individual telecommunications systems to provide various telecommunications services. In order for the systems, jointly, to provide a given service efficiently, there must be agreement on technical standards. This topic is discussed in Section 4.2. In addition, by comparing the four systems discussed in Section III, other potential cooperative and competitive relationships emerge.

In developing the system interrelationship, the systems are treated in pairs: for example, the relationship between the special carriers and the telephone and telegraph carriers is examined. It seems apparent, however, that many of the significant issues probably will have to do with the rapidly evolving capabilities of broadband coaxial cable (CATV) systems. This emphasis is a result of the transmission capability of broadband coaxial cable to carry BROADCAST, POINT-TO-POINT, and GATHERED services over an entire range of bandwidths, unrestricted by the frequency spectrum limitations and subsequent government regulation inherent in methods which employ transmission through the earth's atmosphere. Thus, even though the study examines the local distribution of commercial telecommunications from a broad viewpoint, it is found that widespread use of broadband shielded media for local distribution — now almost exclusively provided by CATV systems — will have a major impact upon near- and intermediate-term policy issues.

Those areas where competition among the systems is expected to occur can be identified from an inspection of Figures 3, 4, 6 and 7. The four systems can be expected to interact in those areas where more than one system has the ability, or the potential ability, to provide a particular service. Selected areas where competition is indicated are shown in Figure 8. They include:

(1) provision of higher resolution television, interactive television (i.e., viewer response) and national network programming. The systems capable of providing these services are the broadband coaxial cable (CATV) systems and over-the-air broadcast systems. In order to make viewer responses available to the over-the-air broadcasters, it may be necessary for them to rely on the telephone and telegraph carriers.

(2) provision of low-data-rate GATHERED services and asymmetrical and symmetrical POINT-TO-POINT services. Technically both the telephone and telegraph carriers and the broadband coaxial cable (CATV) systems could provide these services. Also, these services may involve the use of computers owned by the telecommunications system operators.

(3) provision of POINT-TO-POINT services. These can be supplied by both the telephone and telegraph carriers and the special carriers. The special carriers are expected to rely initially on the former for their local distribution facilities; however, if CATV systems

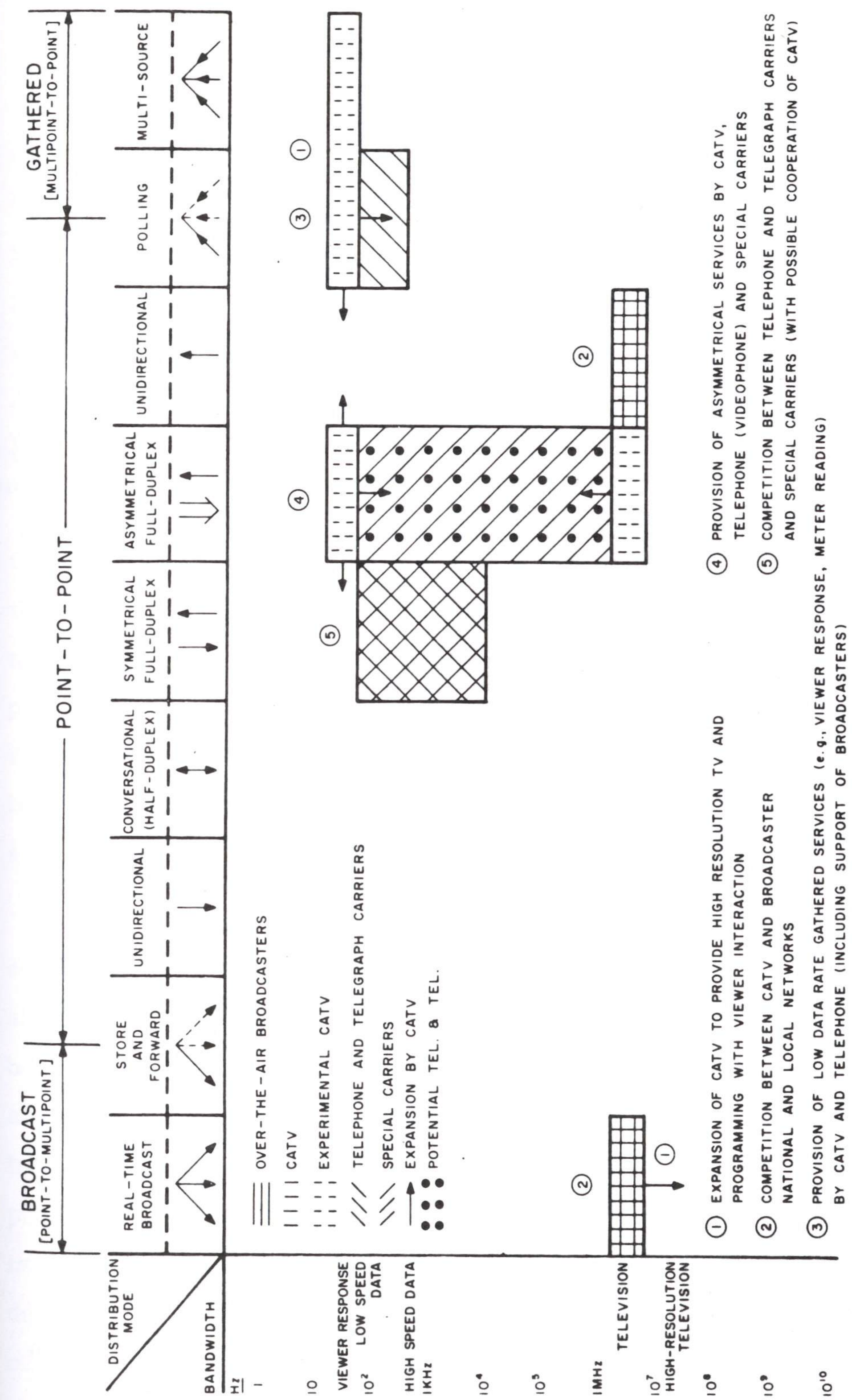

Figure 8. Selected Inter-System Relationships

are available and current technology trends continue, the special carriers may choose to rely on them since the latter systems may not be competitors. Also, there is a "match" between the long-haul capability of the special carriers and the local nature of coaxial cable (CATV) facilities.

To the extent that "interactions" develop in these areas, it probably will be necessary for the government to address certain policy and regulatory issues. Specific potential issues are included in the discussion of the system interrelationships presented in the following Sections 4.2 through 4.7.

4.2 TECHNICAL STANDARDS FOR INTER-SYSTEM COMPATIBILITY

When all of the systems are viewed together, it becomes apparent that, under many circumstances, they will need to interconnect with one another. This will be possible only if suitable technical standards are developed.

Technical standards are needed not only to allow various telecommunications systems to interconnect with one another but, as well, to achieve economies of scale in manufacturing, to promote widespread use of a product or service, and to specify a level of performance for the product or service. Generally speaking, a standard is most useful if it is formulated during the early development phases of a technology, if it is evaluated on a forward-looking and comprehensive basis so that many alternatives and system configurations are analyzed, and if all affected organizations participate and coordinate with one another in their adoption and use.

In the United States the standards formulation process for commercial telecommunications systems is primarily one of voluntary participation by, and negotiation among, those industries that are active in various independent standards groups. These groups are sponsored by such organizations as the American National Standards Institute (ANSI), the Business Equipment Manufacturers' Association (BEMA), the Electronics Industries Association (EIA), and the Institute of Electrical and Electronics Engineers (IEEE).

In addition to voluntary organizations, the Federal Communications Commission has a responsibility in standards establishment. For example, the Commission has been involved in the formulation of standards for color television, and it is currently involved in the grade of service for signals provided by CATV systems (Docket No. 18894) and the direct interconnection of customer-owned equipment with the telephone network. Also, it is becoming more involved in standards for the use of microwave in urban areas by both the present carriers and the new specialized carriers.

This report has identified the special carriers and CATV systems as new entrants into general telecommunications service markets. They should be participants in the standards-generation process, since they will be establishing a position of compatibility or incompatibility with existing standards. The less they participate, the more likely it is that they will be incompatible with other systems. For example, the special carriers could participate in the activities of such groups as ANSI Section X.3.3, which is concerned with data communications standards. As CATV systems develop their own concepts, using digital technology, they could also participate in organizations such as ANSI, in addition to formulating standards just for use within their own industry.

In order that future telecommunications services may become widely available, universally accepted standards are needed in the rapidly developing technologies of low-speed data entry devices, all aspects of digital telecommunications systems, facsimile, higher resolution television, and electronic video recording. In some of these areas, such as electronic video recording, it is difficult to determine which of many alternative systems will dominate the market. In other areas, such as facsimile, it may be possible to arrive at a high level of standardization. The standards-formulation process of the voluntary organizations may or may not keep pace. If they fail to provide timely acceptable standards, it may be necessary for the government to become more intensively involved in the formulation and coordination process.

4.3 THE OVER-THE-AIR BROADCASTERS AND CATV SYSTEMS

The present competitive relationships between the over-the-air broadcasters and CATV systems are being considered by the FCC under Dockets 18397, 18397-A, and 18894. These issues include the effects of CATV systems on the viability of UHF stations, importation of distant radio and television signals, copyright liability, common carrier aspects of CATV, and Federal versus state and local regulation of CATV. This section will not deal with these current considerations, but instead, explores their relationship with regard to new broadcast services and studio-to-studio distribution.

4.3.1 New Broadcast Services

When one compares Figures 4 and 6, it becomes apparent that CATV systems can offer two kinds of BROADCAST-related services that the over-the-air broadcasters presently cannot: rapid, large-scale gathering of viewer responses, and higher resolution video. Depending upon regulatory decisions and technological development, CATV systems could achieve a competitive advantage in these areas with respect to the broadcasters.

The first service, rapid large-scale viewer responses, is expected to make certain kinds of programming more appealing to the audience by giving them the opportunity to participate in the activity at the studio. It also would enable the programmer to nearly instantaneously evaluate his audience and to receive information from them. For instance, one can obtain voting information and customer orders on a real-time basis from numbers of people. If the competitive relationship of the over-the-air broadcasters is to be maintained, it may be necessary that the CATV system be required to provide the viewer-response service to them also.

Higher resolution television, the second service, would be useful in providing a better quality picture on larger screens. This could be attractive to audiences in a single large room and also to the home viewer. Detailed print and graphic information may also be presented. Assuming that there is significant demand for such a service, decisions would have to be made in the areas of signal structure compatibility and standardization, and revisions made to the Table of Frequency Allocations.

4.3.2 Studio-to-Studio Program Distribution

The establishment of a national program distribution network for CATV systems has been proposed that will compete with existing networks. As a result, regulatory agencies are currently considering whether or not to permit and foster the development of such a network.

Currently, many of the applicants for the domestic satellite systems intend to offer program distribution services to both over-the-air broadcasters and CATV systems. (Only the Hughes Aircraft Company proposes to serve CATV systems alone). If both the CATV operator and the broadcaster access their network programming through the same earth station, it could encourage closer ties between CATV systems and the three present national television networks, since the signals would be easily accessible by both parties. Also, if the same satellite and earth stations carried programming for both, it might make the cost and risk of network programming for CATV systems much lower than if the CATV systems had to develop their own network of satellites and/or earth stations. This could enhance the feasibility of national program distribution for CATV systems.

4.4 THE BROADCASTERS AND TELEPHONE AND TELEGRAPH CARRIERS

Over-the-air broadcasters might avoid relying on a CATV system for viewer response data by using, instead, augmented facilities of local telephone companies. The telephone companies presently provide unidirectional program transmission for the broadcasters. They also provide telephone service to make possible audience participation in talk shows, contests, and money-raising auctions and appeals. If requested, a telephone company could also provide a rapid, large-scale, viewer-response

polling system similar to that of the CATV company. The service could be provided by polling a group of subscribers over a single, specially configured, wideband circuit, or by augmenting the present telephone system wires and central offices. Such a capability would limit the ability of CATV systems to obtain a monopoly in providing this service.

4.5 THE TELEPHONE AND TELEGRAPH CARRIERS AND CATV SYSTEMS

The following paragraphs examine the relationship of CATV systems to the telephone and telegraph carriers. The present cooperative relationship between them, and the economic advantages of integrating some of the aspects of CATV and telephone company operations — specifically, joint construction of facilities and reaching rural areas with broadband services — are discussed in Section 4.5.1. Possible areas of competition between the two are examined in Section 4.5.2.

4.5.1 Cooperative Relationships

Since telephone companies are prohibited from operating CATV systems in their service area, the primary interaction between telephone and CATV systems currently involves the sharing of pole and duct space, or the leasing of a telephone company-constructed CATV system to an operator. This requires a cooperative relationship since the parties must reach an agreement in order to provide the CATV service.

If it were possible to integrate, and simultaneously to construct, both the CATV and telephone and telegraph systems, significant cost savings could result. For example, the labor cost alone for installation of aerial CATV or telephone cable is over $200 per mile. With the simultaneous installation of separate systems — in new towns or developments, for example — nearly the entire labor cost for installing one separate system can be saved. Actual electrical integration of the systems could provide savings substantially greater than installation labor alone. Thus, as telephone plant is upgraded (e.g., goes underground or is replaced), it may be advantageous from a cost viewpoint for both systems to be integrated as much as possible. Also, as discussed below, it may be necessary for the CATV and telephone and telegraph carriers to use an integrated system in order to economically provide broadband BROADCAST and POINT-TO-POINT services to rural areas with low population densities.

There are a variety of ways to bring broadband BROADCAST services to the rural subscriber. These include satellite-based radio and terrestrial radio and cable systems. For many rural locations where subscriber densities are very low but where telephone service is now provided, a cable system that provides both BROADCAST and POINT-TO-POINT services may be the preferable alternative. A cable system can economically provide many more channels of video than is available by radio and can offer economies due to integration with the telephone plant.

The distribution system could be a hybrid version of the DISCADE or Rediffusion CATV system and telephone station carrier. Each subscriber would be provided with an incoming video channel and several narrowband channels all transmitted over a coaxial cable. In the reverse direction, using a wire pair, he could transmit several outgoing narrowband channels including a telephone signal, a teletype signal, a polling signal, and a signal to select the video channel to be received from the headend or central office. Several subscribers could have their signals multiplexed on a single cable, similar to the present telephone station

carrier configuration, or just one subscriber could be served. The basic difference in transmission line configuration would be the total bandwidth transmitted and the spacing of amplifiers. The results of a preliminary cost study (which is described in the Appendix) indicate that such a joint system should be feasible in many areas, and distribution costs would be less than twice that of the current telephone distribution system although much more than the cost of a typical suburban 12-channel CATV system.

To provide such a system to bring broadband BROADCAST and POINT-TO-POINT services to rural subscribers, CATV companies and the carriers, again, would have to cooperate. Presently, the FCC requires the telephone companies to cooperate with CATV companies in the use of pole and duct facilities. However, the FCC also prohibits telephone companies from operating a CATV system, although they may build and maintain it. Another constraint to this cooperation and integration is the section of the Rural Electrification Act that prohibits REA borrowers from using the borrowed funds to provide CATV service. If the integrated system proves to be a technically and economically desirable way of providing these services, and if such services are required, the above regulations may have to be modified.

4.5.2 Competitive Relationships

If CATV systems provide GATHERED and POINT-TO-POINT services, the relationship between CATV and the telephone and telegraph systems will become competitive. In the following paragraphs the extent to which this competition could develop is discussed.

The first competitive service will probably be the provision of low-data-rate polling and multi-source GATHERED services. These services include meter reading, burglary and fire alarms, and data entry services such as point-of-sale recording. It could also include viewer responses to broadcast programming. A few of these services are now being provided by the telephone company on either a regular or an experimental basis. The low-data-rate "upstream" transmission capability of CATV systems will also be able to provide them.

Competition in providing POINT-TO-POINT services could occur in the area of asymmetric full-duplex services. The low-data-rate polling and gathering terminal of the CATV system could be used to access a central data base that contains news items, price quotations, and a variety of alphanumeric or pictorial information. The data base would transmit the desired information so that only the proper subscriber receives it. However, the PICTUREPHONE network can also provide this capability. It may occur that the CATV system will primarily serve residential subscribers with the PICTUREPHONE system primarily serving commercial subscribers, so that the two will not usually compete, but this does not seem likely.

CATV companies, in providing low-data-rate subscriber services for voting and polling, ordering of merchandise, audience participation, data-base access, and monitoring of alarms, meters and other sensors, will have to use a computer to control the data collection system and, possibly, to summarize and analyze the data. The processing capability could be made available not only to customers who interact with the system through the headend (i.e., advertisers, utilities, etc.) but also to system subscribers. The FCC recently completed an inquiry into regulatory and policy questions raised by the growing interdependence of computers and telephone and telegraph communications systems (Docket No. 16969). It ruled that regulated common carriers with operating

revenues of $1 million or greater must operate their data processing affiliates separately from the parent company. In view of current trends in CATV system development it may occur that the FCC will have to re-examine its policy concerning the integration of computers and communications as it regards CATV systems.

As the cost of multiplexing equipment decreases, it may become economical to use a broadband coaxial distribution system subdivided into large numbers of efficiently routed narrowband channels to provide all POINT-TO-POINT services. This could provide an alternative to the telephone company for the installation or modification of the present cabled wire pairs. The CATV systems, with coaxial cable already installed, could also provide these POINT-TO-POINT services.

In order to determine the feasibility of this, a cost comparison of CATV and telephone distribution systems was undertaken to serve as the basis for analyzing possible areas of competition between the two systems. (For cost analysis, see Appendix). A 12-channel CATV network was configured for a small residential community. The cost of this network was compared with estimated telephone subscriber loop costs for the same community. The cost of both systems was estimated based on 100 percent penetration. The CATV system was estimated to cost approximately $100 per subscriber, exclusive of headend equipment. The telephone loops were estimated at approximately $300 per subscriber.

This initial work provides a base for the development of quantitative information that can demonstrate more conclusively the possible competitive relationships of these two types of distribution systems. Both present and future technology could be incorporated into this kind of model. One conclusion can be drawn, however. Under the 100 percent penetration assumption, a 12-channel CATV system in a suburban area has an investment in distribution facilities of about $100 per subscriber. A telephone system in the same area has an investment in loops of approximately $300 per subscriber. If station-carrier and multiplexing equipment can be obtained at a cost less than $100 per subscriber, and, in the case of switched services, switching costs can be made acceptable relative to demand and revenue, then it is likely that a two-way cable system could be installed at an overall cost comparable to that of the multi-pair telephone plant. This station carrier multiplexing cost is not unlikely in view of current trends. Thus, from a technological viewpoint, CATV systems may ultimately achieve the capability to provide most — and possibly all — of the services that the established telephone and telegraph carriers provide now and could provide in the future.

4.6 THE TELEPHONE AND TELEGRAPH CARRIERS AND THE SPECIAL CARRIERS

The special carriers intend to build long-haul transmission facilities to connect district offices in the major metropolitan areas. Subscribers would be connected to these district offices via a local distribution network which will, at least initially, be leased from the local telephone company. The special carriers also could install their own distribution nets. For example, they could share pole space and ducts with the telephone and telegraph carriers and could construct their own multi-pair wire facilities. Also, if a group of subscribers is densely clustered, and weather conditions are suitable, they might install a broadband line-of-sight microwave or optical link.

Thus, even though the special carriers would compete with the established carriers for long-haul commercial customers, they would probably have to have the cooperation of the local telephone company in order to establish the end-to-end connection. Eventually, they may install their own facilities or, as discussed in the next section, they may choose to rely on local CATV companies to provide this function.

4.7 THE SPECIAL CARRIERS AND CATV SYSTEMS

If CATV systems are able to expand into the cities, either because of favorable government policy decisions and/or because of a large demand for new services, it is quite possible that a cooperative relationship between the special carriers and CATV could develop and accelerate the rate at which CATV systems provide two-way, POINT-TO-POINT services.

If CATV expands into these markets, and if multiplexing equipment becomes sufficiently low in cost, then a cooperative relationship between the special carriers and the CATV systems could develop, with the CATV systems providing the local distribution network needed by the special carriers. In turn, the special carriers could provide long-haul transmission of programs and other information for the CATV companies. Special carriers could also make available their local network of broadband microwave and optical links as an alternate medium for the CATV trunk lines. This could be accomplished in the same way that the 12.7 to 12.95 GHz band is used for this purpose, except that the links could be two-way instead of one-way.

APPENDIX A
COST ANALYSIS

A.1 INTRODUCTION

A.1.1 Scope

Service areas where telecommunication systems overlap and possible competition results were identified in the body of the report. Selected policy issues which result from the competition were then discussed. The cost aspects of several policy issues are addressed in this appendix.

The major portion of the cost information was generated to aid in the comparison of the CATV and telephone systems because they could, in the future, provide overlapping telecommunication services. Additional cost data on the application of new technologies by specific systems is included. Back-up data for cost information contained in the text of the report is also provided.

A.1.2 Background

CATV costs are of primary concern because the technology employed in this type of distribution system is still developing and therefore can be significantly affected by policy decisions. A large number of different CATV distribution systems are being configured to provide a variety of telecommunications services. Service can range from conventional broadcast distribution of 12-channel television capacity to the high-capacity, two-way systems envisioned in "wired city" proposals. The costs for providing the different degrees of service vary significantly. However, the basic cost factors of CATV systems are understood, and estimates of system costs can be made with reasonably high degrees of confidence. Unfortunately, quite often it is difficult to compare the costs of different CATV systems because actual cost data, or information shown in system descriptions, are based on different ground rules. This appendix stresses the development of CATV costs and utilizes these costs in a comparative sense. The costs of CATV distribution systems are compared with one another and with the telephone distribution system.

Telephone and telegraph as well as commercial radio and television represent mature telecommunications distribution systems. The great majority of people in this country currently receive these services. Although significant improvements, from a cost standpoint, are being made in the techniques for the distribution of these services, the overall cost per person serviced is known and not subject to significant near-term changes. Improvements in telephone distribution (such as station carrier) and in commercial broadcast transmission techniques (such as beam shaping) can affect the costs of individuals being served. However, the magnitude of the current physical plant used by these systems precludes rapid introduction of technologies of this type to all consumers of the service. Therefore, since telephone costs are known and are not particularly volatile, they are included in this appendix primarily as points of comparison against the more variable CATV costs.

The special carriers have not yet completely defined the configuration of their local distribution systems. Current system proposals vary between use of the existing telephone plant and use of microwave and optical links. Accurate cost estimates for the individual system proposals may be prepared, but they will rapidly become outdated as the systems change. Therefore, no cost information relating specifically to the special carriers is contained in this appendix.

A.1.3 Approach

Relative costs of CATV distribution systems and telephone distribution systems have been the subject of a great deal of discussion. The discussion has become somewhat confused when significantly different services have been inaccurately compared, such as video telephone versus 12-channel broadcast television, or conventional telephone loops versus the "wired city." A basis for comparison of two telecommunication distribution services was prepared, and is discussed in Section A.2.1 of this appendix. The costs of conventional telephone loops and a 12-channel, one-way CATV system were estimated for a suburban community. Using this baseline, the costs of additional telecommunication services provided by different system alternatives can be estimated at a later date. The comparative costs of the different CATV configurations ("tree" and "star") are discussed in Section A.2.2 of this appendix. The analysis of these different approaches was based on a simplified suburban 12-block model. The comparative costs of providing CATV and telephone service to the rural subscriber is investigated in Section A.2.3. Finally the cost of obtaining increased channel capacity using a conventional "tree" configuration in a large urban environment is shown in Section A.2.4.

A.2 ANALYSIS

A.2.1 Suburban Area: CATV "Tree" and Telephone Systems

The Town of Bedford, Massachusetts, was selected in order to model CATV and telephone distribution networks. All housing units for the town were located on a Bedford street map. Distribution networks, serving all the residential units, were then prepared and costed for both the telephone and the CATV networks. Because our interest is in telecommunication distribution systems, the cost of headend equipment for the CATV network and the central office and switch of the telephone network has not been included in this analysis.

A.2.1.1 <u>CATV Network</u>

Assuming 100% market penetration, a 12-channel, all-aerial CATV distribution network was overlaid on the Bedford street map. Bedford has a population of 13,513 and 60.2 miles of street. Since an actual CATV system normally services an area greater than this size, the headend site was located near the Bedford-Burlington border. Therefore, the same headend could also service the adjacent town of Burlington. Maintrunk CATV cable was used to provide three primary links through the town. Subtrunk and feeder cables were used to distribute the signal to the residences from this trunk cable. Amplifiers and line splitters were located as needed along the cable. The number of required power supplies was determined by calculating the total system power and dividing by the average power provided by each supply. The cost of directional taps assumes that the system will utilize two-, four-, and eight-way taps with an average cost per tap of $5.00.

The cost of all required equipment was based upon current industry prices for quantity purchases. The costs for system preparation were estimated using industry cost factors. The cost of installation was based on an average per-foot cost for similar suburban installations. As shown below, the total cost for distribution of the CATV network based on 61.2 miles of cable and 2,844 subscribers is $296,000.

CATV Distribution Costs
(in thousands of dollars)

Electronics and Associated Equipment	$ 55
Cable	46
Preparation	48
Installation	147
	$296

Electronics and associated equipment is composed of amplifiers, power supplies, and terminating equipment. The trunk amplifiers include bridging amplifiers, which allow trunk cable to bridge off in more than one direction. The system uses 22 dB gain amplifiers throughout. The spacing of these amplifiers was determined by the attenuation characteristics of the cable. Line splitters were used at all feeder cable junctions where amplifiers were not required. All cables are terminated by a terminating tap. The cost and quantities of the required electronics and associated equipments are summarized in Table A-1.

In some cases the distribution network uses larger cable than was presently required, to allow for a reasonable amount of system growth in conjunction with the future growth of the service area. A total of 61.2 miles of cable was required. As is normally the case with installations of this type, the required number of cable miles approximates the 60.2 miles of accepted streets in the service area. The cable costs were based on the purchase of standard lengths of jacketed cable. The national average drop length of 135 feet was used to determine drop cable requirements. The system cable requirements for this model are presented in Table A-2.

Table A-1

Electronics and Associated Costs for Bedford CATV Network

Equipment	Unit Cost ($)	Quantity	Total Cost ($)
Trunk			
Bridging Amplifier (2)	485	6	2,910
Bridging Amplifier (4)	515	7	3,605
Intermediate Bridger	135	5	675
Trunk Line Amplifier	320	6	1,920
Feeder			
Line Amplifier	115	185	21,275
Line Extender	90	56	5,040
Line Splitter	25	117	2,925
Associated			
Power Supply	195	11	2,145
Power Coupler	20	11	220
Directional/Terminating Tap	2844	5	14,220
System Cost			54,935

Table A-2

Cable Costs* for Bedford CATV Network

Cable	Cost/1000 Feet ($)	Number of 1000-ft Units	System Cost ($)
Transmission Cable			
Cable Size:			
.750	242	37	8,954
.500	119	45	5,355
.412	87	242	21,054
			35,363
Drop Cable			
Number of Drops:			
2,844	28	384	10,752
System Cost			46,115

*Cable costs assume jacketed cable is used.

System preparation costs were estimated using standard CATV factors. Pole inspection is estimated at $2 per pole. Using the local average of 45 poles per mile, a total of $90 per mile is required. A pole rearrangement cost of $600 per mile must be added to this cost. The cost of the strand required to support the CATV cable, the cost of associated hardware, and the network installation costs are based on actual industry costs for similar networks. This cost is estimated at $1,700 per mile. The drop cost of $15 per installation is based on actual industry data for aerial installations and assumes 100% market penetration. System preparation and installation costs are summarized in Table A-3.

The total system cost, as discussed above, was estimated at $296,000. This yields a cost of $105 per subscriber, $4,900 per street mile, and $4,800 per cable mile.

A.2.1.2 Telephone Network

In the case of the telephone network, a specific distribution network was not prepared. Instead, loop cost planning factors derived from General Telephone and Electronics (GT&E) experience were applied. The switch location was hypothesized near the center of Bedford, near the location of the existing switch. The telephone switch was located differently from the CATV headend because telephone switches can be economically sized to service a single town the size of Bedford. Since we are interested in comparing distribution networks, the costs of the switch are not included in the analysis. Using the same street map for Bedford as was used for the CATV model, the average loop length for each subscriber was calculated to the nearest 1000 feet. The regression formula shown below was derived by

Table A-3

Preparation and Installation Costs for Bedford CATV Network

Preparation	
Engineering (Layout and Inspection)	$100/mile
Utility Companies' Inspection	90/mile
Pole Rearrangement	600/mile
	$790/mile
Installation	
Install Equipment, Cable, and Strand — Including Hardware	$1,700/mile
Install Drops	15/drop
System Cost	
Preparation 61.2 Miles at $790/mile	$ 48,348
Installation	
Transmission Cable: 61.2 Miles at $1,700/mile	104,040
Drop Cable: 2,844 Drops at $15/drop	42,660
TOTAL	$195,048

GT&E and verified by a statistical analysis conducted on independent telephone systems receiving loans from the Rural Electrification Agency (REA). The estimated total distribution cost for the town is \$970K.

$$C = 58.08 + 15,841L + 1.1758L^2 + 0.04215L^3 - 0.000529L^4$$

where: C = Cost in dollars

L = Length in thousands of feet

The number of subscriber drops provided is 3,326. The telephone system provides 482 more individual drops than the CATV system. The additional drops are required because the telephone system supplies a loop to each individual housing unit, while the CATV system provides only one drop to the mobile home park and one to each apartment complex in the town. Costs of \$290 per subscriber and \$15,850 per street mile were computed for the telephone distribution system.

In comparing these two networks for this geographical area, the 12-channel, one-way CATV distribution system has a lower cost per subscriber than does the distribution network for the conventional two-way telephone system. The primary reason for the higher cost of the telephone distribution system is the greater total mileage of the telephone loops compared to the cable system. As will be shown later, the per mile loop cost for telephone system twisted pair is significantly lower than the per mile cost of CATV coaxial cable. However, the total loop mileage required for a telephone distribution system in Bedford was 4,436 miles, compared to the 61.2 miles of CATV cable. As more services are provided by CATV and telephone systems, the costs will increase. If a competitive situation develops as the types of services provided overlap, the lower cost system will, of course,

have the advantage. The time frame of this study has not permitted this projection, although the above cost model provides a base for such an analysis. However, as discussed in Section IV of the report, there are indications that the evolving CATV systems can effectively compete in many non-BROADCAST service areas and, because of their broadband nature, have certain unique capabilities.

A.2.2 Suburban Area: CATV "Tree" and "Star" Systems

A.2.2.1 Methodology

The "tree" CATV system hypothesized and costed in Section A.2.1 was prepared to facilitate the estimating of costs for services to the suburban town of Bedford, Massachusetts. In addition to this "tree" configuration, CATV can also be distributed by using a "star" configuration. In the investigation of CATV systems, a comparison of the distribution system costs between "tree" and "star" configurations was prepared.

Previous cost estimates have been made on the "star" configurations of Ameco, Inc., and Rediffusion, Ltd. In order to be consistent with these previous estimates, the same assumptions were used in this comparison: the area to be served was defined as consisting of 12 blocks, each of which contained twenty 50' x 100' lots; and a high-capacity one-way system providing 36-40 channels was hypothesized. Costs are estimated for the two "star" configurations and one "tree" configuration.

A.2.2.2 Configuration Descriptions

As was stated in the report, the conventional "tree" configuration is designed with all of the signals from the headend available for each subscriber. In contrast, the "star" configuration provides each subscriber with a dedicated cable and utilizes a switch to select which signal each subscriber receives.

Using the basic design of a "star" configuration, two variations of the design can be identified. One variation, the DISCADE system, has switches scattered throughout the system and connects the subscriber to the switch by coaxial cable. The other variation, the Rediffusion system, normally has one switch at the headend and connects to the subscriber by four 26-gauge wires.

A.2.2.3 Configuration Costs

A conventional "tree" configuration provides distribution of the signals from the headend to the subscribers via trunk and feeder cable, with a drop to each housing unit. Since the hypothetical model requires at least 36 channels, an entire second cable network will be installed parallel to the first. In the 12-block area, the system requires 1000 feet of 0.750 cable, running along the cross street which divides the area into two 6-block sectors. A total of 13,600 feet of feeder cable is required to connect the house drops to the trunk cable. The system also uses 28,800 feet of drop cable to connect the houses to the feeder cable, assuming an average length of 60 feet per drop. The cable cost includes $242 per 1000 feet for the 0.750 cable, $87 per 1000 feet for the feeder cable, and $28 per 1000 feet for the drop cable.

This configuration cost also includes the cost of trunk amplifying and bridging equipment along with line splitters, line-extending amplifiers, and line-terminating equipment. The cost for the required amount of power equipment is also included. Preparation and installation costs are estimated,

using the same factors as those shown for the CATV distribution network in Bedford. Provision of 40 video channels requires the use of converters at each television set. The cost of these converters was estimated at $27 for each set.

Total system costs for the model area are summarized in Table A-4. Using these figures, a per subscriber cost of $100 is calculated. In spite of the dual cable installation, the per subscriber cost in this case is lower than the per subscriber cost calculated in the Bedford layout. The lower cost results from the high-density uniform layout hypothesized in the model versus the actual layout used in the Bedford model.

The DISCADE configuration distribution system has a 40-video channel capacity. It requires an individual drop for each operating TV set, as opposed to a drop for each dwelling unit as in a "tree" configuration. Using an industry estimate that 40% of the subscribers will be dual subscribers, the 240 house lots will contain 336 subscribers. Since each DISCADE switch can service 24 subscribers, a total of 14 switches is required in the 12-block area. The switches required, as in the case of Rediffusion, are in addition to the headend facilities. Sub-trunk cables connect these switches to the main trunk. This main trunk consists of 11 coaxial cables and the sub-trunk consists of 10 coaxial cables.

AMECO has estimated the installed costs of their cables and amplifiers at $11,000 per mile, or $2,083 per 1000 feet, for the trunk assembly and $8000 per mile or $1,515 per 1000 feet for the sub-trunk assembly. Assuming a 50-foot street width, the geometry of the area to be served is a rectangle 500' x 3300'. A total of 500 feet of main trunk cable will be required. This main trunk will connect to 4 sub-trunks via a bridging amplifier. With equal spacing of the 14 switches, 6240 feet of sub-trunk cable will

Table A-4

Conventional CATV "Tree" Configuration Costs

Components	No. of Units	Unit Cost ($)	System Cost ($)
Electronics and Associated Equipment			
Trunkline Amplifier	.5	320	160
Intermediate Bridger	2	135	270
Line Splitter	4	25	100
Line Extender	8	90	720
Tap (Directional/ Terminating	120	20	2,400
Power Supply and Coupler	.4	205	86
Cable (1000' units)			
Trunk (.750)	1	242	242
Feeder (.412)	13.6	87	1,184
Drop	28.8	28	806
Preparation			
$790/mile (with 7300' or 1.38 miles)			1,090
Installation			
Distribution cable (7300' or 1.38 miles at $2300/miles)			3,174
Drops (with 240 drops at $15 each)			7,200
Converters (with 240 units at $27 each)			6,480
System Total Cost			23,912

be required. Subscriber drops average 200 feet in length. A cable cost of $28 per 1000 feet and an installation cost of $15 per drop gives an installed cost of $183 per 1000 feet for drop cable.

In addition to the trunk amplifier, the required system electronics include the switches and a converter for each television receiver. Utilizing contractor information, the cost of the switch is estimated at $60 per subscriber module plus $192 for switch housing and power supplies. The switch can be installed in the aerial network without special requirements (i.e., land, pole reinforcement, etc.). The relatively simple converter required is estimated to cost $15 per subscriber. Table A-5 summarizes the estimated system cost for the DISCADE system with 336 subscribers served. A per subscriber cost of $135 is computed for this configuration.

The Rediffusion system also individually services 336 subscribers in the 240 houses with 36 video channels. Switching for this number of subscribers is accomplished at one location. This switch is connected to the headend by a 36-channel trunk cable which uses a separate coaxial cable for each video program and wire pairs for the program sound. The video is carried at high frequency, hence trunk amplifiers between exchanges normally are not required. Contractor estimates of the cost of this trunk cable are $2,520 per 1000 feet. Each subscriber is serviced by a Rediffusion "Quist" cable which consists of one pair of 25-gauge signal wires and one pair of 26-gauge control wires twisted together in a special manner. The wires are currently manufactured in six-subscriber and single-subscriber cables. Present costs of the cable are $172 per 1000 feet for the six-subscriber Quist shielded cable, and $77 per 1000 feet for the single Quist shielded cable.

From the geometry of the area to be served, a total of 500 feet of trunk cable is required. The 6-Quist cable will form the basic distribution system and a total of 53,200 feet will be required. Single-Quist cable will be used

Table A-5

CATV "Star" (DISCADE) Configuration Costs

Components	No. of Units	Unit Cost ($)	System Cost ($)
Installed Cables (1000' units)			
Trunk (including Amplifiers)	0.5	2,083	1,042
Sub-Trunk (including Amplifiers)	6.3	1,515	9,545
Drop	67.2	103	6,922
Switching and Associated Equipment			
Housing and Power Supplies	192	14	2,688
Switch Modules	60	336	20,160
Converters	15	336	5,040
System Total Cost			45,397

for the subscriber drops, which average 100 feet in length for a total of 33,600 feet. These drops are connected to the 6-Quist cable by junction boxes. A total of 56 of these boxes are required at a cost of $15 each. Installation costs for this system have been estimated at $30,000 by Rediffusion. The total equipment cost for the switch is quoted by Rediffusion at $25,370, of which $14,952 is for selectors.

Land and a building for the switch must also be obtained. A switch serving 336 subscribers can easily be housed in a building the size of a one-car garage. The cost of land and building was estimated at $5,000. Table A-6 summarizes the total costs for the Rediffusion system. The subscriber cost for this system is $221 each.

A service area of this type with all users uniformly spaced at a relatively high density ideally suits the hierarchical layout of the "tree" configuration. Therefore, relatively low costs result. For the Rediffusion system, this type of service area is highly unfavorable. Since all subscribers are spaced closely together, it is not possible to take advantage of the relatively inexpensive Quist for long runs to single subscribers.

A.2.3 Rural Area: CATV and Telephone Systems

The cost of providing telecommunications services to a single rural subscriber was investigated, using the costs derived in Sections A.2.1 and A.2.2. The analysis examines the comparative cost of one mile in a multi-mile distribution link for telephone and CATV systems. It assumes that an isolated subscriber is being served by a buried distribution line. It also assumes that the subscriber is located several miles from both the distribution switch and any other subscribers.

According to information obtained from independent telephone companies who borrow funds from the REA, a buried telephone distribution loop serving a single rural subscriber can be installed for approximately $700 per mile.

Table A-6

CATV "Star" (Rediffusion) Configuration Costs

Components	No. of Units	Unit Cost ($)	System Cost ($)
Cable (1000' units)			
Trunk	.5	2,520	1,260
6-Quist	53.2	172	9,150
Single-Quist	33.6	77	2,587
Electronics			
Switch	1	25,370	25,370
Junction Boxes	56	15	840
Land and Building (for Switch)			5,000
Installation			30,000
System Total Cost			74,207

This cost consists of $250 per mile for labor and $450 per mile for shielded buried cable. Engineering charges to this subscriber are estimated at $60 per mile, giving a total per mile preparation and installation cost of $760.

Over the same route, a 12-channel conventional CATV "tree" distribution system can be installed and buried at a cost of $1,400 per mile. The engineering and labor costs for burying the cable are estimated to be equal to those used for the telephone system. Material costs of $1,090 per mile include the costs of 0.412-diameter cable, amplifiers and power supplies.

For the DISCADE configuration, a 0.412-diameter coaxial cable run with amplifiers was hypothesized. Again, the engineering costs and the labor cost for burying the cable are estimated as equal to those used for the telephone system. The material cost for one mile of 0.412 cable is $450. The required amplifiers are spaced at 4000-foot intervals. Their cost, including required power supplies, is estimated at $160 per mile. The installation and engineering costs are $310 per mile. Combining all costs yields a total per buried route mile cost of $920.

For the Rediffusion "star" configuration, a one-way shielded Quist cable with amplifiers will be used. The same total of $310 was estimated for the cost of engineering and the labor cost of burying the wire. (Recent REA borrower experience indicates there is very little variation in labor costs in burying cable as a function of the cable size.)

The material costs for one mile of one-way shielded Quist is $400. The amplifiers are spaced every 4000 feet. The cost of the amplifiers and their power supplies is $70 per mile. Thus the system cost for one mile of buried Quist is $780.

The route mile "star" configuration costs are lower than the conventional CATV costs primarily because the "star" system carries only one channel of information at intermediate frequencies rather than at the radio frequencies required to carry the full TV band. The attenuation is much lower and the amplifier spacings correspondingly greater.

"Star" configuration CATV systems require more expensive subscriber terminals than do "tree" configuration systems. However, much of this additional cost can be offset by utilizing CATV receivers which would accept the displayed picture at IF frequencies, as it is carried in the cable, rather than going back to RF frequencies at each subscriber. The increased cost of the switching required by "star" configurations does not have an offset as is the case with the terminals. Although this cost is not addressed here, it is significant (see Section A.2.2).

"Star" configuration CATV distribution costs are, then, comparable with telephone distribution costs for the isolated subscriber. On the other hand, "tree" configuration CATV distribution costs are substantially lower than telephone distribution costs in rural population centers. Twelve-channel CATV can be provided for approximately $4,700 per street mile with a density of 45 subscribers per street mile. It costs approximately $16,000 to provide telephone distribution for the same street mile with its higher density of 55 subscribers per street mile.

Consequently, if CATV services are made available to rural areas, the configuration will probably be a mixture of the "tree" and "star" configurations. The "tree" configuration will probably be used to reach concentrations of subscribers, while the "star" configuration will probably be used to reach isolated dispersed subscribers. Neither the "tree" not the "star" configuration has a consistent cost advantage for all operating areas. In general, each configuration should be evaluated as a possible solution to providing a given mix of signals in a given service area.

A.2.4 Urban Area: CATV "Tree" System Extended-Channel Capacity

Discussions involving the "information revolution" normally revolve around high-capacity distribution systems. In order to estimate the cost of distribution systems of this type, the costs for a "tree" CATV distribution system were investigated. Since the costs of originating the information in additional channels of the distribution system will be significant, the costs for headend equipment are included in this analysis for the first time.

Increases in channel capacity can be achieved by changing the type and quantity of equipments within the distribution system. Analysis of the costs associated with the configuration changes required for additional capacity indicates that the costs vary primarily in a steplike fashion as shown in Figure A-1. This figure presents the normalized initial investment cost for a CATV system as a function of the number of 6-MHz TV channels, assuming market penetration rates of 20 percent and 50 percent in a large urban system. An urban system requiring a mixture of aerial and underground cable was costed, since this type of urban installation will probably be the first significant application of the new service. Relative rather than absolute costs are used because the cost of the incremental information channel is of primary importance.

The steplike cost increases in Figure A-1 result from changes in transmission equipment necessitated at certain specific channel increments. The gradual increases in cost result from additions to the headend equipment required for each new channel. To go from a 12-channel system to a 13-channel system requires the addition of converters for each subscriber. The increase in cost from 13 to 30 channels reflects the use of additional headend equipment. For a 20-channel capacity cable, changes in transmission equipment to higher quality (push-pull) amplifiers are required. The increase in cost from 20 to 27 channels reflects the requirements for

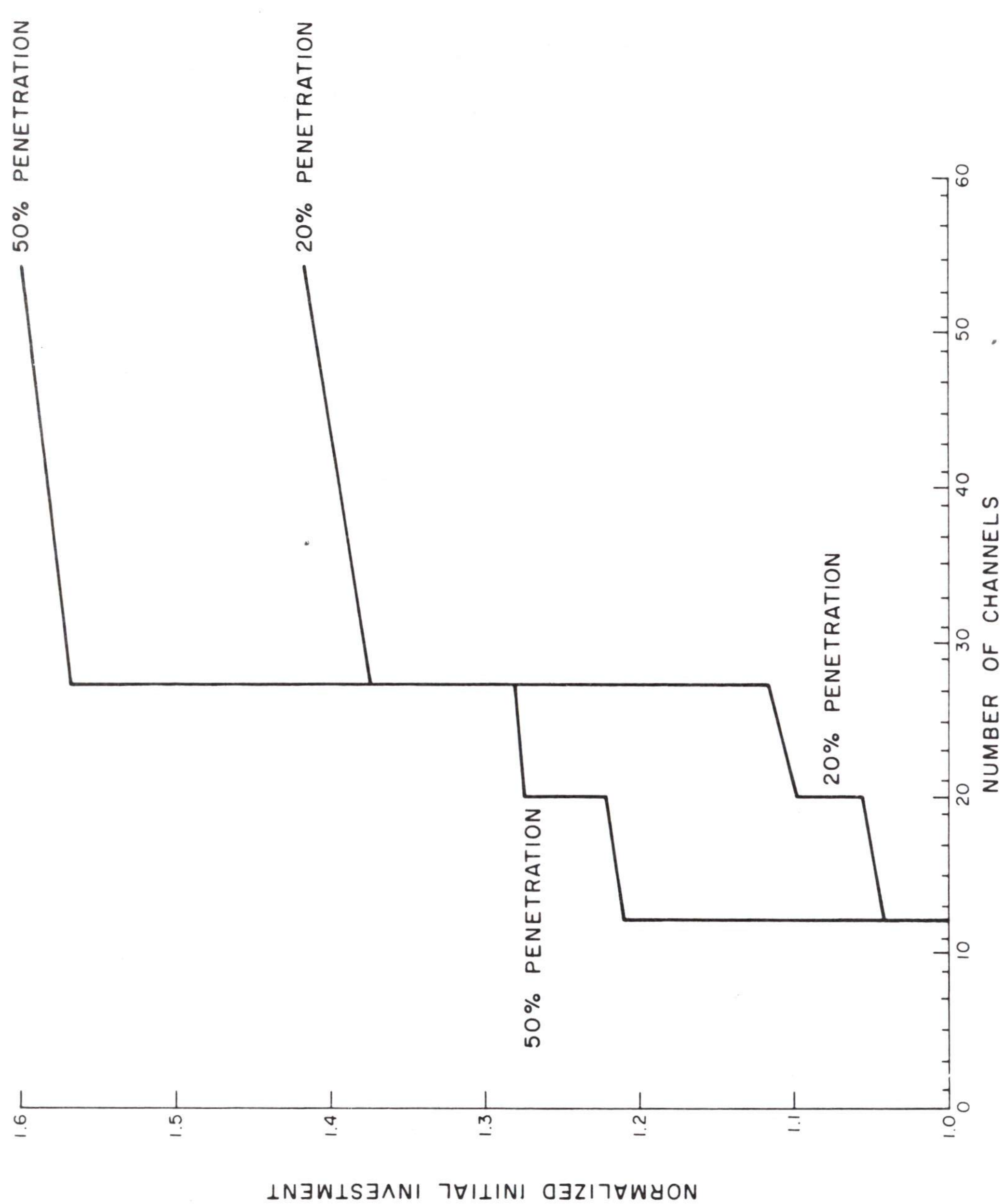

Figure A-1. Normalized Cost of a Large Urban CATV System versus the Number of TV Channels

more headend equipment. At 27 channels, with today's technology, an entire second cable system is added to provide the additional required capacity. No additional converters are required for the second cable. The increase in cost above 27 channels results from the required additional headend equipment.

TO MR. OLSEN

From PETER C. GOLDMARK

This is the latest version of our report which incorporates the comments of Messrs. Busignies, Dunn and Campbell which I received as of November 6th. Not having obtained any other comments by this date, I forwarded the final version to Dr. Goldmuntz. Since then, I received remarks from Tom Rogers, and I will suggest to him, after he has looked at the latest version of our report, that he mail to all of us, including Dr. Goldmuntz, further comments, if any.

November 9, 1971

cc: Dr. Goldmuntz

Py

NOV 10 1971

PSAC

The following comments represent the composite thinking of the Communications ad hoc Committee activated by Dr. Lawrence Goldmuntz, dealing with the study for the Presidential Domestic Council, entitled "Communications for Social Needs" Technological Opportunities," dated September 24, 1971.

Members of the Panel:

Dr. Henri Busignies
Mr. Edwin Campbell
Dr. Donald A. Dunn
Dr. Peter C. Goldmark, Chairman
Dr. Henry S. McDonald
Mr. Kenneth H. Olsen
Mr. Thomas F. Rogers

I. General

We were heartened by the degree of cooperation, commitment, and competence demonstrated by the many government agency personnel involved in this study. In a relatively short time, they produced a comprehensive outline for developing the type of communications system this country will require in the years ahead. The definition of the needs and the value to the nation of meeting these, has been presented in a sound and thoughtful way.

We recognize that under the circumstances the individual tests could not have been thought out adequately as yet, and, therefore, they are still of a more general character. Nevertheless, substantial federal support for funding is warranted, and budgets for specific programs ought to be brought into more precise focus. It will be highly beneficial to the civilian segment of the nation to have the government infuse new concepts and funds for the pioneering phase which later will become the task of business and industry to carry on a commercial basis.

To the extent that the aspirations envisioned here are realized, our society will be even more influenced by the character, amount and availability of the nation's telecommunications resources. It is important, therefore, that a more comprehensive and quantitative understanding be obtained of how telecommunications affects the efficiency by which services and goods are produced and delivered in both the public and private worlds. We do not have a high degree of confidence in the estimates given of the economic benefits to be expected from this program.

The conduct of socially-and politically-related experiments is a complex and sensitive matter. Today, our knowledge of political, psychological and cultural responses to a major "technological intervention" is small. Furthermore, the number of professionals schooled and experienced in conducting and evaluating such experiments is minute. Therefore, these tests should be mounted very selectively and carefully, with sound and sensitive professional groups -- and anticipate unexpected difficulties and even failures.

The experiments may require a great deal more money and time than is estimated to bring them to satisfactory conclusion. We believe it is equally important that the experiments be assessed continuously to obtain a better insight into the impacts which the eventual widespread adoption of their results could have on society, both direct and indirect, desired and undesired.

To the extent that certain of the experiments tend to provide the individual citizen with more information regarding the functioning of his government and the various services which it offers, an increased demand for such information and these services might occur. The overall project should be designed to be able to meet these increased demands.

Experiments in several different areas appear to have some common elements, and thus could be carried out in conjunction with one another and, to some extent could share certain new and expensive telecommunications facilities. An example are the envisioned public broadcasting, postal delivery and law enforcement activities, where prompt and reliable telecommunications services are needed, linking a large number of our cities. Also, many of the experiments concerning educational, health and urban services could be carried out utilizing certain existing cable, telephone, and over-the-air broadcasting complexes.

This report, which is very preliminary, reflects our current feeling regarding the proposed project as a whole. We believe that, if further participation by this Panel is desired, we would like to have available more detailed analyses from the various agencies and authors who composed the study. Additional work is needed to match up more intensively the technological services with the actual needs as well as the substantive components transported over the various links and systems.

We also see a need to sort out in greater detail the techniques and equipment at the various terminals, both as to existing and desired types. Again, the substance and delivery systems must become an essential part of this study.

Another need is to arrive at definitions of services, systems and terminals. This would include known practices and system alternatives. Resulting from this it would be hoped to arrive at standards in close collaboration with the individuals and agencies involved in the overall project.

II. Program for next Phase.

As a result of the preceding, the optimum combination of the most suitable facilities should be redefined to fulfill the identified needs at a minimum cost. Much of this could be based on the excellent material already assembled in the Appendix of the current project report.

III. Looking Ahead.

When considering the application of communications technology towards the social needs of this country, it is important to take into account today's living pattern, where the vast majority of the country's population lives on a small percentage of our land in over-populated urban and suburban areas. Although we are aware of the resultant problems of crime, pollution, traffic, education, social needs, etc., perhaps we do not realize that these conditions have become so critical that the survival of the nation may very well be at stake.

In "The Cities of the Future" study of the National Academy of Engineering* the thesis has been presented that those reasons which caused originally today's cities to come into being, exist no longer and that today's needs for cities cannot be satisfied with resources as they are known at present.

The study showed that today's pattern of life -- the major problems and some of the benefits -- is a result of science and technology expanding at an ever increasing rate from the time the first and greatest invention in communications, namely the printing press, was made. What happened since,

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* entitled: "Communications Technology for Urban Improvement"

was not planned, and we are living in an era dominated by urban conditions. The paradox of communications today is that the closer together people now live, the more difficult they find it to communicate, which is typical of our over-populated urban and suburban complexes where people exist under stresses and strains to which our species has not been able to adapt itself, nor will it for tens of thousands of years. Today we represent an angry race, and our studies have shown that crime and pollution, for instance, increase non-linearly with city size. Where the density of population is high, crime and pollution also increase.

The study brought out the reasons why people migrate from our vast and attractive rural areas to the already crowded urban and suburban centers, and why people are not induced to live in a country environment. The major ingredients seem to be the lack of employment choices in the rural sections; the lack of cultural, educational, entertainment opportunities, inadequate health services, etc.

It is possible that imaginative application of known principles and existing inventions to new systems of communications could solve these problems and make it possible for business not to expand into suburbs, but into distant and attractive rural towns. At the same time, communications techniques have been identified whereby education, cultural, entertainment, health services and other essential factors for a high quality of life could be created in any part of the U. S.

A feasibility project to be funded by HUD for the State of Connecticut is expected to begin soon. The project will encompass the State's Windham Planning Region and involve detailed analysis of communications patterns within business components, medical institutions, educational centers and state government agencies. The study does not propose that new towns be built; this requires a large amount of capital and time. But the distribution and the existence of towns between 5,000 and 100,000 inhabitants has been studied and it is found that 100 million Americans between now and the end of the century could be attracted to these existing towns which would act as nuclei for enlarged centers, but growing in population not above 200,000.

Analyses have shown that the additional land use based on such a pattern, is insignificant, approximately 4%, thereby leaving intact the great majority of our land resources.

The proposed plan simultaneously changes the role of the large cities and would tend to solve their problems. The transformation of the large city, its new role, its social and economic life under such a plan should be the subject of another discussion.

At this time, we are anxious to point out that all the technologies and their application, as outlined in the Domestic Council study, tend to assume that the current pattern of population distribution and mode of life will not change. For that reason, we feel that consideration should be given to new telecommunication methods as well as new combinations of currently known terrestrial, satellite, cable or cassette TV systems in order to enhance the emergence of new living patterns so necessary to the nation's survival.

IV. Education

1. Responding to the statement that by 1975 the number of high school graduates or graduate equivalents could be increased by one million, in our opinion, this is not of the highest priority in education. Making education more useable, and making it more meaningful to the existing school population are much more serious problems. Furthermore, many members of minority groups who currently have a high school diploma cannot get jobs. We could argue that turning out more high school graduates, whose aspirations towards employment or higher education cannot be satisfied, is actually damaging to them as well as to our society.

2. Referring to high school dropouts, the study cites that 40 % of urban students and 25 % of all students nationwide do not finish high school. From this we infer that the percentage of dropouts in rural areas must be less than 10 %. Keeping in mind cost effectiveness, if high school equivalency is desirable, why not concentrate solely on the cities?

3. It was proposed that 20,000 people could be trained in early childhood education by 1976. This is an important new national priority, and substantial funds have already been allocated for the establishment of day care centers. At the same time the major problem in this area has to do with the overall philosophy which early childhood education should espouse (custodial vs. developmental). For advocates of the developmental role, there are related issues of what should be taught, who should teach it (peer groups, older children, adults, etc.) and how it should be taught. No doubt, new communications systems can profitably be employed in this area, and imaginative experimental programs certainly should be undertaken. But a new delivery technology will

alone not solve the most important issues and problems in the area of early childhood education.

4. The study calls for 10,000 new health personnel to be trained by 1976. While this is another important area of national concern, the study does not really address itself to the major problem. It would be fair to say that educational TV, computer-assisted instruction, and other attempts to utilize technology in education and training have not lived up to expectations. We believe that the study should address itself to this question, discuss some of the reasons why educators and other professionals believe technology has thus far not been too successful, and identify possible new experimental approaches. Creating greater technological capacity to reach people will not train them to be effective health personnel unless we know more about how to utilize that technology most wisely: What constitutes effective training? What portion of this training can best be undertaken via telecommunications technology?

5. According to the study, by 1976 an open university and a model for accreditation is to be established. While an effective delivery system will be essential, first priority must be given to such problems as developing the specific role for such a university, providing it with stature so that it will not be a second-rate "degree mill" and working out associated and meaningful tutorial and guidance systems. The real problem is to develop an entirely new educational concept which, while making higher education available to more people at lower cost, will make them want it. A comprehensive communication system by itself, will not make such a university project effective. Unfortunately, the study seems to imply that it will.

6. It is proposed that by 1974, models for delivering modern instructional materials to remote regions will be demonstrated. The comments pertaining to training of health personnel are applicable here. The major problem is to develop effective new models, not merely to deliver the models.

7. Unfortunately, no mention was made of video-cassettes as a means for disseminating knowledge and what this might do for education.

8. We suggest that the study should not only present the case from an "educational problem" perspective (high dropout rates, need for health personnel, etc.) but also from a pedagogical viewpoint. In order to be convinced of the importance of the telecommunications systems proposed, one needs to know

(a) what attracts people to telecommunications media,

(b) what have telecommunications systems (such as educational TV) accomplished in the past and what could improved versions offer in the future,

(c) which educational problems could best be resolved by an improved delivery system utilizing telecommunications technology.

The study should present its case in this important area in a more convincing fashion by addressing itself to these essential points.

The early childhood and open university programs as new concepts may well represent the best opportunities for conducting major educational experiments aimed at utilizing new telecommunications systems. Furthermore, the new approaches once developed may provide application to existing educational systems.

9. In conclusion, we concur that this country needs more effective methods of education and training for all its citizens. A more comprehensive delivery system will be needed, but must be coupled with other resources such as imaginative programming and new curricula in order to fulfill its objective and truly educate.

V. Law Enforcement

Regarding the fingerprint system mentioned in the study, it is not clear whether transmitting an image of a fingerprint to a central facility by electronic means is the only solution. There are alternatives, such as mail for routine cases, and local encoding schemes for characterizing fingerprints and compress them into a small amount of data. Such a distributed classification system is currently being pursued by the FBI and the success of this work would greatly reduce the demand for law enforcement communications as projected. Even if the broadband approach were taken, the law enforcement part would use only 1% of the total communications resource.

Another aspect of law enforcement, which has not been dealt with, has to do with the application of communications technology towards reduction of crime through effective deterrents.

The National Academy of Engineering, in its report on "Communications Technology for Urban Improvement," recommended systems based on known technologies (or those under development) which could give improved protection to citizens on the street, in public housing, subways and other places where the frequency of mugging and robbery have become one of the nation's major problems.

We urge that these recommendations be included in the present study, and that a comprehensive study of the social effects of systems of crime deterrents involving day and night surveillance be initiated as a part of a pilot project to test the feasibility of this approach.

VI. Electronic Mail

Of all the experiments suggested, the one that impresses us most in terms of technical soundness, positive economic impact, and clear public understanding, is that of long-haul electronic mail delivery. We suggest that this area be given a high priority. We also urge that, in ascertaining the full utility of wideband coaxial cable systems, thought be given to exploration of electronic mail delivery directly to the industrial plant, the commercial office and, perhaps, the individual residence.

We would like to stress that the quality, reliability and cost of terminal equipment be considered as major factors in the electronic mail experiments and eventual service.

It would be essential to make a thorough market study to establish what type and what quantity mail will be sent by electronic transmission and whether prospective users will want to convert existing mail forms for use over the new system.

At the same time, the access to points of transmissions and reception, and its effect on the quality and acceptance of the services should be studied.

VII. "Wired City"

1. The opportunities to augment and improve educational and cultural pursuits in a densely populated city through cable services, is one of the major and basic contributions this fast-developing technology can make.

   The study emphasizes communication between city administration and citizens without considering overlap or interaction with PBS activities and proposals.

2. The impacts and benefits in terms of jobs and new business, projected from the HUD program, are not logically derived, since most may occur in any case without such a program.

3. There is need for more information regarding the social impact of new services and the legal and social obstacles to the introduction of some of the services, even though these may be wanted and users are willing to pay for them.

4. We do not feel that the statement concerning Phase I.: that the "most important task will be to evaluate prototype components already developed by industry," is realistic. We recommend an aggressive component development program which should also support an integrated hardware and programming activity. Even a modest federal R&D program in this area could have important effects on the development of components specifically applicable to the public services. Such program should be started immediately, not after "evaluation of commercial hardware."

5. We agree with the objectives of Phase II, but the concept of a pilot network as described, should be regarded only as an example. The total cost and the way this is allocated to different elements of these pilot programs may vary widely, depending on the willingness of industry to pay for the hardware and other aspects. Similarly, the scope of the programs may vary widely, depending on the capabilities and interests of local groups. For example, federal funds to cover all or part of the programming costs for a limited time period may stimulate industry to provide the corresponding innovative hardware for that particular project. Equally, government funding of social experimenters in designing their project and evaluating the public response might be enough to cause industry to provide all other costs.

   The idea of using the leverage of federal funds to get meaningful social experiments or pilot projects underway is essential here. More programs will be possible for the same total federal funds and the transfer of knowledge to industry and local groups will occur much more readily if these become major contributors to the programs in their city. Without paying the whole bill, federal leverage can be used to push programs in the direction of more and better public services and more services oriented toward the disadvantaged. It is not necessary, nor even desirable to maintain direct federal control over all aspects of a project, because of the difficulty of transferring it later to private or local control.

The need for educational services as a major element of the programming and software in the wired city experiments should be emphasized and the connection with the educational initiative program should be strengthened. In some cases, funding of educational programming may be the only leverage needed to get an entire pilot project underway. Federal support for educational programming in a particular city could in many cases render other services commercially profitable at an early stage because of the number of users who would be willing to subscribe to a larger complement of services but only if they included the educational programs.

6. Concerning specific amounts of funding and timing, the panel had insufficient time to agree on alternatives, but could do so at a later date.

7. Phase IV is a logical extension of the Phase II project, but as explained above, Phase II may evolve quite differently from what has been projected presently. There may be no need for federal support of hardware for such city-wide tests; in fact, a large number of these may get under way with the federal government only funding the experimental design and evaluation. As we now see it, the project is too little and too late. At the projected date, a large number of city-wide two-way systems will probably have been built with private funds. There will be a strong need for the suggested all-city study, but this should happen as early as possible.

8. Two-way wideband and other interactive systems are an important part of the wired city. Consideration should be given on: how to handle responses from large groups, from a few hundred to perhaps several hundred thousand or more; and how is the technical and human organization of such an information exchange to be handled. We suggest that this area be thoroughly studied before broad claims are made which could not be demonstrated.

VIII. Communications Technology and Health

The presentation to this panel of telecommunications applications to improved health services left us with the feeling that the technologies involved are feasible but that we lack sufficient information as to the needs and priorities of the medical profession. After exposure to the Health Group's presentation in Washington on October 21, 1971, it seems that closer coordination and discussion between the medical and telecommunications experts is desirable. We, therefore, await further instructions before proceeding in this area.

TO MR. OLSEN

From PETER C. GOLDMARK

OCT 26 1971

I would like to ask you to return this draft as soon as possible with your comments.

10/21/71

PSAC

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To the extent that the aspirations envisioned here are realized, our society will be even more influenced by the character, amount and availability of the nation's telecommunications resources. It is important, therefore, that we obtain a more comprehensive and quantitative understanding than we now have, of how telecommunications affects the efficiency by which services and goods are produced and delivered in both the public and private worlds. We do not have a high degree of confidence in the estimates given of the economic benefits to be expected from this program.

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We also see a need to sort out in greater detail the techniques and equipment at the various terminals, both as to existing and desired types. Again, the substance and delivery systems must become an essential part of this study.

Another activity we propose, is to arrive at definitions of services, systems and terminals. This will include known practices and system alternatives. Resulting from this we would hope to arrive at standards, but always in close collaboration with the individuals and agencies involved in the overall project.

II. <u>Program for next Phase.</u>

As a result of the preceding, we would re-define the optimum combination of the most suitable facilities to fulfill the identified needs at a minimum cost. Much of this will be based on the excellent material already assembled in the Appendix of the current project report.

III. <u>Looking Ahead.</u>

When considering the application of communications technology towards the social needs of this country, it is important to take into account today's living pattern, where the vast majority of the country's population lives on a small percentage of our land in over-populated urban and suburban areas. Although we are aware of the resultant problems of crime, pollution, traffic, education, social needs, etc., perhaps we do not realize that these conditions have become so critical that the survival of the nation may very well be at stake.

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We have examined the reasons why people migrate from our vast and attractive rural areas to the already crowded urban and suburban centers, and why people are not induced to live in a country environment. The major ingredients seem to be the lack of employment choices in the rural sections; the lack of cultural, educational, entertainment opportunities, inadequate health services, etc.

It has been our belief that imaginative application of known principles and existing inventions to new systems of communications could solve these problems and make it possible for business not to expand into suburbs, but into distant and attractive rural towns. At the same time, we have pinpointed communications techniques whereby education, cultural, entertainment, health services and other essential factors for a high quality of life can be created in any part of the U. S.

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The proposed plan simultaneously changes the role of the large cities and would tend to solve their problems. The transformation of the large city, its new role, its social and economic life under such a plan should be the subject of another discussion.

At this time, we are anxious to point out that all the technologies and their application, as outlined in the Domestic Council study, tend to assume that the current pattern of population distribution and mode of life will not change. For that reason, we feel that consideration should be given to new telecommunication methods as well as new combinations of currently known terrestrial, satellite, cable or cassette TV systems in order to enhance the emergence of new living patterns so necessary to the nation's survival.

IV. Education

1. Responding to the statement that by 1975 the number of high school graduates or graduate equivalents could be increased by one million, in our opinion, this is not of the highest priority in education. Making education more useable, and making it more meaningful to the existing school population are much more serious problems. Furthermore, many members of minority groups who currently have a high school diploma cannot get jobs. We could argue that turning out more high school graduates, whose aspirations towards employment or higher education cannot be satisfied, is actually damaging to them as well as to our society.

2. Referring to high school dropouts, the study cites that 40 % of urban students and 25 % of all students nationwide do not finish high school. From this we infer that the percentage of dropouts in rural areas must be less than 10 %. Keeping in mind cost effectiveness, if high school equivalency is desirable, why not concentrate solely on the cities?

3. It was proposed that 20,000 people could be trained in early childhood education by 1976. This is an important new national priority, and substantial funds have already been allocated for the establishment of day care centers. At the same time the major problem in this area has to do with the overall philosophy which early childhood education should espouse (custodial vs. developmental). For advocates of the developmental role, there are related issues of what should be taught, who should teach it (peer groups, older children, adults, etc.) and how it should be taught. No doubt, new communications systems can profitably be employed in this area, and imaginative experimental programs certainly should be undertaken. But a new delivery technology will

alone not solve the most important issues and problems in the area of early childhood education.

4. The study calls for 10,000 new health personnel to be trained by 1976. While this is another important area of national concern, the study does not really address itself to the major problem. It would be fair to say that educational TV, computer-assisted instruction, and other attempts to utilize technology in education and training have not lived up to expectations. We believe that the study should address itself to this question, discuss some of the reasons why educators and other professionals believe technology has thus far not been too successful, and identify possible new experimental approaches. Creating greater technological capacity to reach people will not train them to be effective health personnel unless we know more about how to utilize that technology most wisely: What constitutes effective training? What portion of this training can best be undertaken via telecommunications technology?

5. According to the study, by 1976 an open university and a model for accreditation is to be established. While an effective delivery system will be essential, first priority must be given to such problems as developing the specific role for such a university, providing it with stature so that it will not be a second-rate "degree mill" and working out associated and meaningful tutorial and guidance systems. The real problem is to develop an entirely new educational concept which, while making higher education available to more people at lower cost, will make them want it. A comprehensive communication system by itself, will not make such a university project effective. Unfortunately, the study seems to imply that it will.

6. It is proposed that by 1974, models for delivering modern instructional materials to remote regions will be demonstrated. The comments pertaining to training of health personnel are applicable here. The major problem is to develop effective new models, not merely to deliver the models.

7. Unfortunately, no mention was made of video-cassettes as a means for disseminating knowledge and what this might do for education.

8. We suggest that the study should not only present the case from an "educational problem" perspective (high dropout rates, need for health personnel, etc.) but also from a pedagogical viewpoint. In order to be convinced of the importance of the telecommunications systems proposed, one needs to know

(a) what attracts people to telecommunications media

(b) what have telecommunications systems (such as educational TV) accomplished in the past and what could improved versions offer in the future

(c) which educational problems could best be resolved by an improved delivery system utilizing telecommunications technology.

The study should present its case in this important area in a more convincing fashion by addressing itself to these essential points.

The early childhood and open university programs may well represent the best opportunities for conducting major educational experiments aimed at utilizing new telecommunications systems.

9. In conclusion, we concur that this country needs more effective methods of education and training for all its citizens. A more comprehensive delivery system is essential, but must be coupled with other resources such as imaginative programming in order to fulfill its objective and truly educate.

V. Law Enforcement

Regarding the fingerprint system mentioned in the study, it is not clear whether transmitting an image of a fingerprint to a central facility by electronic means is the only solution. There are alternatives, such as mail for routine cases, and local encoding schemes for characterizing fingerprints and compress them into a small amount of data.Such a distributed classification system is currently being pursued by the FBI and the success of this work would greatly reduce the demand for law enforcement communications as projected. Even if the broadband approach were taken, the law enforcement part would use only 1 % of the total communications resource.

Another aspect of law enforcement, which has not been dealt with, has to do with the application of communications technology towards reduction of crime through effective deterrents.

The National Academy of Engineering, in its report on "Communications Technology for Urban Improvement", recommended systems based on known technologies (or those under development) which could give improved protection to citizens on the street, in public housing, subways and other places where the frequency of mugging and robbery have become one of the nation's major problems.

We urge that these recommendations be included in the current study and that at the same time steps be considered to educate the citizenry to systems of crime deterrents which involve day and night surveillance and may be objected to unless the purpose and lack of alternatives are clearly defined.

VI. Electronic Mail

Of all the experiments suggested, the one that impresses us most in terms of technical soundness, positive economic impact, and clear public understanding, is that of long-haul electronic mail delivery. We suggest that this area be given a high priority. We also urge that, in ascertaining the full utility of wideband coaxial cable systems, thought be given to exploration of electronic mail delivery directly to the industrial plant, the commercial office and, perhaps, the individual residence.

We would like to stress that the quality, reliability and cost of terminal equipment be considered as major factors in the electronic mail experiments and eventual service.

VII. "Wired City"

1. The opportunities to augment and improve educational and cultural pursuits in a densely populated city through cable services, is one of the major and basic contributions this fast developing technology can make.

   The study emphasizes communication between city administration and citizens without considering overlap or interaction with PBS activities and proposals.

2. The impacts and benefits in terms of jobs and new business, projected from the relatively small HUD program, are extreme.

3. There is need for more information regarding the social impact of new services and the legal and social obstacles to the introduction of some of the services, even though these may be wanted and users are willing to pay for them.

4. We do not feel that the statement concerning Phase I. : that the "most important task will be to evaluate prototype components already developed by industry", is realistic. We recommend an aggressive component development program which should also support an integrated

hardware and programming activity. Even a modest federal R&D program in this area could have important effects on the development of components specifically applicable to the public services. Such a program should be started immediately, not after "evaluation of commercial hardware."

5. We agree with the objectives of Phase II, but the concept of a pilot network as described, should be regarded only as an example. The idea of using the leverage of federal funds to get meaningful social experiments or pilot projects under way is essential here. Similarly, federal funding for designing the experiment and evaluating the public response might be enough to induce industry to provide the other costs. This would make it possible to conduct more programs for the same total federal expenditures. Also, the transfer of knowledge to industry and local groups will occur more readily if local business and other groups become major contributors to the programs in their community. Federal support for educational programming in a particular city could in many cases be sufficient to render other wired services commercially profitable at an earlier date, since the users would subscribe to a total service rather than to fragmented ones.

6. Concerning specific amounts of funding and timing, the panel had insufficient time to agree on alternatives, but could do so at a later date.

7. Phase IV. is a logical extension of the Phase II. projects, but as explained above, may evolve quite differently from what has been projected presently. There may be no need for federal support of hardware for such a city-wide test; in fact, a large number of these may get under way with the federal government only funding the experimental design and evaluation. As we now see it, the project is too little and too late. At the projected date, a large number of city-wide two-way systems will probably have been built with private funds. There will be a strong need for the suggested all-city study, but this should happen as early as possible.

8. Crime, emerging as one of the critical problems of the nation, particularly in high density urban centers, should be dealt with extensively in the "Wired City" project. While the opportunities for crime are highest in large cities, so are the ways of using communications technology to combat it. We must think in terms of deterrents rather than apprehension and correction. As pointed out earlier under "Law Enforcement", this subject has been dealt with in more depth in the NAE report "Communications Technology for Urban Improvement", and we feel it should become an essential component of the HUD "Wired City" proposal.

VIII. Communications Technology and Health

The presentation to this panel of telecommunications applications to improved health services left us with the feeling that the technologies involved are feasible but that we lack sufficient information as to the needs and priorities of the medical profession. After exposure to the Health Group's presentation in Washington on October 21, 1971, it seems that closer coordination and discussion between the medical and telecommunications experts is desirable. We, therefore, await further instructions before proceeding in this area.

October 27, 1971

COMMUNICATIONS FOR SOCIAL NEEDS

Notes on the Mail Service:

The U.S. mail delivers 85 billion pieces of mail a year; 73 billion in envelopes and 12 billion in magazines. In addition, there are 1 billion packages.

One-third of the cost is delivery; 11% in transportation; 43% in processing; and 8 to 10% in collection.

Only 5% of the cost of mail is in personnel.

9/14/71

PSAC Initiative

TELECOMMUNICATIONS INITIATIVE

OBJECTIVES

- NATIONAL, REGIONAL, AND URBAN PUBLIC EXPERIMENTS USING EXISTING AND PLANNED TELECOMMUNICATIONS FACILITIES TO DEMONSTRATE:
  - IMPROVED AVAILABILITY OF SOCIAL, EDUCATIONAL, AND CULTURAL SERVICES TO ALL THE PEOPLE
  - IMPROVED QUALITY AND AVAILABILITY OF HEALTH CARE SERVICES
  - MODERN, RAPID, ELECTRONIC MAIL SERVICE
  - IMPROVED ABILITY TO ENFORCE THE LAW AND ADMINISTER JUSTICE
  - ADEQUATE MEANS FOR WARNING THE PUBLIC OF NATURAL DISASTERS
  - SIGNIFICANT IMPROVEMENTS IN URBAN PLANNING

- NATIONAL STUDY TO:
  - DETERMINE OPERATIONAL TELECOMMUNICATIONS CAPABILITIES NEEDED TO SUSTAIN EXPERIMENTALLY DEMONSTRATED BENEFITS
  - DEVELOP COST-EFFECTIVE, TIMELY PLAN TO ESTABLISH THESE CAPABILITIES EMPHASIZING PRIVATE INVESTMENT

SUB-OBJECTIVES

- TEST SOCIAL AND POLITICAL ACCEPTANCE

- DETERMINE ECONOMIC VIABILITY

- DEVELOP ATTRACTION FOR INDUSTRIAL INVESTMENT

NEEDS ARE PUBLIC*

EDUCATIONAL AND CULTURAL

- PRESENT SYSTEM DOES NOT PROVIDE:

  - ADEQUATE AND EQUAL OPPORTUNITIES TO ALL THE PEOPLE (ALASKA, ROCKY MOUNTAIN FEDERATION, APPALACHIA)

  - ADEQUATE EDUCATIONAL OPPORTUNITIES OUTSIDE THE CLASSROOM

    . PRE-SCHOOL: 20% OF CHILDREN HAVE DIFFICULTY WITH FUNDAMENTAL, QUANTITATIVE CONCEPTS AT EARLY ELEMENTARY LEVELS (V-42)

    . POST-SCHOOL AND HIGH SCHOOL EQUIVALENCY FOR ADULTS: 18,000,000 AMERICANS CANNOT READ OR WRITE WELL ENOUGH TO PERFORM BASIC FUNCTIONS; 1½ MILLION ENTER JOB MARKET ANNUALLY WITHOUT NECESSARY SKILLS FOR EMPLOYMENT; 40% OF URBAN STUDENTS, 25% OF ALL STUDENTS DO NOT FINISH HIGH SCHOOL (I-1)

    . UNIVERSITY TRAINING WITHOUT OVERLOADING FACILITIES: BOTH JAPAN AND BRITAIN HAVE BEGUN OPEN UNIVERSITIES OF THE AIR. THE U.S. LAGS! (I-36,37)

NEEDS ARE PUBLIC* (CONT'D)

EDUCATIONAL AND CULTURAL (CONT'D)

- CAREER TRAINING (AND RETRAINING) OPPORTUNITIES ARE INADEQUATE

  - SEVERE SHORTAGES EXIST IN:

    . SKILLED CRAFT AREAS: ONLY 35% OF DEMAND WILL BE FILLED IN 1971
    . HEALTH PROFESSIONALS: ONLY 38% OF DEMAND WILL BE FILLED IN 1971 (I-2)

- OPPORTUNITIES FOR EDUCATIONAL PROFESSIONALS TO CONFER ARE LIMITED

- TRAINING AIDS TO ASSIST TEACHERS IN EDUCATING ARE INADEQUATE

  - "OUR GOAL MUST BE TO INCREASE THE USE OF THE TELEVISION MEDIUM AND OTHER TECHNOLOGICAL ADVANCES TO STIMULATE THE DESIRE TO LEARN AND TO HELP TO TEACH." (PRESIDENT'S MESSAGE ON EDUCATIONAL REFORM, MARCH 3, 1970)

- PUBLIC, NONCOMMERCIAL BROADCASTING NOT AVAILABLE TO ALL THE PEOPLE

  - "...NATIONAL POLICY...MAKE NONCOMMERCIAL EDUCATIONAL RADIO AND TELEVISION SERVICE AVAILABLE TO ALL THE CITIZENS...INCLUDING THE USE OF MEDIA FOR INSTRUCTIONAL PURPOSES..." (PUBLIC LAW 90-129, SECTION 396, NOVEMBER 7, 1967)

  - WITH ALL EXISTING 209 STATIONS, PUBLIC BROADCAST SERVICE (PBS) REACHES ONLY 74% OF POPULATION WITH A SINGLE CHANNEL. REQUIREMENTS COULD GROW TO 10-15 CHANNELS (I-27,28)

NEEDS ARE PUBLIC* (CONT'D)

HEALTH SERVICES

- NOT ADEQUATELY ACCESSIBLE TO PUBLIC, PARTLY BECAUSE OF:
  - LIMITED MEANS FOR PUBLIC DISTRIBUTION OF HEALTH INFORMATION
  - DIFFICULTY OF PROFESSIONALS' ACCESS TO PATIENTS' MEDICAL RECORDS
  - LIMITED FACILITIES FOR CONSULTATION AMONG HEALTH PERSONNEL
    - APPROXIMATELY 20 MILLION IN URBAN AREAS AND 15 MILLION IN RURAL AREAS HAVE INADEQUATE ACCESS TO HEALTH CARE THEY NEED (I-13,14,15)
    - 40% (80 MILLION) LIVE IN RURAL LOCATIONS WHERE SPECIALIST MEDICAL CARE IS NOT READILY AVAILABLE (I-13,14,15)
- DISPROPORTIONATE RISE IN COSTS
  - 25% OF HOSPITAL BED COST IS ATTRIBUTABLE TO HANDLING BILLS AND MEDICAL RECORDS (I-24)

NEEDS ARE PUBLIC* (CONT'D)

LAW ENFORCEMENT

- INFORMATION FLOW AT ALL LEVELS MUST BE SPEEDED UP
  - TO REDUCE DELAYS IN APPREHENSION OF CRIMINALS
  - TO REDUCE DELAYS IN ADMINISTRATION OF JUSTICE
    - AT PRESENT, FINGERPRINTS ARE FORWARDED BY U.S. MAIL WITH A TRANSIT TIME OF 4 DAYS (-38,41)

POSTAL SERVICE

- INCREASING MAIL VOLUME IS FORCING INCREASES IN HANDLING COSTS (I-48)
- EXISTING POSTAL SYSTEM CANNOT PROVIDE IMPROVED SERVICES DEMANDED BY PUBLIC (I-48)
- CURRENT MAILING PRACTICES PREVENT AN ECONOMICALLY SELF-SUFFICIENT POSTAL SERVICE (I-48)
  - ELECTRONIC MAIL HANDLING IS PREDICTED TO YIELD A COST SAVING OVER DEPLOYED MECHANICAL SYSTEMS OF $31.88, or 72.5%, PER 1000 LETTERS PROCESSED (V-95)

9/14/71

NEEDS ARE PUBLIC* (CONT'D)

DISASTER WARNING

- UNNECESSARY LOSSES OCCUR FROM NATURAL DISASTERS BECAUSE OF LIMITED PUBLIC WARNING CAPABILITY
  - LOSSES AVERAGE $15 BILLION, 600 DEATHS, 10,000 INJURIES ANNUALLY (I-63)
  - SINCE START OF NATIONAL WEATHER SERVICE'S TORNADO WARNING SERVICE IN 1953, ANNUAL TORNADO DEATHS DECREASED 48% (222 to 116) IN PRESENCE OF 27% POPULATION INCREASE (I-63)

URBAN PLANNING: THE WIRED COMMUNITY

- SOCIAL AND POLITICAL ALIENATION OF INDIVIDUALS IN PART CAUSED BY:
  - ONE-WAY NATURE OF PRESENT COMMUNICATION BETWEEN THE INDIVIDUAL AND SOCIETY (I-69)
  - LACK OF TIMELY AVAILABILITY OF INFORMATION AND SERVICES TO LARGE SEGMENTS OF OUR SOCIETY (I-69)
  - MISUSE OF RESOURCES BY THE PUBLIC IN OBTAINING NEEDED SERVICES AND IN CONDUCTING DAY-TO-DAY BUSINESS (I-69)
- COMMUNICATIONS WITHIN THE COMMUNITY NEEDS TO BE PLANNED SYSTEMATICALLY

* ALL FACTUAL DATA PROVIDED BY REPRESENTATIVES OF RESPONSIBLE OPERATING AGENCIES

IMPORTANCE

- RECOGNITION OF INADEQUATE DISTRIBUTION OF EDUCATIONAL AND CULTURAL MATERIALS (PUBLIC BROADCASTING ACT, 1967; NATIONAL ACADEMY OF SCIENCES STUDY ON SPACE APPLICATIONS, VOL. 10, BROADCAST, 1967-69; CARNEGIE COMMISSION REPORT ON EDUCATIONAL TELEVISION, PUBLIC TELEVISION: A PROGRAM FOR ACTION, 1967)

  - POTENTIAL FOR WIDESPREAD DISTRIBUTION

    - BY TERRESTRIAL MEANS TO POPULATED AREAS

    - BY SATELLITE TO REMOTE REGIONS (ROCKY MOUNTAIN STATES, ALASKA, APPALACHIA)

- CONGRESSIONAL RECOGNITION OF URBAN PROBLEMS (MODEL CITIES ACT OF 1970)

  - POTENTIAL FOR WIRED CITIES SERVICES TO REACH APPROXIMATELY 75% OF TOTAL UNITED STATES POPULATION WITH

    - INTERACTIVE EDUCATION

    - PUBLIC BROADCASTING

    - PUBLIC ACCESS (CHANNEL FOR OPEN FORUM DISCUSSIONS)

    - STATE AND LOCAL GOVERNMENT PUBLIC INFORMATION

    - PROTECTIVE SERVICES

    - UTILITY MONITORING

    - PUBLIC PREFERENCE POLLING

    - HEALTH CARE INFORMATION

    - RESTRICTED SERVICES FOR SPECIALIZED USERS (HEALTH PERSONNEL, LAW ENFORCEMENT PERSONNEL, ETC.)

IMPORTANCE (CONT'D)

- SATELLITE SYSTEMS CAN EXTEND MANY WIRED-CITY SERVICES TO COVER ENTIRE UNITED STATES

- DEMONSTRABILITY OF OPERATING AND COST EFFECTIVENESS OF ADVANCED COMMUNICATION SYSTEMS, BOTH WIRED-CITY AND SATELLITE, IN:

  - DELIVERING EDUCATION TO LARGE PORTIONS OF TARGET POPULATIONS

    - CAREER TRAINING (DAY-CARE AND HEALTH PERSONNEL)

    - HIGH SCHOOL EQUIVALENCY FOR ADULTS

    - UNIVERSITY OF THE AIR

  - MAKING PUBLIC AWARE OF AVAILABLE HEALTH SERVICES AND ASSISTING IN THEIR DELIVERY WITH REDUCED COSTS

  - REDUCING TRANSMISSION TIME OF INFORMATION ON CRIMINAL EVENTS FROM 4 DAYS TO ONE HOUR

  - PROCESSING LARGE VOLUMES OF LETTER MAIL (UP TO 100 MILLION PIECES) WITHIN A 12 HOUR DAY

  - PROVIDING 99% GEOGRAPHICAL COVERAGE FOR TIMELY WARNING (WITH WAKE-UP CAPABILITY) OF NATURAL DISASTERS

IMPACTS AND BENEFITS

- PUBLIC BROADCASTING
  - INCREASE ACCESSIBILITY FROM 74% TO NEARLY 100% OF POPULATION (V-64,66)
- EDUCATION
  - INCREASE HIGH SCHOOL EQUIVALENT GRADUATES BY 1 MILLION IN 1975 AND 3 MILLION IN 1976 (V-38)
  - TRAIN 20,000 PERSONNEL IN EARLY CHILDHOOD EDUCATION AND INCREASE ABILITY OF DAY CARE CENTERS TO COPE WITH PROBLEM SOLVING THROUGH COMMUNICATIONS BY 1976 (V-39)
  - TRAIN 10,000 NEW HEALTH PERSONNEL BY 1976 (V-41)
  - ESTABLISH AN OPEN UNIVERSITY AND A MODEL FOR ACCREDITATION (V-42)
- HEALTH SERVICES
  - ESTABLISH REGIONAL MEDICAL INFORMATION CENTER (POTENTIAL OF 90,000 JOBS) (I-23)
  - REDUCED HOSPITAL BED COSTS BY 12½% (SAVINGS OF $5 M/MILLION POP) (I-24)
- POSTAL SERVICE
  - HANDLE 30 BILLION PIECES OF MAIL (OF THE 86 BILLION PIECES EXPECTED) IN 1981 ELECTRONICALLY AT A SAVING OF $960 MILLION OVER TODAY'S PRACTICES (I-62)
  - ASSURANCE OF A 1-DAY DELIVERY OF LETTER MAIL TO ALL OF THE URBAN POPULATION

IMPACTS AND BENEFITS (CONT'D)

- **LAW ENFORCEMENT**

  - REDUCED DELIVERY TIME OF FINGERPRINTS FROM 4 DAYS TO 1 HOUR (I-41)

- **URBAN SOCIAL SERVICES**

  - ESTABLISH COMMUNITY MUNICIPAL INFORMATION CENTER AS PART OF EXPERIMENTAL WIRED-COMMUNITY NETWORK TO PROVIDE CITIZENS IMFORMATION AND SERVICES ON REQUEST (I-71,72)

- **ECONOMY**

  - OVER 130,000 NEW JOBS IN 1980'S (I-23,75)

  - STIMULUS TO PRIVATE INDUSTRY TO DEVELOP AND PRODUCE SYSTEMS AND EQUIPMENT: POTENTIAL MARKET OF $28 B IN WIRED-CITY TERMINAL AND HEADEND EQUIPMENTS; POTENTIAL MARKET OF $700 M IN TERMINALS FOR ELECTRONIC MAIL HANDLING (I-70; V-96)

  - SYSTEMS CONCEPTS AND EQUIPMENTS EXPORTABLE

  - $69.8 BILLION POTENTIAL ANNUAL SAVINGS FROM TIME SAVED THROUGH WIRED-CITIES' SERVICES (I-77)

PROGRAM SUMMARY

WIRED CITY

- HUD

  - DEVELOPMENT OF SYSTEMS COMPONENTS

  - PILOT NETWORKS: 4 CITIES EACH WITH 150 HOMES AND 4 NEIGHBORHOOD CENTERS

  - COMMUNITY INFORMATION CENTER

  - CITY WIDE SYSTEM (ROCHESTER, NEW YORK)
    1976 ENTIRE CITY WIRED, BASIC HOME, SCHOOL, AND HOSPITAL SERVICE
    1980/86 EXPANDED SERVICES

  - EXPERIMENT COSTS

FY72	73	74	75	TOTAL
$2M	$3M	$5M	$5M	$15M

  - OPERATIONAL SYSTEM: ALL CENTRAL CITIES LARGER THAN 50,000 PEOPLE PLUS THEIR CONTIGUOUS URBAN FRINGE (I.E., 75% OF POPULATION) WIRED AND INTERCONNECTED

  - OPERATIONAL SYSTEM COST (IN BILLIONS)

	FY 73	74	75	76	77	78	79	80	81	82	83	84	85	86	TOTAL
INVESTMENT	-	-	1.14	2.98	4.08	4.08	4.15	4.15	4.07	4.07	3.94	3.94	2.87	1.03	40.5
OPERATION AND MAINTENANCE	-	-	-	-	.38	.76	1.14	1.52	1.90	2.28	2.66	3.04	3.42	3.80	
TOTAL	-	-	1.14	2.98	4.46	4.84	5.29	5.67	5.97	6.35	6.60	6.98	6.29	4.83	

PROGRAM SUMMARY

WIRED CITY

- HEALTH CARE

  - PUBLIC EDUCATION: "MEDICAL MUZAK" AND "DIAL ADVICE"
  - AVAILABILITY OF HEALTH CARE: INTERCONNECTING NEIGHBORHOOD HEALTH CENTERS WITH HOSPITALS VIA 2 WAY TV
  - HEALTH RECORDS AND BIOMEDICAL INFORMATION
  - COMMUNICATION AMOUNG PROFESSIONALS: CAI AND COMPUTERIZED BIBLIOGRAPHIC SEARCH AND RETRIEVAL; 2 WAY COLOR TV

	FY 73	FY 74	FY 74	TOTAL
EXPERIMENT INVESTMENT	7.0M	6.5M	.79M	14.3M
EXPERIMENT OPERATION	6.7M	7.3M	8.2M	22.2M
TOTAL	13.7M	13.8M	8.99M	36.5M

PROGRAM SUMMARY

SATELLITE SYSTEMS

- HEALTH SERVICES

  - EXPERIMENT - 2-WAY COLOR TV, FOUR STATE AREA, 4 HOSPITALS, 40 REMOTE CLINICS/ DOCTOR OFFICES

  - OPERATIONAL SYSTEM - NOT DEFINED

  - EXPERIMENT COSTS: FY 73

    $3.99M

- CPB/PBS

  - ATS-F EXPERIMENTS - EXPLORE TECHNICAL, ECONOMIC AND EDUCATIONAL PRACTICALITY OF TV TRANSMISSIONS TO LOW-COST REMOTE RECEIVERS AT 2.5 GHz

  - OPERATIONAL SYSTEM - 10 to 15 CHANNELS IN EACH TIME ZONE BY 1980, WITH GROUND COMPLEX AND OPERATIONS FOR 2 - TEN CHANNEL MULTIPLE BEAM SATELLITES

  - COSTS

	FY 72	73	74	75	76	77	78	79	80	TOTAL
EXPERIMENT	-	4	2	-	-	-	-	-	-	6
O.S.	-	8	15	20	20	20	39	56	72	
TOTAL	-	12	17	20	20	20	39	56	72	

PROGRAM SUMMARY

SATELLITE SYSTEMS

- ELECTRONIC MAIL HANDLING (EMH)
  - EXPERIMENT - EVALUATE SUBSYSTEM PERFORMANCE BY INTERCONNECTION OF TWO CITIES
  - OPERATIONAL SYSTEM - 2-4 CITIES FY 77, 25 CITIES FY 79, 125 CITIES FY 82
  - COSTS

	FY 72	73	74	75	76	77	78	79	80	81	82	TOTAL
EXPERIMENT	0.63	.36	-	-	-	-	-	-	-	-	-	1.
O.S.	-	43	20	28	31	65	197	237	277	316	356	
TOTAL	0.63	43.4	20	28	31	65	197	237	277	316	356	

- DISASTER WARNING *
  - EXPERIMENT - EVALUATE EFFECTIVENESS, RESISTANCE TO JAMMING, SURVIVABILITY, OF A 1000 RECEIVER SYSTEM
  - OPERATIONAL SYSTEM - FULL UNITED STATES COVERAGE, WITH TWO SYNCHRONOUS SATELLITES, 250 TRANSMITTING STATIONS, EMERGENCY COMMUNICATIONS NETWORK
  - COSTS

	FY 73	74	75	76	77	78	79	80	81	82	TOTAL
EXPERIMENT	-	28	42	41	37	16	4	2.3	2	-	172
O.S.	-	1	13	13	17	9	3	77	219	292	
TOTAL	-	29	55	54	54	25	7	79	221	292	

* PREDICATED ON NEED FOR DEDICATED SATELLITE. THIS POINT NEEDS FURTHER INVESTIGATION.

PROGRAM SUMMARY

SATELLITE SYSTEMS

- EXPERIMENTAL CAPABILITY DEVELOPMENT

  - ATS H/I - NEXT GENERATION APPLICATIONS TECHNOLOGY SATELLITES AFTER F & G. MULTIDISCIPLINARY, ADVANCED FLIGHT EXPERIMENTS IN SYNCHRONOUS ORBIT. HIGH POWER & MULTIBEAM, CONTOURED-PATTERN ANTENNA TECHNOLOGIES IDENTIFIED FOR COMMUNICATIONS CAPABILITY DEVELOPMENT.

	FY 73	74	75	76	77	78	79	80	TOTAL
EXPERIMENTAL MISSION COSTS *	2.5	20	55	80	57	25	5.7	2	247

- OPERATIONAL-SUPPORT OF HEALTH, EDUCATION, CPB/PBS, POSTAL SERVICE, LAW ENFORCEMENT PROGRAMS

	FY 73	74	75	76	77	78	79	80	TOTAL
OPERATIONAL SYSTEM SATELLITE COSTS**	-	-	43	54	68	86	92	102	

* THE TOTALITY OF TECHNICAL ADVANCEMENT IN APPLICATIONS TECHNOLOGY (COMMUNICATIONS, EARTH AND OCEAN PHYSICS, METEOROLOGY, NAVIGATION) IS EXPECTED TO JUSTIFY THE ESTIMATED MISSION COSTS OF $247M. THE COMMUNICATIONS RELATED PORTION, TIMELY AND RELEVANT TO MANY OF THE REQUIREMENTS DEVELOPED HERE, PROVIDES PART OF THE MISSION JUSTIFICATION.

** DISASTER WARNING PROGRAM SUPPORTED BY DEDICATED SATELLITES.

FEASIBILITY

- SOLUTIONS TO NEEDS DEFINED BY RESPONSIBLE AGENCIES; TELECOMMUNICATIONS SERVICES REQUIRED DETERMINED BY NASA; COSTS ESTIMATED BY EACH
  - SERVICES CANNOT BE PROVIDED BY EXISTING, OR CURRENTLY PLANNED EXPANSION OF, TELECOMMUNICATIONS RESOURCES
  - EXISTING AND PLANNED TECHNOLOGY DEVELOPMENTS ARE ADEQUATE
  - COSTS TO PROVIDE TOTAL SERVICES WITHIN NATIONAL CAPABILITY
  - ECONOMIES OF SCALE EVOLVE FROM COMBINING REQUIREMENTS INTO SINGLE SYSTEM
- EXPERIMENTAL VERIFICATION OF BENEFITS RECOGNIZED AS FIRST PRIORITY EFFORT
  - SATELLITE FACILITIES ALREADY PLANNED
  - WIRED CITY NEEDS INDUSTRIAL OR FEDERAL FUNDING
  - USER AGENCIES APPEAR PREPARED TO DEVELOP EXPERIMENTAL PROGRAMMING EFFORTS - FUNDING REQUIRED
  - RESULTS CAN BE VISIBLY DEMONSTRATED SOON
- USER AGENCY ACCEPTANCE OF PROGRAM
  - PROBLEM IN ESTABLISHING PRIORITY AND POLICY WITHIN USER'S AGENCY
  - USERS DIVIDED AND UNCERTAIN OF RELATIVE MERIT
  - MULTIAGENCY INTERESTS DIFFICULT TO RESOLVE
- PUBLIC ACCEPTANCE
  - MARKETABILITY OF SERVICES AND TERMINAL EQUIPMENT, AND CONSEQUENT ATTRACTION FOR INDUSTRIAL INVESTMENT, COULD BE SEEN DURING EXPERIMENTAL PHASE

SUMMARY

- WIRED CITIES COMMUNICATIONS SERVICES REACH URBAN POPULATION; SATELLITE SERVICES ARE PREFERABLE TO REACH THE 25% IN RURAL REGIONS.

- EXPERIMENTS WILL TEST:

  - PUBLIC ACCEPTANCE OF SOCIAL SERVICES PROVIDED VIA TELECOMMUNICATIONS

  - MARKET POTENTIAL OF EQUIPMENT/APPLIANCES NEEDED

  - ECONOMIC UNCERTAINTIES AND ATTRACTION TO INDUSTRY

- EXPERIMENT PROGRAM COSTS AGGREGATE $126 MILLION, EXCLUDING

  - ATS H/I (TOTAL MISSION COSTS $247 MILLION)

  - DEDICATED-SATELLITE EXPERIMENT FOR DISASTER WARNING ($172 MILLION)

- POTENTIAL MARKET OVER $29 BILLION

- POTENTIAL NEW JOBS OVER 130,000

- REGULATORY ACTION MAY BE NEEDED TO DECIDE QUESTIONS OF OPERATING STANDARDS (POTENTIALLY AFFECTING MARKETABILITY AND INDUSTRIAL PARTICIPATION) AND RESPONSIBILITY

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T. F. ROGERS
VICE PRESIDENT
URBAN AFFAIRS

October 22, 1971

Mr. Kenneth H. Olsen
President
Digital Equipment Corporation
Maynard, Mass. 01754

Dear Mr. Olsen:

I think that you will find the enclosed article from the Washington Post of Thursday, October 21st, to be interesting. It casts some additional light on our recent discussions regarding the "requirements" expressed by the Corporation for Public Broadcasting.

Sincerely,

T. F. Rogers

Enclosure

Wash. Post 10/21/71 C1

Chastising Public TV

By Tom Zito

The Nixon administration's top adviser on communications policy chastised public broadcasters yesterday for copying the national commercial networks instead of pursuing innovation, diverse programming and local station control.

Clay T. Whitehead told the National Association of Educational Broadcasters in Miami that the Carnegie Commission and Congress originally envisioned a public broadcasting structure "built on a bedrock of localism."

The emphasis, Whitehead said, was to be on pluralism, community service, local autonomy—a public broadcasting system that would provide an alternate to the standardized fare of the centralized, commercial networks.

Now, he said, "there is evidence that you (local public television stations) are becoming affiliates" of a fourth national network. "You check the Harris poll . . . and point to increases in viewership. Once you're in the ratings game you want to win. You become a supplement to the commercial networks and do *their* thing . . ."

The trend toward "networking" programs aimed at mass audiences may bring a massive reputation and massive impact, he noted. And it may be cheaper and simpler to manage, "less demanding on local leadership than the system adopted by the Congress."

But, he asked the delegates, is that the kind of public broadcasting system "your community needs, what's best for the country?"

Whitehead's speech was the second call by the director of the White House's Office of Telecommunications for major changes in television practices within two weeks. On Oct. 6, Whitehead urged that the "fairness doctrine" be abolished and suggested an automatic right for the public to purchase television air time.

It also comes at a time when agreement on a formula for appropriations for public broadcasting is being sought in Congress and the Nixon administration is unhappy over the Public Broadcasting Service's (PBS) creation of a national news show anchored by Sander Vanocur.

"Instead of aiming for 'overprogramming' so local stations can select among programs produced and presented in an atmosphere of

See BROADCAST, C12 Col.

Chastising Public TV: No 'Bedrock of Localism'

BROADCAST, From C1

diversity" continued Whitehead, "the system chooses central control for 'efficient' long-range planning and so-called coordination of news and public affairs—coordinated by people with essentially similar outlooks. How different will your networked news programs be from the programs that Fred Friendly and Sander Vanocur wanted to do at CBS and NBS?"

Centralization critics say that Vanocur's selection as a "senior correspondent" for the newly formed National Public Affairs Center for Television is a symbol of the trend away from local news emphasis.

But defenders of the Public Affairs Center say the administration attack is aimed as much at the selection of Vanocur, whose Kennedy sympathy and criticism of the Nixon administration is scarcely a secret, as at centralization.

"On a national basis," Whitehead said, "PBS says that some 40 per cent of its programming is devoted to public affairs. You're centralizing . . . because someone thinks autonomy in regional centers (eight originally were planned) leads to wasteful overlap and duplication. But it also enables the system of reflect "America's diversity," Whitehead observed.

Some critics cite the cancellation of WETA's "Newsroom" here as an example of a news program with strong local emphasis yielding to the pressures of becoming a national news outlet or network center for the gathering of national (in Washington's case, political) news.

In response, supporters of a national news outlet question the value of spending large amounts of money purely for local news. They also cite the excellence of the "Seseme Street" and BBC-produced "Civilization" programs that centralization enables them to present. To refute Whitehead's charges of PBS playing "the rating game," they ask "what's the use of having great quality for a few select viewers?"

"Between 1968 and 1970," said Whitehead, "national broadcast hours went up 43 per cent. But local production of instructional and 'public' programs continued a decreasing trend — down 13 per cent from 1968 to 1970. The financial picture at the local stations looks bleak, even though the Corporation for Public Broadcasting (PBS's controlling organization) can now raise the range of its general support grants to between $20,000 to $52,000 per TV station.

"Do you remember," he said, "that the Carnegie group put its principal stress on a strong, financially independent group of stations as the foundation of a system that was to be the clearest expression of American diversity and excellence; that the emphasis was on pluralism and local format control instead of a fixed-schedule, real-time network . . . CPB was supposed to increase options and program choices.

"The concept of dispersing responsibility was essential to the policy chosen in 1967 for public broadcasting . . . The centralization that *was* planned for the system —in the form of the Corporation for Public Broadcasting—was intended to *serve the stations*—to help them extend the range of *their* services to *their* communities. The idea was to break the National Educational Television (NET) monopoly of program production combined with networking and to build an effective counterforce to give appropriate weight to local and regional views.

"In 1967, the public broadcasting professionals let the Carnegie dreamers have their say—let them run on about localism and 'bedrocks' and the rest of it — let them sell the Congress on local diversity and plu-

gone back to the boardrooms and classrooms and union halls and rehearsal halls, the professionals will stay in the control rooms and call the shots," he said.

"It would be a shame for you to go into the new world of electronic education centers offering a dazzling array of services without engaging in the most exciting experiment of all—to see if you as *broadcasters* can meet your wide responsibilities to your communities in instructional and public programming. It's never been tried and yet, as a policy, it's America's **unique** contribution to broadcasting—it's our concept of mass communications federalism . . .

"Your task, then, is one of striking . . . a balance between advancing the quality of electronic instruction and the quality of programs for the general public . . ."