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ABSTRACT

State and local governments have not been involved in the complexities of cable television interconnection issues in the past despite opportunities. Without their intervention, the result may well be a lack of concern for local public services. However, the entertainment and communications industries will interconnect cable systems without the assistance of state and local governments. The FCC will license firms to do so. On the other hand, local government initiative in regional interconnection can be the catalyst which forces communications technology to address problems of urban congestion, rural decline, etc. Nevertheless, there are several problems public officials must address: (1) interconnection facilities do not necessarily fit public jurisdictional boundaries; (2) public uses of cable may require audiences and program sources larger than those available to a single cable system, but more localized than a national network; (3) cable systems deliver services only to cable subscribers, but the audiences for public services may not necessarily be connected to cable system. (WCM)

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CABLE TELEVISION INTERCONNECTION

CABLE TELEVISION INFORMATION CENTER
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PREFACE

This document was prepared by the Cable Television Information Center under grants from the Ford Foundation and the John and Mary R. Markle Foundation to The Urban Institute.

The primary function of the center's publications program is to provide policy makers in local and state governments with the information and analytical tools required to arrive at optimum policies and procedures for the development of cable television in the public interest.

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INTRODUCTION

In a century characterized by an explosion of technologies, there has probably been no development with quite the impact of television. This medium has lent a sense of immediacy and intimacy to events in the life of the nation — and to events from halfway around the world, as they are beamed via satellite into the living rooms of even the most geographically isolated people. Intercommunication has transformed the U.S.A. into a citizen in the "Global Village," as well as a land whose inhabitants are in instant touch with its own pulse.

Yet broadcast television, with all its ability to transfer a wide variety of experiences, is limited — first, to a mass audience, and second, to merely one-way communication. Broadcast television has altered our perceptions, has changed our lifestyles, but — for all of its power — has not contributed to the solution of many of the problems our society faces today.

However, some answers may be found through cable television, with its two-way communications capability, enabling voice and data transmission between homes, businesses and institutions. Combined with developing satellite, videotape and cassette technologies, cable has the potential to bring greater diversity to TV programming, to deliver important public services and to provide access to voices which have not been heard in the past.

But cable television systems today serve only one town or city in most cases. Before these new technologies can bring their changes, those cable systems — both the ones that exist today and the ones to be built in the future — must be interconnected, joined together.

Interconnection is a matter sometimes considered in local franchise legislation; but frequently local officials do not fully understand the issues it gives rise to. Moreover, interconnection will often involve cable systems in more than one governmental jurisdiction, so that interconnection problems must be solved by regional or state organization officials as well as local governments. Most officials are concerned about the technical issues of interconnection — particularly in the development of franchise provisions that will make technical compatibility with other systems easy and straightforward.

Although the technical problems of equipment and performance compatibility are serious ones — particularly for older systems — they are by no means the most important. The key issue for local officials is the impact of interconnection on the delivery of public services via cable television.

It is likely that the commercial development of cable networks, though exciting, will not provide the opportunities for local expression and public services that concern many public officials. The proliferation of commercial communications links to cable systems promises greatly expanded and diversified television programming for subscribers. Indirectly, commercial links may strengthen the revenue base for cable systems, and thus expand the prospects for more public services by cable systems. But local programming and the provision of public communication services may not be enhanced by commercial networking for several reasons:

— Commercial links to cable system headends may result in interconnection facilities which do not fit public jurisdictional boundaries.

— Commercial links will tend to be one-way systems for bringing programming from national networks directly to cable TV systems. However, public uses of cable may require audiences and program sources larger than those available to a single cable system, but more localized than a national network. The pooling of audiences and programming sources at this regional level requires two-way switched facilities not likely to be provided commercially.

— Commercial networks will be mainly linked to cable systems and thus can deliver services only to cable subscribers. But the audience for public services may not necessarily be connected to cable systems.

Each of these reasons is explored in more detail in Sections I and II, which follow. Taken together, they provide the rationale for an important new role for public officials at state, regional and local levels: promoting the development of local interconnection resources for public services.[1] What makes this new responsibility difficult to discharge is the fact that interconnection of cable systems is likely to entail more than one governmental jurisdiction.

If five communities, each with operating cable systems under different owners, wish to pool their local resources to improve the quality of educational programming available to residents, planning and implementation of the project would involve cooperation among public officials and system

[1] It should be clear that the center understands that the distinction made here between commercial and public interconnection is made sharper, for analytical purposes, than may in fact be the case. Obviously, commercial and public interconnection needs overlap considerably. However, in this report, we take the viewpoint that the public's needs can be slighted unless understood and planned for.

operators from all five communities. Arrangements would have to be made for financing, construction, operation and regulation of the interconnection facility. Possibly the system could be "piggybacked" on a commercial system planned for program distribution to the cable systems. Alternatively, a public agency might have to be created, solely for the purpose of providing the public services made feasible by interconnection. The process of organizing concerted action to devise the specific solution is difficult, though the solution from an engineering viewpoint is not.

Yet, without farsighted and effective cooperation among local officials, the prospects for enriched local expression and the development of public services on cable may lie fallow. Cable's promise for diversity may remain subject to the commercial pressures which have dominated network television for the past two decades.

I. NETWORKING AND COMMERCIAL LOCAL INTERCONNECTION

In order to gain a background for a discussion of public benefits of cable system interconnection, we turn first to an examination of national interconnection networks — both existing, and forthcoming — and local interconnection links developing mainly around cable television. We will also discuss briefly the existing commercial forces behind both national and local interconnection and evaluate them in terms of their influence upon the development of public services.

Before proceeding further, it is worthwhile to set forth a definition of terms which will be used in this report:

Network — a national or regional communications system which links together communications facilities within cities and in areas distant from one another. It does not include equipment for direct connection to cable system headends, or cable system subscribers. A network is a "long haul" system.

Local interconnection — a communications system which links cable systems' headends in several adjacent cities and towns with each other and with the local outlets of networks. In some instances, a local interconnection system may connect directly with customers not served by a cable system.

Common carrier — generally means an entity which has promised to supply communication services to all who ask for them, at published rates. The interstate activities of all communications common carriers are regulated by the Federal Communications Commission (FCC) while their intrastate activities are regulated by the states. All of the common carriers file tariffs with their regulatory bodies which, in greater or lesser detail, set forth the type of services, conditions and cost.

National Communications Networks

EXISTING COMMUNICATIONS NETWORKS

Most people think of "networks" in terms of the broadcast television corporations which produce and distribute national programming to affiliated local TV broadcast stations — ABC, NBC and CBS. Actually, the electronic equipment that delivers programs is operated by other companies which distribute forms of electronic traffic all over the country — notably telephone and computer communications.

Most long distance interconnection involves the facilities of common carriers. The largest communications carrier is the American Telephone and Telegraph Company (AT & T), the "Bell System." The independent telephone companies — those not owned by Bell — provide telephone service to about 20 per cent of the population. The independents usually offer long distance telephone services in cooperation with Bell.

Bell provides a wide variety of nationwide communications services. Among these are voice, audio and data communications. Voice is the normal telephone circuit with a bandwidth of up to 3.5 kilohertz (KHz); audio lines are higher quality circuits designed for the transmission of music, with up to 5 KHz of bandwidth; data links are designed to carry digital signals or characters, such as teletype, where the bandwidth can vary from 300Hz to 60KHz.

AT & T, in the past, has maintained a near monopoly in the delivery of television network programming to affiliated broadcast stations via terrestrial microwave. In October 1969, the FCC accepted the AT & T proposal for a network tariff increase in excess of 50 per cent. Independent microwave companies, which had previously carried distant television station signals to cable systems, then began to compete more actively with AT & T for network business. Denver-based Western Telecommunications Incorporated (WTCI) carried

NBC signals from Denver to Salt Lake City, and after the AT & T tariff increase expanded its operations into Portland, Oregon. Midwest Video carried network signals west from Chicago, and other companies offered service elsewhere. Recently the telephone company returned to the FCC and asked for a downward revision of the tariff, claiming that net revenues would decline from almost $56 million in 1973 to a projected $11 million in 1975.

The broadcast networks were willing to continue using the AT & T main distribution routes, but they contracted with local independent companies for regional routes to stations off the main microwave routes. In the near future, however, there may be competition to AT & T with both regional and national networks. Two developments account for this: the rapid growth of specialized common carriers, and the imminent launching of domestic communications satellites. Both developments have more to do with voice and data communications than with television, but they will provide video networking services to cable television systems.

NEW NETWORKS

Specialized Common Carriers

After several years of allowing individual companies to operate common carrier networks in competition with AT & T, the FCC in 1972 gave overall policy approval of the specialized common carrier concept.[1]

Now a number of companies are attempting to finance and construct microwave networks linking major U.S. cities, which will compete with Bell in long distance communications. One important difference between them and the telephone companies should be noted. Most of the specialized carriers do not plan to provide customer location to customer location service. Rather they will provide service from their terminal to their terminal (usually located in the larger cities). Local telephone or microwave companies would then complete the circuit.[2]

Recently, cooperative participation in such ventures has resulted in the growth of several regional cable TV networks. There are networks in Colorado, Utah and other western and southwestern states. In the east, there are networks in Pennsylvania, New York and also in several southern states. And there is a network which feeds Madison Square Garden events to 100 cable television systems in the northeast.

There are some microwave networks which distribute noncommercial educational programming, although on a much smaller scale than commercial cable networks. In most cases, such networks were designed to carry programming directly to schools without the use of cable systems. For example, the South Carolina Educational Television Network uses closed circuit television to carry programs from the ETV Center in Columbia to 275 schools, hospitals, technical education centers and colleges. In addition, however, the network employs five UHF broadcast television stations to reach the 900 elementary schools not connected to the closed circuit cable, and the general public. This pattern of interconnection of universities for the generation of programs to be used by the State Department of Education will be repeated in additional states in the near future.

As commercial networks grow (especially via domestic satellites, which are discussed next), local state education networks likely will be supplemented by sources of national programming, such as the arrangement between the Public Broadcasting Service and its member stations.

Much commercial interest today is focused upon pay television (programs offered to subscribers for an extra charge). There are major technical differences between each of the half-dozen or so pay-cable operations presently being market tested in various parts of the country. Presumably, competition will settle into some standardization.

The pay schemes operate by scrambling the picture at the cable system's headend and providing a method for the subscriber to unscramble it. This

[1] *First Report and Order*, Docket No. 18920, 29FCC2d 870 (1971).

[2] One major specialized common carrier is Datran, which has proposed a switched network (including local distribution facilities) exclusively for data transmission. It also provides occasional use for those with small requirements.

Datran asserts there is "a need for competition in communications to motivate technological innovations, cost reductions, and efficient allocation of facilities ...." *First Report and Order, supra* ¶6 (1971). It feels the users of computer technology are not obtaining adequate service from communications facilities constructed for transmission of voice and data records.

Unless television signals can be coded into digital pulses (similar to computer communications), Datran will probably not deliver television signals to cable television systems. However, it may well provide data network service to cable subscribers and closed circuit users.

Microwave Communications, Inc. (MCI) is more typical of the other specialized carriers in proposing point-to-point, rather than switched service, to meet the closed circuit requirements of the large scale users. The MCI carriers propose a nationwide, interconnected network which they estimate would be accessible to 75 per cent of the population in the United States. *First Report and Order, supra* ¶¶9, 10, 36. Unlike Datran, MCI networks can process television signals as well as data traffic, and offer TV signal carriage.

may be done by inserting a coded card into a box near the television receiver or by dialing a computer which instructs the headend remotely to unscramble the subscriber's home terminal.

For the time being, pay television networking will rely on existing common carrier terrestrial networks, and expansion of the microwave links which service cable TV systems. Soon, however, terrestrial networks will be augmented by the launching of domestic communications satellites, which will offer many more opportunities for commercial cable system networks.

What is important is that investment in pay television ventures has created new demands for commercial networking of cable systems which may benefit national education programming for cable.

The Satellite Revolution

The Communications Satellite Act of 1962 chartered a private company (COMSAT) owned by common carriers and the public, to develop expeditiously a commercial communications satellite system. In 1964, COMSAT represented the United States in the formation of the International Telecommunications Satellite Consortium (INTELSAT), which today has 68 member nations.

The first communications satellite was launched in 1965, and it was followed by more numerous and advanced models, gradually forming a grid of stationary satellites, for advanced international communications — including both telephone and television. By 1967, the FCC began to examine proposals for domestic satellite service. In 1973, the commission completed its domestic service ruling, setting the stage for launch of several domestic satellites in 1974 and 1975, to provide new voice, data and television circuits. Many of these satellites will provide service to cable systems.

Satellite service in general falls into two categories:

— High powered transmitters on board the satellite, which permit the use of low-cost receivers. Potentially, this system offers low-cost television to remote areas, but it has not yet been deployed.

— A low-powered satellite transmitter for use in areas of dense population where interference with terrestrial microwave systems could be a problem. Here the ground receiver stations may cost $100,000, and the reception points will be at centrally-located points such as cable system headends or local interconnection centers.

The first domestic satellites were launched by Canada. Called ANIK I and II, they were used by TelePrompTer Corporation in June 1973 to demonstrate low-powered satellite transmission for cable system interconnection. RCA leases part of ANIK II for low-powered telephone and television service to Alaska. Eventually, ANIK is to be used to test high-powered transmission to television receivers in remote Canadian villages. This project is still in the development stage.

Western Union has launched its own satellite, Westar, and offers private business telephone service, television and long-distance transmission.

A proposed Application Technology Satellite (ATS-F), planned for launch in 1974, is intended to test satellite applications. It will transmit directly to low-cost microwave receivers designed to service schools in the Rocky Mountain region. The system will operate on microwave frequencies dedicated to educational television use, and defined by the FCC as Instructional Television Fixed Service (ITFS).[1] Later, the satellite will be moved to India, where it will broadcast on UHF, carrying programs from Bombay to some 5,000 Indian village television sets. A receiving antenna can be a 10-foot diameter disk constructed of chicken wire.

Other satellite proposals envision carriage of programming for pay-cable and other commercial offerings to increase the attractiveness of cable service.

Not enough is known about the demand for satellite services to predict whether high or low-powered transmission will predominate, and how much capacity will be devoted each to voice, data, direct television broadcast and interconnection television signal carriage. The most likely prognosis is that demand will prove to be a mixture of all, with emphasis on low-powered uses.

Potentially, high-powered satellite transmission could compete with conventional one-way cable systems by beaming programs directly to subscribers. This is more likely to take place in rural areas too sparsely populated to support cable service (or even broadcast television service). Meanwhile, satellite transmission in urban areas is likely to be low-powered, requiring expensive receivers and the need for further local distribution.

Satellites function best as a means of delivering signals from a few sources to thousands of r ivers (see Figure 1). Although satellite service is likely to significantly expand the networking capability available to cable systems, it will probably also result in an expansion of predominantly one-way services. Further, while the availability of national programming will presumably stimulate the

[1] ITFS interconnection will be discussed fully in subsequent sections of the report.

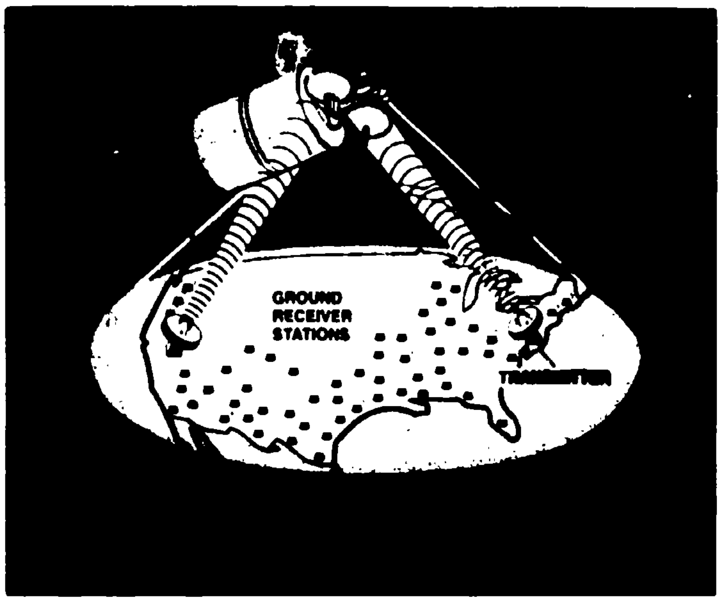

Figure 1. Television Signal Delivery by Satellite.

development of local distribution interconnection between satellite ground stations and cable system headends, it will not similarly promote the development of switched, two-way local interconnection facilities — an important public issue, which will be explained in more detail in Section II.

It is worthwhile to explore, before going further, how existing commercial networks, the new specialized common carriers and the proposed satellite systems appear to structure the development of commercial local interconnection, since commercial technology for the most part will provide the hardware for public interconnection services as well.

Local Interconnection

Local interconnection is defined here as the communications system which links together cable system headends in several local communities with terminals from the national networks (satellite receivers, long-haul ground microwave, etc.). It permits transmission of national programming to each of the cable systems for further distribution to subscribers. The interconnection system, if properly designed, can also be used to carry programs back and forth between cable headends, enabling each to use the others' programs.

Interconnection facilities consist of communications links between two or more places via coaxial cable, or three different types of microwave radio transmitters and receivers — LDS, ITFS and MDS — which are discussed in the following pages.

COAXIAL CABLE

Coaxial cable can be used either for one-way or two-way communications between two points less than 20 miles apart, when large channel capacities are needed. The cable is the same as that used for the trunk arteries in a cable television system, and depending upon performance requirements, may vary in diameter from one-half to one inch or more. Since the cable is used to connect relatively few points — that is, it is not connected to every home — the distance signals can be carried is greater than it would be in a cable distribution system.

MICROWAVE RELAY

Microwave radio operates at frequencies much higher than those used for broadcast television and cable systems. It was first developed to carry one or two TV channels over long distances by means of chains of receivers and transmitters 20 to 30 miles apart. Cable TV systems use this system to "import" distant broadcast television channels, and, increasingly, special programming for pay-cable.

In recent years, the FCC has authorized microwave frequencies for use in local interconnection. Each system operates differently, and is authorized for specific purposes.

Local Distribution Service (LDS)

The most important microwave system for cable television interconnection is Local Distribution Service (LDS). This is a form of microwave used to deliver as many as 39 television channels and the FM radio portion of the electromagnetic spectrum from a single transmitter to a large number of receivers located in a 20 to 25 mile radius around the transmitter. It is specifically mandated by the FCC to provide interconnection of many cable system headends, especially in urban areas where geographic barriers or the high cost of underground construction make cable interconnection prohibitively expensive. The microwave frequencies allocated to LDS for cable operators is called Community Antenna Relay Service (CARS).

The major weakness in LDS microwave is its similarity to broadcast television. Once an LDS transmitter is in operation, the frequencies it occupies cannot be used by another transmitter within 20 miles. Thus, although LDS is capable of very high channel capacity, signals can only be distributed one-way from the central transmitter to many headends.[1]

This high one-way capability is eminently suitable for local distribution of satellite-delivered national

[1]Several LDS equipment suppliers offer single-channel microwave links which permit each headend to communicate back to the LDS facility.

programming, as it was designed to be. It is less useful as a means of signal carriage from one headend to others, from universities to schools and other interconnection requirements which involve many local program sources as well as consumers.

One proven way to overcome the inherent one-way character of LDS is the use of coaxial cable in combination with LDS microwave, the cable providing upstream communications. This will be explored more fully in Section III.

Multipoint Distribution Service (MDS)

Another form of microwave interconnection is called Multipoint Distribution Service (MDS). The FCC authorized a narrow, unused portion of the frequency spectrum for microwave transmission of data or television in urban areas. Commercial interest has grown recently in the possibilities of using this service to deliver pay television channels directly to hotels and apartments without involving cable system operators, who would then share the revenues of a pay-cable venture. Further, entrepreneurs may not need a franchise from the city in which they operate.

MDS until recently was authorized only 10 MHz of frequency bandwidth — sufficient for little more than one TV channel. The FCC has expanded the MDS frequency allocation to 12 MHz in the top 50 television markets, to permit carriage of two TV channels, for pay TV or closed circuit use.[1]

Like LDS, MDS is mainly a one-way broadcast medium, with limited potential for two-way capability. Its potential for local interconnection is further limited by its low channel capacity.

Instructional Television Fixed Service (ITFS)

Finally, there is a microwave radio system authorized specifically for the local interconnection needs of educational institutions and, under some circumstances, local governments. It is Instructional Television Fixed Service (ITFS), mentioned earlier in connection with satellites.

ITFS is designed to be operated by an educational organization primarily for the transmission of visual and aural instructional, cultural and other types of educational material to one or more fixed receiving locations.

There are two general types of applications. The most common is the use of a central studio for originating educational programs and then beaming them via an omni-directional antenna to all of the schools in the community. Potentially, cable system headends could receive these signals also, for further distribution to more distant schools or home subscribers.

The second application is the use of a directional antenna to transmit programming from a single school or university to a central point, for further distribution via cable or LDS microwave elsewhere. There is thus great potential for the use of ITFS as a means of supplementing the one-way character of LDS with microwave return links.

Further, ITFS facilities are relatively inexpensive. The FCC normally allocates four channels to each ITFS licensee (although more may be granted if a need exists). If the school is equipped with closed circuit classroom television, the four channels could be inexpensively delivered to each classroom on channels 7, 9, 11 and 13.

ITFS has not been widely utilized by educational institutions in the U.S., partly because of a lag in development of classroom instructional programming. Its real benefit may lie in the future, as a component of a public local interconnection system.

SUMMARY

The prospects for the networking of cable systems, especially with the onset of domestic satellites, seem bright. National cable networks will in turn generate demand for local interconnection systems for distribution to individual cable TV systems.

Unfortunately, these developments may lead to a highly sophisticated system for national distribution of programming to cable system headends, without regard to local needs for exchanging public programming and pooling both audiences and resources. LDS operators in a particular region may be willing to lease channel space to educational authorities, if it can be paid for. But distribution will be defined in terms of the LDS operator's commercial contracts with cable television system operators and national program suppliers.

Further, LDS and MDS operators will construct their facilities to reach customers who will pay for national programming. The layout of an interconnection system is thus unlikely to conform to jurisdictional boundaries for education and local government. Eventually — in decades — local interconnection facilities will be part of a redundant and ubiquitous switched telecommunications network that will provide tailored services to meet local public needs.

[1] *Report and Order*, Docket No. 19493, FCC 74-34, ____ FCC 2d ____ (January 18, 1974).

In the meantime, the development of public services on cable systems will be constrained by the limited resources within most cable system boundaries. A small suburban community may provide a profitable market for a cable operator able to draw upon national commercial programming resources. But neither the community nor the cable operator may be able to afford the studio facilities and trained manpower to allow the local educational access channel to flourish as was envisioned.

ITFS by itself, has not proven to be a sufficient answer, in part because it was not conceived in terms of cable television interconnection, and in part because it is, by itself, only a fragment of the kind of interconnection capability needed for local public services.

Broadly conceived and well-planned public local interconnection facilities which combine the several hardware technologies presently available potentially may overcome both the scale weaknesses of cable television systems, and the limited usefulness of commercial networks now being constructed.

This point will be made clearer in Section II, where the specific needs and benefits of local interconnection for public services are detailed.

II. PUBLIC BENEFITS OF LOCAL INTERCONNECTION

As noted earlier, local interconnection is likely to link national network program sources with cable systems, which further distribute those programs to subscribers. But in addition, if properly devised, local interconnection offers three important kinds of public communications benefits:

— It can enrich the quality of program material offered on the access channels of an individual cable system

— It permits the link-up of specialized audiences with specialized program sources

— It permits delivery of some kinds of public services to people and agencies not served by cable systems.

The remainder of this section explores these benefits in some detail.

Program Enrichment

In the 1972 cable television rules, the FCC required cable systems constructed in the top 100 television markets to designate for public use one access channel each to educational authorities, local governments and the general public (47 CFR § 251). The commission also permitted communities outside the 100 largest television markets to require these channels as well. In addition, it required that a cable system with 3,500 or more subscribers must operate "to a significant extent as a local outlet by origination cablecasting ..." (47 CFR § 201(a)).[1]

Both of these provisions are intended to guarantee local access to an important communications medium, and to ensure that cable television serves as a medium for local expression. However, economic realities may tend to militate against the achievement of these goals. Capital and operating expenses for program production are costly and tend to rise dramatically as higher professional quality is sought.

Broadcast television has largely become the creature of the three national networks, mainly in response to the need to reduce production costs per viewer. Economic self-interest is likely to lead cable operators in the same direction, particularly as cable networks develop.

Local officials concerned with programming the three access channels must face these same economic realities. Although the FCC mandate reserves channels for local access, it does not stipulate specific equipment and production requirements for the use of the channels.[2] In most instances, it will be up to local officials and educational authorities to provide these resources. In small communities the cost per viewer will be high and may prove just as economically unattractive to the keepers of the public purse as it does to advertisers who support broadcast television.

Local interconnection can provide some relief. Five small communities at the fringe of a major metropolitan area may each not be able to afford a color production studio for public service cablecasting on the local government access channel.

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[1]In *United States v. Midwest Video Corp.*, 406 U.S. 649 (1972), the United States Supreme Court upheld the FCC's authority to impose the origination rule. However, while the litigation was before the courts, the commission stayed the effect of the rule pending the outcome of the litigation.

Nevertheless, when the Supreme Court ruled in favor of the FCC, the commission did not vacate the stay. There is some question as to whether it was necessary for the FCC to take such action since the stay may have expired by its own terms. Although the commission's Cable Television Bureau takes the position that the rule is not in effect, the legality of that position has been questioned.

In addition, the commission has commenced a rulemaking proceeding inquiring whether the rule should be altered or even repealed in its entirety. *Notice of Proposed Rule Making and Inquiry*. Docket No. 19988, FCC 2d , FCC 74-315 (April 3, 1974).

[2]An exception is the public access channel, for which the operator must provide minimum production facilities to users.

Operating together, however, they may be able to support a single facility that serves all five.

This arrangement takes advantage of economies of scale, but it does not sacrifice the local character of the enterprise. Further, if the communities, by virtue of geography or history, have a strong legacy of common interest, the interconnection facility will provide reinforcement of that tradition.

Similarly, cable operators in the five communities may feel they cannot afford more than minimal facilities for public access — for example, a one-half inch black and white videotape recorder. Combining efforts might permit the operation of a small studio as well as two or three portable videotape recorders, perhaps with a full- or part-time technical assistant.

It might be argued that pooling facilities could retard the development of public access, since the studio would not be easily accessible to most users, and because users from all five communities will have to share a single public access channel. This need not be the case. Maintaining several portable videotape recorders would permit localized or neighborhood programming. Further, the interconnection facility might be designed to permit the distribution of two public access channels to each community if there was sufficient programming for each channel. The net result would be an improvement in public access for each community.

In a rural setting, the implications of economies of scale may be equally striking. If, for example, three or four unincorporated communities in a large predominantly rural county had populations of sufficient density, they might be able to support a traditional community antenna TV system for each town, bringing to citizens basic broadcast television service from a distant major city. If the county were outside a major television market area, there would be no FCC requirements for access channels or local origination (unless each system served more than 3,500 subscribers).[1]

A modest interconnection facility might permit a local television studio to be linked to each cable system, serving as a means of local expression for the entire county. Although the interconnection links would not permit two-way communications between cable systems and other institutions, it would nonetheless provide a powerful communications medium for regional affairs. Programming a single channel could serve the needs of several public agencies, including the county agricultural office, the local school system, farmer's cooperatives and regional offices of state and federal agencies. A second channel might be supported by local commercial firms which service the farm industry.

The result of such an interconnection effort might well be a substantial improvement in the attractiveness of cable service — thus improving the odds that cable could exist in the county — and an important vehicle for local expression where none existed before. Further, the interconnection facility would provide a means of linking the community to satellite-delivered national programs in the future.

These two examples are meant to illustrate possible benefits for small communities that take advantage of the economies of scale principle. For larger urban settings, the prospects for leavening the public services character of cable are in some respects even more exciting. These prospects are discussed in the two sections which follow.

Linking Specialized Audiences to Specialized Programming

The technology of cable television — though increasingly expensive — is likely to provide sufficient capacity for delivery of television-based services to homes for at least the next decade. Present electronic equipment permits the carriage of as many as 40 channels in a single cable, and the next generation of equipment may provide as many as 55 channels.

Capacity has not hindered the development of cable television; but the lack of program sources has. In this respect, local interconnection facilities may provide powerful assistance.

For example, in a large metropolitan area with several cable systems, there might be a university with television studio facilities and a productive programming capability. If there were no interconnection facility, only subscribers to the local cable system serving the university town could benefit from university programs. But interconnection would permit all cable subscribers in the metropolitan area to benefit.

Similarly, if a cable system serving the central city were under minority ownership, it might well undertake a major programming effort for the benefit of its subscribers. But those minority citizens located in the suburbs or satellite cities could receive that special programming only if their cable system were interconnected with the central city system.

Cable systems seldom follow political and governmental jurisdictions other than city or county boundaries. Yet increasingly, public services are being coordinated and delivered on a metropolitan or regional basis. A state office of manpower

[1] See Footnote 1, p. 13.

development might undertake a daily or weekly job bank program series in which subscribers could telephone inquiries about specific jobs described on the program. Such an effort might be justifiable if a large enough portion of the target population could be reached at relatively low cost — a possibility, with interconnected cable systems.

Many of the public services envisioned for cable will not be delivered to all subscribers, but will nonetheless be influenced by interconnection. For example, in some states there exist specialized programs for continuing professional education for physicians and nurses. Programs are distributed through cable systems on a private channel to both clinics and physicians' homes. State or regional arrangements like this require interconnection of cable systems.

Similarly, an ambitious effort to tie together television and computer supported instruction among several college campuses (or secondary schools) is likely to cross cable system boundaries. If the organizational focus for campus interconnection is a state university, it will require an ambitious interconnection system.

Some kinds of closed circuit uses of cable television require switched two-way communications. For example, many law enforcement agencies are developing communications networks on a state or regional basis between police agencies. Metropolitan, state and county law enforcement forces are linked to a computer-supported data base and communications system which permits rapid coordination of law enforcement activities.

Until recently, most of these systems have involved mobile radio and data communications. Now, via interconnected cable systems, the prospect of video exchange of information between law enforcement agencies promises a major increase in communications capability. But to be effective, the system must provide cameras and receivers at each agency tied into the network.

None of these examples taken alone is likely to provide public officials sufficient rationale for construction of costly interconnection facilities. However, joint use of interconnection facilities, with costs shared by each user, may well make the benefits of interconnection attractive.

Delivery of Services to Those Not Connected to Cable Systems

Public uses of telecommunications tend to be defined in terms of services that can be delivered over cable systems, partly because it is cable television that has caused so much excitement in the prospect of the "Wired Nation." Yet, even the most optimistic predictions for the growth of cable envision that no more than 50 per cent of the homes in the country will be wired by the end of the decade. Interconnection, conceived broadly, may provide the means of delivering some services to those not connected to cable.

Interconnection facilities normally consist of combinations of cable, and microwave transmitters and receivers. In some cases, a UHF or VHF broadcast transmitter, called a translator, might be part of an interconnection system.[1] The combination depends upon the "traffic" demands made upon the interconnection system, and the geography of the area of service. (The specific factors involved will be addressed in Section III of this paper.) Both technical approaches presume that the interconnection facility will link cable system headends.

There are several ways that interconnection facilities can be used to link public telecommunications services directly to subscribing agencies. The FCC, for example, has dedicated one portion of the microwave frequency spectrum (2,500 MHz) for use as Instructional Television Fixed Service (ITFS). The service is designed to link educational (and sometimes governmental) institutions in a microwave network which transmits educational programming. The key to the service is the low cost of the receiver — $500 for four channels instead of $4,000 to $5,000 per channel for most common carrier microwave receivers — which permits inexpensive link-ups to the system.

It is possible to use ITFS as an interconnection mode in those cases where not all schools are tied into cable systems. Programming for classroom instruction might be sent via ITFS microwave to the headends of cable systems which serve some schools, and broadcast direct to ITFS receivers in those schools not served by cable.

The system could be built with cable, if the cost of service delivery were competitive — as would probably be the case in systems where two-way communications were needed.

It may also be possible to deliver services directly to homes not connected to cable. For example, in a particular community (without cable, for the sake of discussion), it may not be economically sound to install a cable system because of low popu-

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[1]A translator is a broadcast transmitter used to extend the range of a television station into an area that does not receive the station's signal. The translator automatically receives the "weak" signal from the distant TV station, boosts its strength and retransmits the signal to homes in the unserved area.

lation density. If a television translator station were licensed as part of an interconnection system, it might be used to broadcast several channels (delivered by an interconnection system microwave link) to a rural community too sparsely populated to support a cable system (see Figure 2).[1]

Both of these examples illustrate the potential of a properly organized interconnection facility to extend public communications services beyond the reach of existing or potential cable systems.

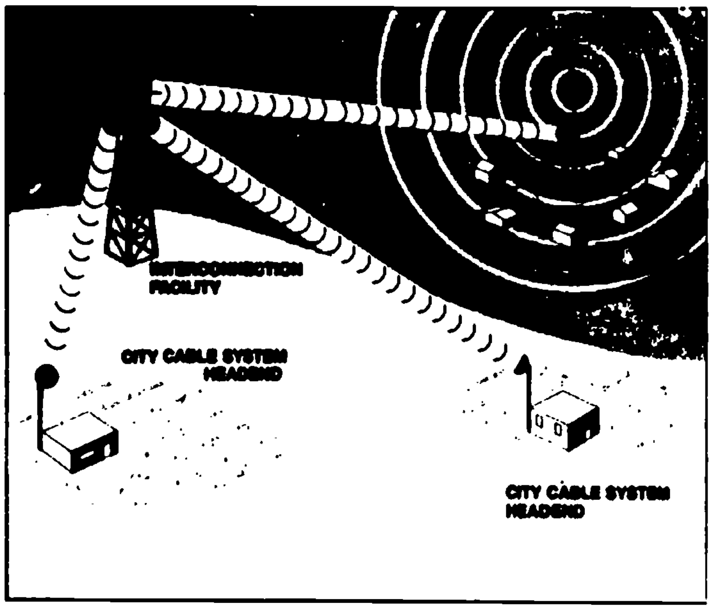

Figure 2. Television Translator as a Component of Interconnection System.

SUMMARY

Public interconnection facilities can potentially serve two broad purposes: they can permit the public services cable is capable of delivering to flourish, and they can permit the delivery of services not only via cable, but directly to users. Commercial forces will undoubtedly generate major interconnection facilities in tandem with the development of new networks. But there is no convincing evidence — at least in the short term — to believe that commercial interconnection facilities will be well suited to public local interconnection needs.

Public interconnection facilities provide a means for stimulating the development of public telecommunications services. Planning for and operating such facilities provides a basis for regional planning among different jurisdictions. It also encourages local and state officials to begin thinking in terms of the larger issues of telecommunications policy planning rather than simply the regulation of cable television. Both implications are likely to influence the long range development of public communications.

The remainder of this report examines the specific problems facing public officials who decide to promote public services through interconnection, and suggests ways to solve those problems.

[1]It should be noted that such an arrangement would require a waiver of present FCC rules which govern licensing of translators.

III. SOLVING LOCAL INTERCONNECTION PROBLEMS

Interconnection problems in voice and data communications have existed for a long time, and there are established precedents for solving public policy problems. But interconnection is a relatively new concept for cable television, and there is little in the way of established local public policy about how it should be handled. Were it not for the importance of the issue in terms of public services, a good case could be made for letting the forces of the commercial marketplace experiment and define how local interconnection services should be provided. In some situations, that may be the best solution, particularly if no mechanism exists for public planning and decision making on interconnection issues.

Local officials would be well advised to ensure that a study group is jointly formed to provide a forum for continuing study of interconnection on a regional basis. Such a group would differ considerably from region to region, but ideally it should be sufficiently official to assure that its recommendations will be seriously considered, and it should have sufficient staff and/or funding available to enable it to study effectivel, the issues that arise.

For the purposes of this report, it will be assumed that such a study group has already been established. Practical suggestions regarding the formation of such a group may be found in Appendix.

In the following sections, specific problems facing the study group will be categorized briefly and then examined in detail.

Interconnection questions can be conveniently categorized into four sets of issues. They are summarized below in the sequence that facilitates analysis by the study team. Each issue is examined in detail in the sections which follow.

1. Defining a Prototype Interconnection System

Since there is no "standard" interconnection system (as there are "standard" cable systems), the study group must develop a prototype that would be feasible for the communities in question, as a basis for further discussion and analysis. This prototype development involves engineering and financial analysis, but it is not in any sense a final design. It provides participants in the decision making process with a concrete specification of what an interconnection system could be. Once this point is reached, the study team can proceed with further analysis and decisions much as it would do with cable television.

2. Investigating National and Regional Jurisdictional Issues

There exists relatively little settled body of law explicitly devised to deal with local interconnection service. Instead, components or aspects of interconnection service may invoke diverse provisions from federal, state and local law governing such matters as public utility regulation, federal licensing requirements, antitrust prohibition and authority for concerted public or private action, to name just a few. Since few of these laws will have been designed to govern interconnection, and because the particular law involved will vary greatly from state to state, a thorough legal inventory is an important prerequisite to further action.

3. Defining Issues for Decision

The study team should next identify what decisions must be made. Fundamentally, they fall into these categories:

— How shall prototype design be modified before the system is built?
— How shall the system be owned and financed?
— How shall it be managed and operated?
— How shall it be regulated?

All of these decisions are interdependent and therefore need to be considered together. The study team should define them in terms of alternative choices, with the economic and public policy consequences of each alternative explored as fully as possible.

4. Devising a Strategy for Implementation

Because the regional planning agency may not have the power to make decisions for participating local governments, the study team will have to devise procedures for educating local government officials and the public, for securing the legal authority and financing to proceed and for establishing the management and regulatory mechanisms decided upon.

Each of these four sets of issues will be explored in detail in the parts of this section which follow.

Defining a Prototype Interconnection System

It is difficult to ascertain what interconnection services customers in fact desire and are willing to pay for, if they cannot be shown exactly what services will be offered, and at what prices. The reason is in part that local planners will not know who all the potential customers will be. However, the most important reason is that cable system operators, educators and public service agencies may not know what kind of interconnection services would be useful to them. And, even if they did, they would not be likely to make meaningful commitments for the purchase of such services unless they knew the price. But, the price of one service is virtually impossible to determine unless all users' needs have been identified.

Unfortunately, pricing specific interconnection services requires that the system be designed, assumptions made about how it would operate financially and prices derived from analysis of the assumed financial operations.

Once all of this is accomplished, enough is known about interconnection service to permit concrete judgments to be made about how valuable the service is to users (and, therefore, who will purchase the service), and specifically how the service should be provided.

Specifically, three steps are required:

— Development of assumptions about demand upon the system

— Engineering design of a system to meet those assumed demands, including specification of hardware costs

— Financial analysis of the proposed system, to determine its economic viability under assumed conditions, and to devise a schedule of rates for further discussion with potential users.

DEVELOPMENT OF ASSUMPTIONS ABOUT DEMAND

From an engineering perspective, questions about system usage are very straightforward; designers need to know where each point of interconnection is located, the kind of signal traffic involved (frequency, capacity, one way or two way, etc.) and the time schedule for use of the system. However, the answer to such questions from a user point of view are difficult to define if users do not have considerable experience in the use of telecommunications to support their activities.

The most promising way for the study team to resolve this "chicken and egg" problem is to define possible ways for users to take advantage of interconnection, to discuss the possibilities with potential users and to decide upon meaningful assumptions that will permit engineering design and financial analysis. Confirmations and adjustment of the assumptions can be made later.

Potential uses of interconnection can be logically categorized broadly as follows:

— Government uses
— Educational uses
— Health services delivery uses
— Business uses, including cable system operator's needs as well as the communications requirements of other business firms
— Public access
— Sports
— Arts & culture.

Further, each of these categories can be subdivided in terms of using interconnection to communicate with other institutions, or with a specified general audience.

The study team should draw up a list of potential communications activities within each category and evaluate those which would require the use of an interconnection system.

It is not possible here to define a list of every conceivable use which would fit within each category, but some illustrative examples may make the analytical process involved more clearly understood.

An Example: Police and Fire Communications

In its discussion of possibilities, the study team examines police and fire communications. Police and fire officials describe two general kinds of communications needs applicable to the general public. One is an emergency capability to override commercial television broadcasting on all available channels in the event of an impending or ongoing disaster. The other is the capability to telecast weekly public information programs designed to educate the community about programs and goals of the police and fire departments, and suggestions about public safety.

On the one hand, discussions reveal that an effective emergency communications override capability must encompass an entire metropolitan region, and interconnection is therefore involved. But on the other, local public education programs must be developed to support each local fire and police department. Programming is thus not likely to cross the jurisdictional boundaries of each of the involved communities (and thus their cable systems), and interconnection is not required.

Next, the study team examines the potential institutional uses that might involve interconnection of police and fire departments. Four possibilities are identified:

— Both police and fire departments need the ability to transmit to every station educational programs to improve the level of training of police officers and firemen.

— Police stations need to be linked together to transmit video displays of missing persons, criminal suspects and other information not easily conveyed by written and spoken word.

— The state highway department plans to install video traffic surveillance cameras on all commuter access highways as part of program to improve rush hour traffic management.

— Both police and fire departments would like to install medical telemetry systems connecting rescue vehicles with the hospital emergency room.

Analysis by the study team reveals that the state university is the best source of educational programs, and it should be connected to every police and fire department in the region with one private television channel. Video origination from every police station is feasible, but very expensive. The study team defines two alternative levels of service: modest studio facilities at each precinct, with a regional interconnection network of four channels linking precincts; or, a studio facility at police headquarters in each community, and one regional interconnection channel. The study team learns that the traffic surveillance network involves 30 cameras on six major highway routes. The highway department can monitor as many as five cameras at once, and would like to be able to remotely control the cameras from a central monitoring and control facility downtown. Further, the team learns that the surveillance network is needed only during daylight, and rush hour in the evenings.

Finally, the team's analysis reveals that medical telemetry systems require radio transmitters in each police and fire vehicle, which send coded signals back to a central metropolitan hospital. The signals are then displayed to medical personnel. The system relies on radio broadcast, and therefore neither cable television systems nor interconnection are involved.

Similarly, the study team analyzes educational needs, sorting out services to the general public versus services to schools, and services which involve interconnection versus those that do not. Clearly, this initial effort involves some research efforts on the part of the study team, both in the area of basic telecommunications technology and in the area of public service activities. But this is neither an effort to design a system nor to secure agreement among participant agencies about what the system should do. It is an initial attempt to develop a list of plausible interconnection services, given the specific circumstances of the region involved.

The next step should be a series of discussions with potential users in each of the participant communities to refine a rough list of possibilities into specific assumptions (or alternative sets of assumptions) which will permit engineering design. How this step should be accomplished depends heavily upon local circumstances. In one group of communities the study team may wish to hold public hearings, to give interested citizens in each community an opportunity to contribute to the study effort at an early stage. In a large metropolitan area, however, it may be impractical to visit every community until later, when the final plan is presented for public discussion. The study team in this instance might assemble an advisory committee of experts in local government, communications technology and private enterprise to assist the study team. In large part, the decision regarding procedures to refine the list of service demands should be based upon the composition and experience of the study team. A task force composed of electrical engineers, economists and representative administrators from each of the public agencies concerned may be able to develop a list of service assumptions without outside consultation, especially if they are familiar with the region.

Once this information is assembled, it will become the basis for detailed engineering (discussed in the next phase which follows). The transition from locally defined service needs to technical specifications is a critical one. Many important policy issues might be buried in detailed engineering work if the dialogue between the study team and engineering consultants is not defined with precision. The procedure described here may be helpful. The study team can categorize its list of service assumptions by preparing a series of data sheets for the engineers in the following manner:

Proposed use description — a detailed description and evaluation of each proposed use, including an assessment of the extent to which planning and implementation of the proposed use has progressed (see Table 1, pp. 20-23).

Service summary — a summary list of proposed uses, tabulated according to basic kinds of capacity demands to be met by the interconnection system (see Table 2, p. 24).

Maps of the region — annotated to show the locations of installations to be connected (with the codes referring to proposed use description sheets), heights of tall buildings and areas in which cables must be installed underground.

There are, of course, other ways to define and tabulate service assumptions. The examples are given simply to show how information can be elaborated in sufficient detail to permit engineering design.

ENGINEERING DESIGN OF THE SYSTEM

An engineering consultant charged with developing a specific design should do four things:

— Decide in detail which interconnection services should be independent of cable systems (that is, which are better suited for direct connection to the user's facilities).

— Make estimates for built-in excess capacity and approaches for adding capacity in the future.

— Design a system which provides all of the stipulated service and excess capacity requirements, meets technical standards for signal quality, and does so at approximately least cost.

— Specify the system design, in terms of cable, amplifiers, microwave equipment and switching equipment for each link in the system; the hardware and construction costs for building the system; and the technical performance capability of the system. Also included should be suggested design concepts and technical standards for cable systems in the participating communities, for discussion either with operators of existing systems (who may have to modify their systems) or with local governments developing a franchise ordinance.

The engineering consultant will need the assistance of the study team in the early stages of engineering design, both for acquisition of data and for advice about status of the cable television franchising process in each community yet without cable service. Feasible locations for cable system headends, interconnection cable routes and microwave paths must be decided upon. Some of the

(Text cont'd. p. 25)

Table 1(a). Proposed Use Description

1. General description of program
Regional Medical Telecommunications System: Continuing Education for Doctors at Home Program

2. Project number (for summary sheet and map reference) *#27*

3. Sponsoring agency *Metropolitan Medical Association*

4. One-way services:

a. General description of programming (e.g. live, videocassette, film chain, etc.) *Existing materials on 16mm film; gradually being converted to 3/4" color videocassettes. Occasional live programming.*

Number and kinds of channels *1 color TV channel, with some degree of privacy preferred.*

Time period of transmission (hours and days) *Live programming between 4:00 PM and 7:00 PM Monday-Friday; cassettes to home VTR's when convenient.*

Building location and height *State University Medical Library (UTM coordinates PZ 632529); building height 104 feet.*

Facilities description (e.g. studio equipment) *Operating room studio with 2 color cameras; 16mm film chain; computer-controlled 3/4" video cassette player; patching and control equipment. Studio and library linked with cable headend by cable.*

b. Audience information:

Description (e.g. general public, cable TV subscribers, doctors at home, schools, etc.)
Doctors at home; general hospitals and local clinics

Projected number of subscribers (for institutional users totaling 20 or less, attach list of specific identification, location in coordinates and building height)
Approximately 375 doctors at home; State University Hospital; Metropolitan General Hospital; six local clinics (additional data attached)

Terminal equipment required: (i) Television sets Yes *X* No __ (ii) Color Yes *X* No __

c. Special service requirements (privacy, special terminal) *Privacy, either by converter or decoder; 3/4" videocassette player with record capability.*

5. Two-way services: *Not applicable*

a. Master facility information

General description of communications use ________

Number and kinds of channels from master facility to subordinate stations ________

Time periods of transmission (hours and days) ________

Building location and height ________

Facility description

b. Subordinate facility information

Number of subordinate stations

Subordinate facility description, location and building height (attach list, if necessary)

Terminal facilities description

Description of upstream signal traffic to master facility (including bandwidth and frequency, if known or necessary)

c. Number of simultaneous users (i.e., minimum number of simultaneous two-way conversations).

6. Project status evaluation

a. Describe existing program, including date it began, its source of funds, capital and operating budgets and nature of the facilities used (use additional sheets if necessary).

Program began in 1971, as cooperative venture between State University Medical Library and Metropolitan Medical Association. Library loaned over 1400 films to two general hospitals and six clinics, for exhibition to off-duty doctors. State University paid $1.3 million for library building and films; doctors pay $25 annually to support program through Metropolitan Medical Association. Operating room studio installed in 1972 at a cost of $150,000. Cable link established this year, but not yet operational. At home program presently stalled because only 100 doctors live within boundaries of local cable system.

b. Describe status of planned new program that will involve interconnection. Discuss prospects for funding, size of projected budgets and the status of planning for the new program (use additional sheets if necessary).

Metropolitan Medical Association survey indicates all doctors willing to pay $300 per year for service which permits at home recording of programs for replay at doctors' own schedule. State University has budgeted $400,000 for development of videocassette library; computer-controlled VTR purchased 1973. The three cable operators involved have agreed to supply channel free in exchange for right to lease channel converters to doctors. Local TV distributor will lease VTR's. Program planned to begin by fall 1974.

7. Remarks (use this section to expand on comments above, and to describe the degree of potential user interest).

Metropolitan Medical Association unusually active in this area; it requires member doctors to take five update courses each year, with examinations held at State University for all participants. Doctors must be relicensed every four years. New program looked upon with great interest because it will facilitate existing programs. Both Medical Association and State University officials are quite familiar with software problems and budget implications. Interconnection seen as key to area wide program. Planning is well advanced, and financing is likely to be no problem once interconnection facilities are approved and construction begun.

8. Responsible study team contact person:

Name

Address

Telephone number

Table 1(b). Proposed Use Description

1. General description of program
   Regional Medical Telecommunications System: Telediagnosis Program

2. Project number (for summary sheet and map reference) *#28*

3. Sponsoring agency *Metropolitan General Hospital*

4. One-way services: *Not applicable*

   a. General description of programming (e.g. live, videocassette, film chain, etc.)

   Number and kinds of channels

   Time period of transmission (hours and days)

   Building location and height

   Facilities description (e.g. studio equipment)

   b. Audience information:

   Description (e.g. general public, cable TV subscribers, doctors at home, schools, etc.)

   Projected number of subscribers (for institutional users totaling 20 or less, attach list of specific identification, location in coordinates and building height)

   Terminal equipment required: (i) Television sets Yes____ No___; (ii) Color Yes____ No___

   c. Special service requirements (privacy, special terminal).

5. Two-way services

   a. Master facility information

   General description of communications use
   Metropolitan General Hospital Telediagnostic Center to provide 24 hour diagnostic services to State University Hospital and six local clinics, using two-way video and data communications.

   Number and kinds of channels from master facility to subordinate stations *Black and white TV channel with audio to each clinic and hospital; potential future links to airport, bus and railroad stations*

   Time periods of transmission (hours and days) *24 hours daily, 7 days a week*

   Building location and height *Metropolitan General Hospital (UTM coordinates PZ 326943); height 160 feet*

Facility description *Initially 3 control consoles, each with color TV display, black and white camera, microphone, facsimile reproduction and computer terminal. Each unit can be patched to each clinic and hospital. Two consoles to be added later.*

b. Subordinate facility information

Number of subordinate stations *7 initially; 9 later*

Subordinate facility description, location and building height (attach list, if necessary)
University Hospital, six local clinics (list attached)

Terminal facilities description *Emergency Room Telediagnostic Center includes black and white monitor; color TV camera; microphones; EKG equipment and transmitter; facsimile transmission.*

Description of upstream signal traffic to master facility (including bandwidth and frequency, if known or necessary)
One color TV channel from each clinic, with audio and data channels. Bandwidth unknown, but audio and data channels can be carried on telephone lines.

c. Number of simultaneous users (i.e., minimum number of simultaneous two-way conversations).
Initially three simultaneous two-way video conversations; later expanded to five.

6. Project status evaluation

a. Describe existing program, including date it began, its source of funds, capital and operating budgets and nature of the facilities used (use additional sheets if necessary).
Clinics and general hospitals presently tied together via telephone for facsimile exchange of records. Metropolitan General Hospital has $300,000 grant for construction of remote EKG telediagnosis by mobile radio, using six emergency rescue vehicles. Program to begin operation early 1974, with local communities paying operating costs for emergency vehicles.

b. Describe status of planned new program that will involve interconnection. Discuss prospects for funding, size of projected budgets and the status of planning for the new program (use additional sheets if necessary).
Hospital project manager for EKG program has received approval for TV-based system, and has applied to HEW for $400,000 grant. Local share to be $300,000, and has been budgeted, contingent upon HEW grant. Present planning has not yet dealt with link between clinics and Metropolitan General Hospital, but is looking at both cable and ITFS microwave.

7. Remarks (use this section to expand on comments above, and to describe the degree of potential user interest).
Records exchange program has been very successful, and project manager has support for both emergency rescue vehicle program and TV telediagnosis. No apparent hospital experience with telediagnosis, but several doctors and the chief administrator have observed Mass. General and Mt. Sinai experiments. An equipment firm has provided cost and performance data for the master and subordinate consoles, which it manufactures. Cable operators thus far have not provided cost of dedicated channels or private cable. Program will be implemented if HEW approves grant. Federal officials want further analysis of cable versus microwave options.

8. Responsible study team contact person:

Name __________
Address __________

Telephone number __________

Table 2. Summary of Proposed Uses

One-Way Users: summary list of potential users of the interconnection system's one-way communications capability

Use Description	Type of Signal Traffic	Source Description and Location	Subscriber Description and Location	Use Schedule
State University Extension Courses	4 color TV channels	University audio/visual department	Cable TV home subscribers, public libraries	Mon.-Fri. 9-11, 1-4, 7-9
Regional Primary School Instructional Television Program	1 color TV channel	Educational TV station WXYZ-TV studios, downtown area	All primary schools	Mon.-Fri. 9-11
Metropolitan Fire Department In-Service Training Program	1 color TV channel	Colorcast, Inc. downtown studios	All fire stations	Mon.-Fri. 1-3
Regional High School Football League	1 color TV channel	Videotape – can be introduced at main interconnection facility	Cable TV home subscribers	Saturday 4-6
State Medical Association Surgical Techniques Program	1 color TV channel, with privacy	Metropolitan General Hospital audio/visual facility	All regional hospitals, clinics, private group practice offices	2 weekdays 3-5

Two-Way Users: summary list of potential users of the interconnection system's two-way communications capability

Use Description	Type of Signal Traffic	Master Station Description and Location	Subordinate Station Description and Location	Use Schedule
Regional College Cultural Exchange	1 color TV channel each way	University audio/visual department, College Park	Southtown Community College Beltsville Community College Jones City Community College	2-way Mon.-Fri. 9-11 1-way Wed., Thurs. 7-9
State Public Safety Department Police Communications System	1 color TV channel each way, with privacy	Metropolitan Police Headquarters, with microwave link to state network	1) All precinct stations or, 2) Two-way facilities only at regional headquarters	2-way 24 hours a day
Metropolitan Hospital Corporation Telediagnosis Program	1 color TV channel each way, with privacy and digital channel one-way	Metropolitan General Hospital Telediagnosis Department	3 general hospitals, 18 clinics	2-way 24 hours a day
State Highway Department	Black and white video from 30 cameras; digital control signals to each camera	Traffic Management Headquarters, with five monitor and control consoles	5 remote control cameras, on 6 radial highways	Daylight (until 7:00 p.m. weekdays)

interconnection demand assumptions assembled by the study team may turn out to be impracticable or unrelated to interconnection systems. The consulting engineer should make adjustments to the system demands, add estimates of excess and future capacity and refer compiled service demands to the study team for approval.

The engineering design itself involves creating a general layout concept, and defining in detail how the link between each interconnection point works. The purpose of the engineering effort is not the production of blueprints, since the design is likely to be modified in later stages of the implementation process. Rather, the engineer details the design to the degree necessary to produce capital cost estimates (for the financial analysis) to state precisely the electronic performance characteristics of the interconnection system's two-way communications capability and to define requirements for cable systems connected to the interconnection system.

It may be possible to assemble the necessary engineering talent for this design phase from within the communities involved, rather than using consultants. But study teams are likely to need professional engineering assistance. If the scope of the interconnection problem is not too large — an interconnection system linking four cable systems and two sources of program origination, for example — it may be possible for the study team to secure the engineering effort by soliciting bids from private communications firms interested in providing the service. But for a major metropolitan area, the interconnection system is likely to be so complex as to require an independent engineering consultant, at least at this preliminary stage.

The engineering design will be very specific for the particular region where it will be built, and it is not possible here to describe what a typical system will look like. However, each of the technologies which an interconnection system might use have typical layouts and capabilities, and it may be useful to illustrate examples.

If the number of interconnection points is low — for example, three cable system headends — and all that is desired is the ability to exchange locally originated programs or to tie certain cable system subscribers together in a data communications network, the simplest method might be to lay cable connecting each headend (see Figure 3). This might be the configuration several cable operators would construct for themselves. The system could operate one-way or two-way in each link, as needed.

If there were more than three interconnection points, and if the purpose of interconnection was

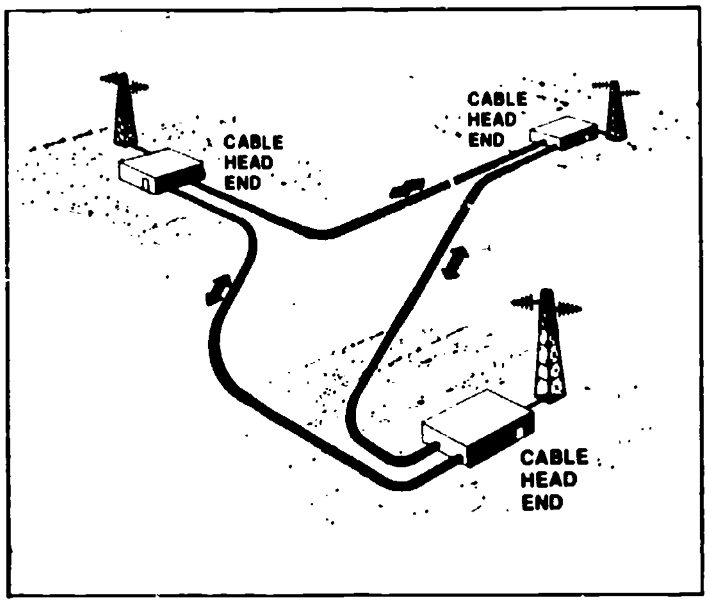

Figure 3. A Cable Interconnection System.

to distribute programming one-way to all of these points, the interconnection system might employ LDS microwave. In this case, the LDS transmitter would beam signals from one central point — atop a mountain or building or near a satellite ground receiver, for example — to each of the separate headends, or hubs (see Figure 4).

LDS transmitters for 18 channels cost upwards of \$100,000; broadband receivers about \$7,000. Because of the lopsided costs between receivers and transmitters (and also because of technical problems), LDS microwave hub systems presently are seldom used for two-way communication. Some straightforward mathematics illustrate why.

If there were five cable system hubs, all within 20 miles of one LDS master transmitter, a one-way system would cost:

Master facility:	\$100,000
Hub receivers: 5 × 7,500 =	37,500
Total	\$137,500

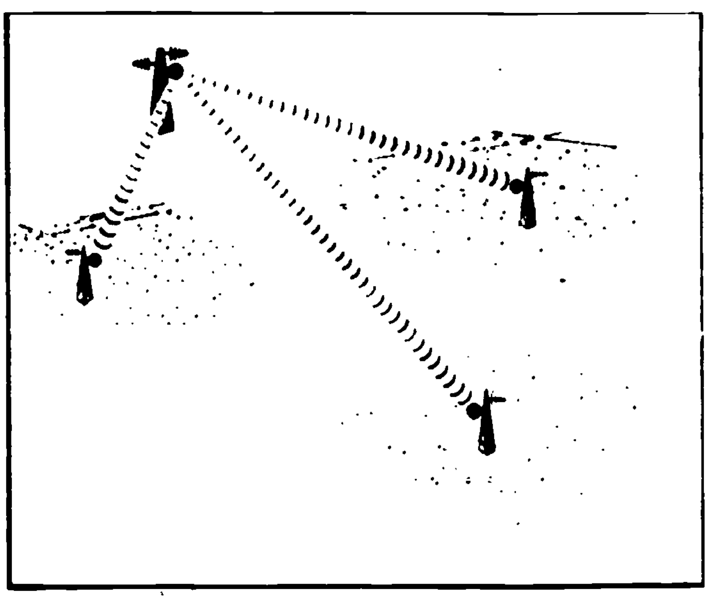

Figure 4. A One-Way Microwave Interconnection System.

But a two-way system, with receivers and transmitters at each hub for two-way communications with the interconnection master facility, would be much more expensive. For example (see Figure 5), suppose each hub transmitted two channels back to the master facility. Each used two single-channel microwave transmitters (costing $7,500 each). And the master facility received all 10 channels with an additional $7,500 broadband receiver. Costs would then be:

Master facility:	
Downstream transmitter	$100,000
Upstream receiver	7,500
Hub facilities:	
Downstream receivers	
5 × 7,500	37,500
Upstream transmitters	
10 × 7,500	75,000
Total	$220,000

As was noted earlier, two-way LDS systems are a new concept, and there are no such systems presently in existence. Further, under present Federal Communications Commission CARS band frequency allocations the maximum number of channels available for LDS is 39. While each downstream channel can be broadcast to a number of hubs, upstream microwave (for technical reasons) requires a separate channel for each upstream link. Thus, in the example above, the hypothetical system consumes 18 channels downstream, plus 10 channels upstream, for a total of 28 channels. This would leave only 11 channels for system expansion.

A more efficient system for two-way communications, with capacity for expansion, involves reserving LDS for downstream hubs — where each channel can have more than one hub — and adding a return link from each hub to the master facility

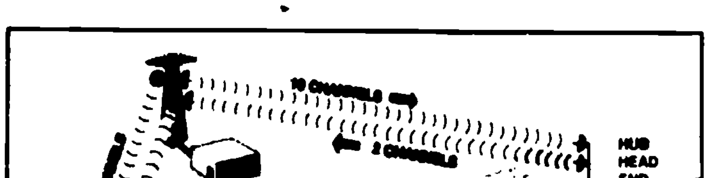

Figure 5. A Two-Way Microwave Interconnection System.

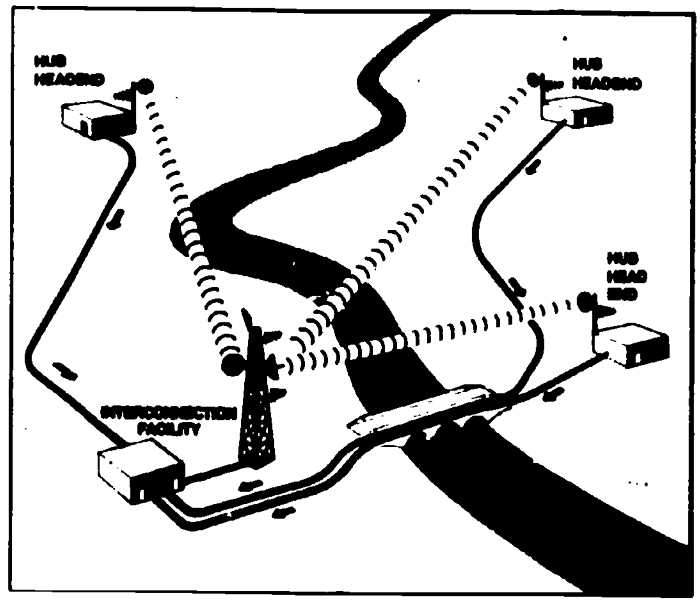

Figure 6. A Cable and Microwave Interconnection System.

via cable. An example of a mixed microwave-cable system is shown in Figure 6. This system permits substantial expansion. Note that all communications between hubs would be routed through the master LDS facility, as compared to the direct hub-to-hub cable system shown previously in Figure 1.

Not all interconnection problems can be solved with a wheel-and-spoke shaped system involving hubs. Some circumstances may require a linear system, analogous to a railroad line, in which signals are carried back and forth past a series of intermediate stations. This is likely to be the case in less densely populated rural areas, where pockets of population are strung out along a major transportation route.

Both microwave and cable systems can provide such service; the choice depends upon services required, and distances traveled. For example, LDS microwave can be used to broadcast from a master facility in one direction to a series of receivers aligned at various distances along the transmission path. Each receiver can then be used to feed a local cable system in the community where the LDS receiver is located (see Figure 7).

LDS is a broadband microwave system (that is, it broadcasts a large number of channels with a single transmitter). Present technology does not facilitate linking chains of LDS transmitters and receivers to extend the transmission distance past 20 miles. However, lower capacity microwave systems which use another kind of electronic processing, such as common carrier FM systems, can be linked together to cover long distances.[1] As noted earlier in Section II, this common carrier concept

[1] Specifically, LDS uses amplitude modulation (AM), while the others use frequency modulation (FM). As in radio, FM is less subject to interference.

is well established for long distance transmission of data and telephone signal traffic, as well as television signal carriage. Further, common carrier microwave can be used in both directions, as shown in Figure 8.

All of these components can be combined to provide a tailor-made system. Further, the systems which serve each city could be tied to a statewide network and a national satellite network. For example, a state system might consist of a "backbone" common carrier microwave chain traversing the state, carrying four channels of educational programming from two state universities. At stations near each city (see Figure 9), an ITFS microwave spur would carry educational signals to the master LDS microwave system serving cable systems and closed circuit users in each city.

The LDS microwave would then broadcast these channels along with local origination signals and leased channel signal traffic to each of the several cable systems in the metropolitan area. Each cable system would be connected to the LDS facility (for "upstream" communications) by coaxial cable. Cable links would also be used to connect heavy capacity closed circuit users to the system.

The precise configuration that could be feasible for a given region and a planned set of uses is a matter of engineering judgment, and requires careful analysis of comparative costs and technical capabilities of each of the separate technologies. The result is an engineering concept elaborated in sufficient detail so as to permit financial analysis and determination of user rates.

FINANCIAL ANALYSIS OF THE PROPOSED SYSTEM

In order to calculate what prices could be charged for interconnection service, some assumptions must be made about how the enterprise would be financed and operated. The most useful and straightforward way to do this is to assume that the interconnection service will be operated independently, in a fashion that permits the service to pay for itself. The actual service might be financed and managed as a public authority, or as a private venture, but the fundamental assumption — that the service would be self-sustaining — would still apply.

Based upon the capital costs of the proposed system and assumptions about the rate of system construction and build-up of subscribers, an analysis is made of operating costs. A cash flow schedule for 10 years of operation is formulated, and from this actual investment costs are calculated. For

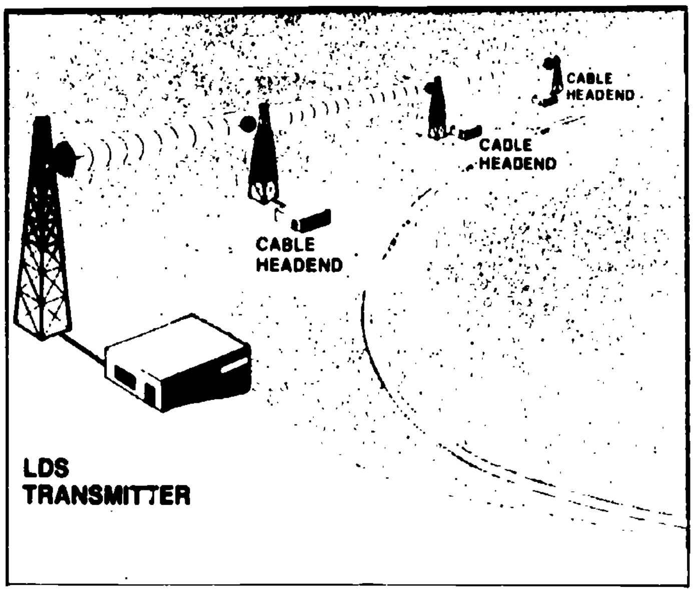

Figure 7. Microwave Interconnection of Several Cable Systems with a Single LDS Transmitter.

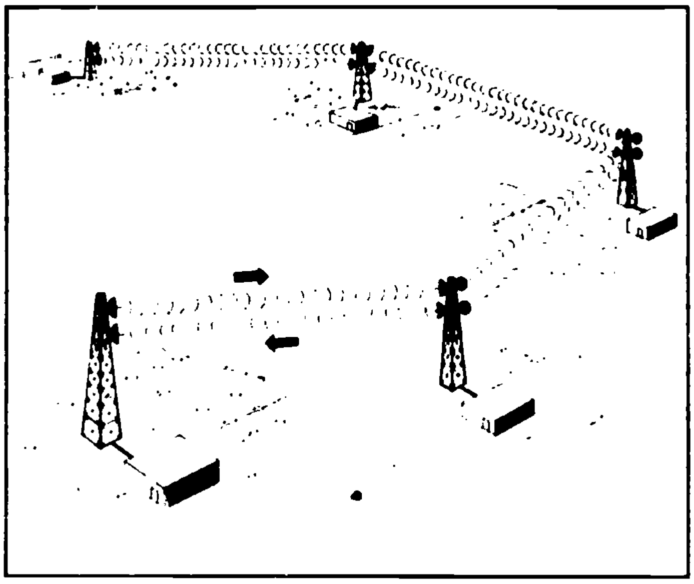

Figure 8. A Two-Way Common Carrier Microwave Network.

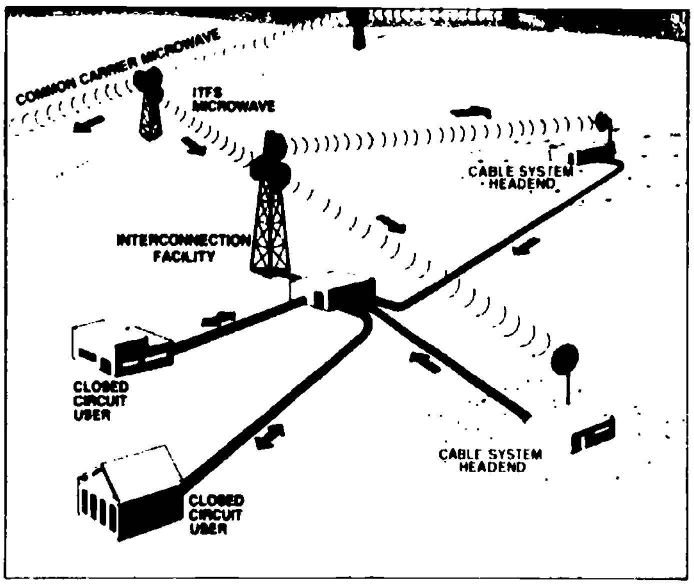

Figure 9. One Type of Combined Interconnection System.

private enterprise, a debt-equity ratio is assumed, tax and depreciation factors added and a suitable rate of return on equity assumed. For public ownership, 100 per cent debt is assumed, using representative municipal bond interest rates.

The next step in the financial analysis involves a search for interconnection service prices which, given the assumption about debt, service demands and operating costs, will yield the target rate of return on equity. This can be done by hand or by computer.

The end result of the analysis should be, at a minimum, a 10-year pro forma estimate setting forth the financial status of the system for each year of operation, a complete explanation of the assumptions used and a description of the price schedule. Additionally, the analysis might include an exploration of the price implications of several alternative sets of assumptions. For example, if the study committee could not ascertain whether the secondary school system should rent two channels from the interconnection system, or three (perhaps because programming plans were not yet firm), both sets of assumptions might be analyzed.

Similarly, the study committee might wish to compare the operation of the interconnection system under public versus private ownership or examine the impact of assumptions about how quickly the system is constructed and users subscribe to the service. This kind of calculation is called sensitivity analysis, and it is one of the most useful tools available to local officials who face complex and frequently puzzling decisions.

The price schedule for interconnection services that results from the financial analysis is likely to be one of the most critical and easily misunderstood elements of the study team's efforts. There are two reasons for this. On one hand, the price for services may be one of the most vital issues affecting the decision of an agency contemplating a major programming effort. On the other, the methodology used to define rates inevitably carries with it the important concerns of censorship and implied or explicit subsidies for certain classes of users. Some examples may make this point clear.

Suppose, for example, that a typical interconnection system consisted of an LDS master hub broadcasting 18 channels to four cable systems, each on the average 10 miles distant from the master headend and 15 miles from the nearest neighbor. Total LDS path distance would thus be:

$$4 \times 10 = 40 \text{ path-miles}$$

Defined in terms of channels, the LDS system's capacity would be:

$$4 \times 10 \times 18 = 720 \text{ channel-miles}$$

In addition, it includes seven channel cable links upstream from each cable system to the LDS facility for two-way capability, and a two-way, three channel cable linking each cable system with all the others. The total path-miles and channel-miles for the cable component would then be:

$$4 \times 10 + 4 \times 15 = 100 \text{ path-miles}$$

and,

$$4 \times 10 \times 7 + 4 \times 15 \times 3 = 460 \text{ channel-miles}$$

Finally, the system includes a 20-mile ITFS link which transmits four educational channels from the state education network to the LDS master headend. Capacity parameters for this component would be:

$$1 \times 20 = 20 \text{ path-miles}$$

and,

$$4 \times 1 \times 20 = 80 \text{ channel-miles}$$

The overall capital cost and capacity parameters for this hypothetical system are summarized in Table 3 below:

Table 3. Capital Cost and Capacity Parameters of Hypothetical Interconnection System

Component	Capacity	Path-Miles	Channel-Miles	Capital Cost
LDS	18 channels	40	720	128,000
Cable Upstream	7 channels	40	280	260,000
Cable Loop	3 channels	60	180	192,000
ITFS	4 channels	20	80	36,000
Control Centers				100,000
		160	1,260	$716,000

The development of overall cost and revenue figures for this system would require more detailed analysis. For the purposes of this discussion, however, a simplified approximation will be sufficient. The model used here to define revenue and cost relationships is as follows:

$$R = (OE + \frac{1}{d} + i)C$$

where

R = annual required revenue

C = capital cost

OE = annual operating expenses as a proportion of capital costs

d = number of years over which the system is depreciated or amortized

i = overall cost of capital, including interest and rate of return on equity, before taxes.

In effect, the model defines operating costs, depreciation charges and rate of return, as proportions of overall capital costs. From these figures, an annual revenue requirement (to cover the costs described above) is defined.

If it is assumed that operating expense (OE) is 30 per cent of capital cost, depreciation (d) is straight-line over 10 years, and return on investment (i) is 13 per cent, then required revenue (R) is:

$$R = (.30 + \frac{1}{10} + .13)(716{,}000)$$

$$= (.53)(716{,}000) = \$379{,}480$$

If the interconnection system operator charged an annual price for the use of the system on the basis of the number of channels (TV bandwidth) and miles of system consumed, then the price would be:

$$\text{Price (P)} = \frac{\text{Revenue per year (R)}}{\text{Channel-miles}}$$

or:

$$P = \frac{379{,}480}{1260} = \$301/\text{Channel-mile-year}$$

Assume that this price were applied to three of the many full-time users of the system:

— A regional educational authority which pays for the importation of the state educational network (four channels), and leases one of the three cable loop channels for closed circuit program exchange among community colleges.

— A consortium of law enforcement agencies, which leases two channels for a party-line two-way video network linking all police precincts in the region.

— A pay-cable distributor, who leases one channel on the LDS system to distribute programming to each cable system in the region.

The costs for each user would be:

1. The education authority:		
ITFS: 4 X 20 X 301	=	24,080
LDS: 4 X 40 X 301	=	48,160
Cable loop: 2 X 60 X 301	=	36,120
	Total	$108,360
2. The law enforcement network:		
LDS: 2 X 40 X 301	=	24,080
Cable upstream: 2 X 40 X 301	=	24,080
	Total	$ 48,160
3. The pay-cable distributor:		
LDS: 1 X 40 X 301	=	$ 12,040

However, if the charges were weighted by the difference in capital costs for each technical component of the system, the bills to each user would be quite different. Assuming the same operating, depreciation and capital investment charges, the price for use of each component would be:

LDS:

$$P = \frac{R}{\text{Channel miles}} = \frac{(OE + \frac{1}{d} + i)C}{\text{Channel miles}}$$

$$P = \frac{(.30 + \frac{1}{10} + .13)(128{,}000 + 100{,}000 \times \frac{720}{1260})}{720}$$

$$P = \$136/\text{Channel-mile-year}$$

Cable upstream:

$$P = \frac{(.30 + \frac{1}{10} + .13)(260{,}000 + 100{,}000 \times \frac{280}{1260})}{280}$$

$$P = \$534/\text{Channel-mile-year}$$

Cable loop:

$$P = \frac{(.30 + \frac{1}{10} + .13)(192{,}000 + 100{,}000 \times \frac{180}{1260})}{180}$$

$$P = \$607/\text{Channel-mile-year}$$

ITFS:

$$P = \frac{(.30 + \frac{1}{10} + .13)(36,000 + 100,000 \times \frac{80}{1260})}{80}$$

$$P = \$280/\text{Channel-mile-year}$$

With these prices, the user's bills would be:

1. The educational authority:		
ITFS: 4 X 20 X 280	=	22,400
LDS: 4 X 40 X 136	=	21,760
Cable loop: 2 X 60 X 607	=	72,840
	Total	$117,000
2. The law enforcement network:		
LDS: 2 X 40 X 136	=	10,880
Cable upstream: 2 X 40 X 534	=	42,720
	Total	$ 53,600
3. The pay-cable distributor:		
LDS: 1 X 40 X 136	=	$ 5,440

In terms of fairness to users, the latter pricing scheme more accurately reflects each user's actual consumption of resources. However, it is also likely to lead to under-utilization of the cable component of the system — which is the heart of the two-way system capability — and may over time be the most important element of the system.

Both of these schemes result in higher charges for users that are located far from the central LDS transmitter (or the center of the overall interconnection system), since prices are charged on a per-mile basis.

Clearly, the choice of pricing methodology has important consequences on which users subsidize which other users. Table 4 below summarizes the differences between the two pricing schemes:

Table 4. Comparison of Pricing Schemes for Users of Hypothetical Interconnection System

User	Average Price	Weighted Price
Educational Authority	$108,360	$117,000
Law Enforcement Network	48,160	53,600
Pay-Cable Distributor	12,040	5,440

Pricing schemes like those discussed above imply that the operator has no economic interest in the content of the information carried by the system. But in an actual market situation, agreements between the operator and users are likely to reflect in part the value the users place on the signals they want carried — especially if the interconnection operator exercises some monopoly power over the services. Thus, in the previous example, if the pay-cable distributor were serving 100,000 subscribers on the four cable systems, it might be worthwhile to pay as much as two per cent of gross revenues to use the interconnection system. If 50 per cent of the cable subscribers paid an average of $75 per year for pay-cable programming, the interconnection operator would receive $75,000 a year — more than six times the average price revenue calculated earlier.

There are positive and negative aspects to this kind of situation. The interconnection operator is likely to have considerable monopoly power, particularly if the system is expensive (and regardless of whether it is publicly or privately owned). If left entirely to maximize profit, the operator may seek users who, like the pay-cable distributor, consume little of the system with high value traffic, rather than expand the system to accommodate all users. However, charging for the value of traffic may permit the operator to offer lower rates to educational and other public agencies otherwise not likely to subscribe to interconnection service.

Operator incentives, the character of the interconnection service local market and the role of government regulation will have enormous influence on the actual rate structure under which the interconnection system operates. The study team should be aware of this as it evaluates the interconnection service prices generated by the financial analysis. Like the technical design of the system, these prices should not be treated as fixed, but instead as a base point for defining concrete decision alternatives.

Investigating National and Regional Jurisdictional Issues

Local officials planning interconnection services face four kinds of jurisdictional problems. First, interconnection normally will involve more than one local government. It is likely that the legal basis for joint governmental action to implement a regional interconnection system will be different from the basis for joint study. A metropolitan council of governments, for example, may be well situated to fund and direct a study effort, but lack the authority either to operate or franchise an interconnection system. Further, an interconnection system may serve jurisdictions not part of an existing regional consortium of governments.

Legal frameworks for joint action in the delivery of some public services are well established in most areas of the country. However, a form of joint action available in one state may be constitutionally prohibited in another. Further, the specific legal definition of what can be done inevitably varies from state to state, and within a state, and varies between rural counties and urban cities and towns. For these reasons, a thorough exploration of state and local law to determine what legal vehicles exist for operating or franchising an interconnection system is needed. Some examples include:

— Joint powers agencies
— Interstate compacts
— Public authorities
— Councils of government
— Regional planning agencies
— County governments
— Special purpose districts.

The second jurisdictional problem involves the role of cable system operators in the areas to be served. If the participating communities have operating cable systems, the interconnection system is likely to be involved in negotiations with cable system operators about technical problems involved in connecting cable systems with different kinds of equipment, as well as matters such as contracting for distribution of signals desired by the cable operators. Two kinds o. issues are involved here: the authority of the interconnection system or participating local governments to stipulate interconnection requirements (including system technical standards for signal distribution), and the framework for resolving problems of signal exchange between cable operators subject to different television market requirements.

Participation in a regional interconnection system is normally in the interest of a cable operator, whose market penetration will increase if the system has more services to offer. But it is possible that cable operators will not find it in their interest to participate. Whether or not they can be compelled to do so — particularly if technical standards require a substantial upgrading of their systems — depends mainly upon the provisions of the specific franchise granted to each operator, and the status of state legislation. Both need careful examination.

Suppose, for example, the proposed interconnection system involved a new cable system operating inside one of the top 100 television markets; an old system also in a top 100 market but "grandfathered" in its right to import more than two distant broadcast television signals; and finally, a small market system. The FCC rules governing distant signal importation and channel capacity would then apply differently to each system — an important issue, if the cable operators plan to use the interconnection system to distribute distant signals.

If cable systems have not yet been franchised in the communities involved, the coordination problem is obviously much simpler, since interconnection requirements can be stipulated in detail in each community's franchise. Nonetheless, the need for careful examination of local franchise plans and FCC market requirements remains.

The third jurisdictional problem is an extrapolation of the second. If the proposed interconnection system is operated by a consortium of its potential users, it may impinge upon federal (or state) laws dealing with restraint of trade. Aside from the issues of internal subsidy between categories of users of the interconnection system, its monopolistic character may invoke — upon complaint — legal action against a governmental entity operating an interconnection system. In most cases, the law operates regardless of whether the enterprise is publicly or privately owned, but in any event legal research ahead of time is well warranted.

The fourth category of jurisdictional issues lies in the regulatory process itself. The FCC has not yet defined a set of rules or regulations which deal directly with the full dimensions of regional interconnection. An interconnection system using cable and serving 50 or more customers with services that include television station signal distribution, for example, could be classified under existing commission rules as a cable system. And if it were operating inside one of the top 100 markets, it would be required to furnish access channels and 20 channels of capacity — requirements that might be wholly out of touch with reality.

Similarly, if the interconnection system involved LDS microwave, it would be licensed by the FCC as a CARS facility. The commission envisioned CARS as a broadband microwave service operated by cable systems. A government-sponsored entity serving other than cable operators — regardless of how it was owned — would have to seek a waiver of the FCC rules in order to be licensed.

Further, state laws and regulatory agencies established to regulate cable systems and public utilities may have some elements of regulatory jurisdiction over an interconnection system.

Finally, there are specific state and local laws governing the use of public funds for public services.

Such matters as authority to issue general obligation, revenue, special district and industrial development bonds frequently contain requirements that affect regulatory relationships.

It is imperative that the study team conduct a thorough legal investigation of the laws that will affect the operation of the proposed interconnection system. It should be emphasized, however, that although the jurisdictional tangle listed here looks formidable, it is by no means insurmountable. As with any new public enterprise, the problems result from the newness of the concept rather than institutionalized resistance to the idea.

Defining Issues for Decision

Once the study team has explored the legal context (see p. 30) in which the system will operate, formulated service assumptions and created a system concept, it should begin to define the specific questions that will have to be decided before the system is implemented. As noted earlier, these issues can be conveniently categorized under four headings:

1. How shall the prototype design be modified before the system is built?
2. How shall the system be owned and financed?
3. How shall it be managed and operated?
4. How shall it be regulated?

PROTOTYPE DESIGN MODIFICATION

In the course of analyzing the basic design concept, the study team is likely to uncover questions about service assumptions, design specifications and prices, which will require decisions. Typical issues might include some of the following:

— Will it be possible to use the XYZ Corporation building for the LDS facility?

— Will all elementary schools in Jones City in fact be connected to the new cable system?

— Is it possible to string the cable links in the system alongside existing cable TV system cables, or must the interconnection system cables be strung independently?

— Is 30 per cent excess capacity in all parts of the system adequate, insufficient or too much?

In addition, all of the assumptions about service demands should be reviewed by potential users, who will want to see how their estimate of demand for service might be priced. Pricing schedules will be affected by additional users who decide that they can be served by the interconnection system proposed, and by those projected users who, after seeing proposed prices, decide not to subscribe. The juggling process involved is similar to that faced by all private entrepreneurs who must define their markets, but in this instance the potential users are intended to be public agencies, whose use programs are not likely to be well established — a more difficult "bootstrap" effort.

As a result, it is worth an extra step on the part of the study team to discuss with potential users the results of the preliminary engineering and financial analysis. The results should be a stronger assessment of the services to be provided by the system, or a clarification of decisions which must be made to determine whether or not a specific public agency should undertake a telecommunications program that involves use of the interconnection system. The most common issues of this type that may arise will involve components of the system which will serve a single user, e.g., an ITFS link to a suburban high school, or a cable link to a distant clinic not connected to a cable system. Service questions such as these inevitably involve subsidy. Unless the single user pays the entire cost of the link, they are likely to be matters for political decision.

Similarly, the amount of excess capacity built into the system, though assumed in the financial analysis, will be a critical decision. Too much excess capacity will burden the initial users; inadequate capacity may mean costly rebuild (especially in cable links) later on. Although engineering judgment is involved here, the real issue is an assessment of the prospects for growth of telecommunications services in the region as time passes — a decision best made by local authorities.

OWNERSHIP AND FINANCING

Ownership questions should be considered together with management and regulation since each affects the others. However, the questions themselves are distinct and will be treated here separately.

It may be that once the regional authority which sponsors the study effort releases its report there will be a great deal of commercial interest in providing the interconnection service. In this case the study team should consider private ownership of the system as an option. The advantages are that none of the participating communities have to accept the economic risk inherent in the venture, and that public and private users may share the use of the system. One potential source of commercial interest might be a consortium of cable operators served by the system.

However, a commercial enterprise, if not properly regulated, may pursue objectives which are not in accord with the fundamental intent of the interconnection effort — the development of public services. For this reason, public ownership may be a more appropriate vehicle for pursuit of system objectives. If public ownership is decided upon, it could take several forms, depending upon state and local law. Some examples are:

— Independent public authority
— Urban service district
— State agency
— Central city agency, with contract arrangements with other cities and towns.

A key issue in selection of public ownership form is how the system will be financed. The usual arrangement is municipal bond authorization. If a new public authority is created, with power to issue revenue bonds, it may have difficulty marketing the bonds without a secondary pledge from the participating local governments. The reason is that the bond markets may be reluctant to finance a major new kind of public enterprise for which there exists no data about financial vitality.

A more flexible — and cheaper — arrangement might be capitalization through contributions from the capital budgets of participating state or local governments, based, for example, on a population formula. This would eliminate the cost of debt service and perhaps permit a lower price structure.

In many cases, mixed public and private ownership arrangements may be the best solution, particularly if both public and private agencies will use the system. Thus, for example, a state department of education might finance the construction of ITFS links in a regional system; local governments, through industrial development bonds, the LDS and cable links; and cable operators, a satellite ground receiver station. The system might be leased to and operated by a local profit or nonprofit corporation.

In part, the ownership decision depends upon what an examination of local and state law indicates is permitted. Mixed public and private arrangements, for example, may be constitutionally prohibited by state law. Further, ownership options may be reduced if the FCC has already licensed an LDS or ITFS operator within the area to be served.

The other factors which impinge upon the ownership decision are management and regulation, which will be dealt with in the sections which follow.

OPERATION AND MANAGEMENT

The financial analysis, as noted earlier, presumes that the interconnection service would be operated as a de facto common carrier. Yet in many instances, both interconnection operators and local agencies will wish to combine signal carriage with an institutionalized effort to promote certain kinds of programming. Pay-cable is a good example. If interconnection operators wish to take advantage of the high profitability of pay-cable program distribution (assuming that it exists), they will seek the right to control the kind of pay-cable programming they must deliver. Similarly, a government interconnection agency such as MRC-TV Network, which serves government agencies in New York, New Jersey and Connecticut, will wish to use its facilities actively to promote programming for governmental uses.

Divorcing control of program content from signal carriage is normally used to safeguard equal access to a communications system and prevent undesirable censorship by the system operator. However, at the early stages of an interconnection enterprise, intelligently regulated program control and opportunities for promotion may be what are needed to develop uses of the system and build a market for its services. Later, once its financial viability is assured, the system might be converted to a common carrier. Thus, a private interconnection firm might be required to develop public user markets, and permitted to take advantage of proven commercial markets such as pay-cable, for a period of 5 to 10 years. Gradually, it could be converted to a common carrier operation, or required to divest itself at the end of the period of all programming interests.

An alternative way to achieve a balance might be the creation of two or more agencies: one charged with operation of the interconnection facilities and the others with promotion of categories of uses. For example, a government owned facility might be leased to a private firm chartered to operate as a common carrier. Promotion of public uses might be vested in a nonprofit corporation funded by each of the local governments, by a share of interconnection revenues and perhaps by federal or foundation grants.

Or, a government agency might — if permitted by law — own and operate a system, promote its public uses and lease a percentage of its capacity to a private firm for use in the private market.

Organizational arrangements such as those described are in some respects a substitute for detailed regulation of the system and should be considered in conjunction with decisions about regulation.

REGULATION MECHANISM

Microwave broadcast facilities are fully regulated by the FCC; cable facilities, depending upon how they are built and used, may be subject to regulation by the commission, local government franchising authority or a state commission. The study team may find, after examining the appropriate laws, that the regulation issue is entirely decided by existing state and local law. Or, there may exist no regulatory demands other than FCC licensing of the microwave facilities. In the latter case, state or local legislation may be required to establish a regulatory authority empowered to oversee the operations of the interconnection system. Whether regulatory power should be vested in a new agency or added to the portfolio of an existing agency is, of course, a matter for local decision.

The study team can best deal with ownership, management and regulatory decisions by defining alternative packages that are internally consistent. Some examples might be:

Alternative 1
System owned and operated by private firm. User prices regulated by metropolitan communications commission (new agency).

Alternative 2
System owned by an organization of local governments, leased to nonprofit corporation. Regulated by council of governments.

Alternative 3
System owned and operated by public authority. Regulated by state cable commission (existing agency).

The end result of the study team's effort should be a report which defines decisions (and options) to be made by the participating local governments. How those decisions are actually made depends upon the nature of the regional authority which commissions the study team's efforts, and the legal and political means by which participating local governments can arrive at a consensus for concerted action. These issues are dealt with in the next section.

Devising a Strategy for Implementation

Implementation, from the study team's point of view, involves two issues:

— How will decisions be made about the interconnection system concept?

— How will the administrative structure to implement the decisions be created?

Devising a procedure for making decisions is not very different from doing so for other kinds of regional services. If there is a formal decision making body, such as a metropolitan council of governments, already in existence, then the pattern for arriving at decisions will be established. In this case, the council might hold a series of public hearings on each of the decision issues outlined by the study team, and then make its decisions. Subject to the council of governments' charter, those decisions may then require state legislative action, ratification by member local governments or simply administrative implementation.

If the study team has a more informal status, such as a citizen's committee, decision making may involve a more flexible process of generating public support for the project in each of the communities involved, and locating a public entity willing to take the lead. Since both of these approaches are familiar ones to most public officials, they will not be elaborated upon here.

Once the decisions are formally made and ratified, the study team should review what steps would be required to implement each decision option dealing with ownership, management and regulation, to ensure that the administrative feasibility of each option has been established.

If the system is to be privately owned and operated, for example, procedures for franchising and regulating the operator must be devised. Similarly, authority for resolution of disputes between cable system operators and the interconnection operator, or between local governments and the interconnection operator, must be established. Legislation may be required to arm a state agency or a regional commission with continuing regulatory authority.

If decisions call for public ownership or mixed public and private ownership, the stream of implementing activities will be very different. A public entity may have to be created, either by referendum, legislation or both. The authority to issue bonds, if applicable, must be created, and control relationships between the local governments and the public authority defined. Finally, administrative procedures must be established for the operation of the new authority.

One key issue in the implementation plan is the problem of tying the development of the interconnection system to the development of cable systems in each community. Ideally, all should proceed at the same time. However, in most instances there will be some cable systems already in operation while other communities will not yet have franchised (licensed). A time-phased implementation plan that accounts for the differences in cable development in each community can help reduce confusion. Another important mechanism is a document which lists specific ordinance requirements which must be followed by each local government. These include provisions for technical standards, public agencies to be wired and interconnection requirements (in those communities already wired, this will require negotiation with the system operator it the existing franchise does not require this cooperation).

SUMMARY

When the study team concludes its work, it should be able to report to its parent body with an analysis that permits intelligent and complete decisions. The format of the report is a local concern, and will not be suggested here. It should, however, contain these elements:

— The concept of public interconnection and local government's role
— A financial and engineering concept for a local system
— Issues for decision
— Suggestions for implementation.

The quality of the study effort rests less upon the sophistication and detail of the engineering analysis than it does upon thoughtful analysis of the implication of the decisions that must be made.

CONCLUSION

Many of the problems discussed in this paper may appear to be forbiddingly difficult. Busy local officials might be tempted to conclude that these "future" benefits to be derived do not warrant the effort. But the complexities of local responsibility stem mainly from the fact that interconnection is a new and largely unseen public concern.

It is precisely because state and local governments have not been involved in interconnection issues in the past that the opportunities are so large. The entertainment and communications industries will interconnect cable systems with satellites, microwave and cable without the assistance of state and local governments. The FCC will license firms to do so. But without local government intervention, the result may well be a disappointing lack of concern for local public services.

Local government initiative in regional interconnection can be the catalyst which forces communications technology to address problems of urban congestion, rural decline and a fading sense of community and place. Communications — especially television — have had an incredible impact on the individual's perception of world affairs. But too often it has been accompanied by a sense of alienation from the local community.

Flourishing local communications may help to restore the balance between perception of the "Global Village" and awareness of neighborhood and community. Cable television systems provide the technology for making this happen. Local government initiative in regional interconnection, with emphasis upon enrichment of public services and giving citizens access to the cultural and social resources of the community, can make the promise a reality.

APPENDIX:
A PROCEDURAL CHECKLIST

The following is a summary guide for action that sequentially lays out major steps that lead to the study, planning, development and implementation of a system of regional interconnection. Most of the steps outlined are treated at some depth in the preceding text. The purpose of providing this checklist is to provide a study team with an overview of the entire study effort and the interrelationship between the subject matter and the issues involved in the decision making process. The checklist might serve as a tool in organizing assignments and defining work products for the study group.

I. Organizing for the Regional Study Effort

Who takes the initiative?

This, of course, will vary in each community. It is mentioned here to mark the starting point of a study effort. The study itself might be initiated by any of a number of groups or individuals — interested mayors, city managers, school superintendents, councils of governments, area wide planning agencies, county officials or cable operators.

What would be a suggested mandate for the study team?

The team's members can be chosen more intelligently if its purposes and activities are at least generally defined in advance. A suggested mandate might include reporting responsibilities, a rough timetable, the audience for the report and the scope of the group's inquiry, whether as suggested in this paper, or otherwise.

Who should serve on the study team?

The study team will be concerned mainly with communications users, the technology and economics of telecommunications and problems of public organizations. All three perspectives should be represented. Potential user groups from which to draw would include:

> City and county governments, public and private schools, community colleges, universities, adult education and university extension departments, libraries, law enforcement agencies, hospitals, medical centers, neighborhood health centers, community organizations, minority groups, art and cultural organizations, banking institutions, insurance companies, computer centers and cable television companies.

Analytical skills might be drawn from:

> Experts in governmental organization, communications technology, systems analysis, electrical engineering, economics, urban planning, municipal finance and investment banking.

A careful process of recruiting will obviously enhance the quality of the study and reduce the need for consultants, especially if the team members are able to devote considerable time to the effort and can bring to bear various analytical skills.

What kinds of technical and financial support may be needed?

Each of the potential user groups may have some technical capacity or may have worked with special consultants who could assist in the study. Each participating group should be encouraged to supply much of the technical and support staff required; however, the question of financial support for the study should be addressed and an appropriate budget established.

How should the study team proceed?

Part II of this procedural checklist is intended to assist a study group in laying out a program of study. Once subject areas are agreed upon, a clearer picture can be developed of how to organize to study subject areas, how assignments can be made to best use the talents of the group, where outside technical assistance may be required, how many meetings might be required, how long the study effort may take and what budgetary or financial support may be necessary to complete the study and to make the necessary presentations.

Where are there sources of outside help?

The Cable Television Information Center, the Cablecommunications Resource Center and the National Education Association, all in Washington, D.C., have established cable TV advisory services for local officials and groups and individuals seeking information about cable TV. The National Cable Television Association and the National Association of Educational Broadcasters, also in Washington, also have information of value. In addition, many local and regional groups have developed to concentrate attention on specific issues relating to cable TV. For example, Open Channel and the Alternate Media Center (located in New York City) specialize in information and advice about public access programming. Many local libraries have developed information and plans for local government programming. Numerous groups, largely within school systems, are working on educational programming. Several universities have active communication research programs, both in hardware and policy uses. For information about groups in a specific area, contact one of the organizations mentioned above.

II. Conducting the Regional Study Effort

Essential steps in the study effort

As described in the text of this report, the steps in the study project might include:

— Developing necessary background in interconnection and the status of cable systems in the region
— Defining a prototype regional interconnection system
— Developing assumptions about demand for interconnection services
— Developing an engineering concept for the proposed interconnection system
— Developing financial alternatives for the proposed interconnection system
— Conducting a legal inventory of regional and national jurisdictional and regulatory issues
— Defining issues for decision making.

Studying general background of interconnection

1. Collect literature.
2. Determine status of systems operating or under construction, including subscriber penetration, public uses offered and pace of construction.
3. Arrange to receive technical presentations on interconnection technology.

Defining a prototype regional interconnection system

1. Develop assumptions about demand for interconnection services.

(a) Analyze prospects for possible user groups. Who would use what services?
— Identify public service needs
— Identify private user groups and institutions.

(b) Learn what individual cable system demands might be on an interconnection system. Are there economies of scale that can be realized by cable companies cooperating in interconnection?

Examine (with cable operators):
— microwave - importing distant signals
— potential use of two-way services for subscribers may require a major cable network to be viable
— size of audience base relates to amount of software investment that is feasible
— pooling of origination facilities.

(c) Tentatively define needs to be serviced by the system.
— Identify existing and likely locations for cable system headends
— Specify:
o location of each point to be interconnected (use maps where possible)
o kind of signal traffic (frequency, capacity, one- or two-way)
o time schedule of usage.

2. Develop an engineering prototype for the interconnection system.

(a) Retain an engineering consultant.

(b) Based upon preliminary consultant discussions with potential user groups, refine list of service demand assumptions to ensure technical feasibility.

(c) Direct the engineering consultant to develop a general system layout, defining in detail how the interconnection system will work. This is not a final plan but should:
— consist of detail sufficient to produce capital cost estimates
— state the technical description of the interconnection system
— define design and technical performance requirements for cable systems connected to the interconnection system.

3. Develop financial alternatives for the proposed interconnection system. (Additional consulting assistance and use of an economic model may be necessary to handle data effectively.)

(a) Examine feasibility of public and private ownership of system for their respective impact on effectiveness of operations and financial viability.

(b) Develop various assumptions regarding pricing schemes, initial demand, rate of system construction, etc., for analytical study of operating costs and revenues.

(c) Prepare a ten-year pro forma estimate, describing various assumptions and description of price schedules.

(d) Examine impact of operator incentives on actual rate structures, character of the interconnection market locally and the role of government regulations.

Investigating regional and national jurisdictional issues

1. Determine status of operating (or planned) cable systems among participating communities:

— How many systems are franchised?
— What provisions does each franchise contain relative to interconnection?
— What microwave licenses have been granted to or applied for by cable operations?

2. Explore state and local laws to determine what legal vehicles exist for operating or franchising an interconnection system.
3. Research federal laws to determine legal requirements for the interconnection system to apply for licenses to operate microwave facilities.
4. Identify possible conflicting jurisdictional problems relating to regulatory activity (FCC, state and local).
5. Determine if or how a regional interconnection system can be publicly financed.
6. Determine what, if any, state or local legislation is needed.

Defining issues for decision making

1. Consider possible modifications to prototype design of system after public exposure of prototype.

(a) New assumptions might be tested
(b) Pricing structures might be reviewed with potential users to test reaction
(c) Subsidization issues should be examined
(d) How much excess capacity should be built into the system?

2. What is the appropriate ownership arrangement for system?

3. What operational and management guidelines are important?

(a) Should the system operate as common carrier or should control be exercised over programming?
(b) What pricing assumptions prove to be most equitable and at same time adequately support system?
(c) What promotional activity is appropriate?
(d) Who should decide what should be interconnected and when?
(e) On what basis can cable operators exchange origination programming (or receive payment for origination productions)?

4. What regulatory features are necessary? What is preempted by FCC or state and local laws?

(a) Stipulate interconnection requirements
(b) Establish technical standards
(c) Recommend uniform franchise requirements
(d) Resolve disputes among operators over use of originated programming, or exchange of signals between regional cities of different market designations (in and out of top 100).

III. Preparing a Strategy for Implementation

Prepare an action report

It should clearly and realistically relate the findings, the possible solutions and the means of financing those solutions and conclude by presenting a time-phased plan that would:

1. Identify steps and decisions that will be required
2. Develop an appropriate sequence
3. Identify who is responsible for making each decision or for carrying out specific steps
4. Relate steps and decisions to an appropriate time frame.

Create a strategy for developing regional awareness

It is quite likely that the report and its recommendations will go unheeded unless a strong effort is made to develop an understanding and acceptance of interconnection among the people and institutions of the region to be affected. The following steps should be considered:

1. Establishing an interim interconnection group. Its purpose would be to focus activities and to provide for full-time coordination in the effort to create the interconnection system. The interim group should be given a specific charge, budget and technical staff support to assist user groups in interfacing with overall system.

2. Arranging for holding public hearings throughout the region to explain the report and the recommendations.

3. Organizing regional workshops and conferences for potential user groups and institutions.