Telephone and Cable Companies: Rivals or Partners in Video Distribution?

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I. INTRODUCTION

In October 1983, only a few weeks before the breakup of the Bell System, Pacific Telephone formally proposed to build a fiber optic and coaxial cable network to serve Palo Alto and several neighboring communities in Northern California.[1] Pacific's proposal trumpeted:

> A New Approach . . . Entertainment and Two-Way Information Services in One System
>
> YOU HAVE AN OPPORTUNITY to be served by the first telecommunications system of its kind anywhere in the nation. It combines several types of systems in one: traditional cable TV, high speed data transfer, and a teleconferencing and video network. (Pacific Telephone 1983)

Pacific's Palo Alto proposal spotlights the intent of the Bell Regional Holding Companies and other telephone carriers to leverage their technological and financial assets in new markets. Local video distribution presents one such attractive market opportunity, particularly in cities that have not yet awarded franchises to cable television companies.

Quite naturally, cable companies view actions such as Pacific's as a major competitive threat. More than DBS, MDS, SMATV or other video distribution technologies, the cable industry sees the telephone companies (telcos) as their longstanding past and chief future adversaries. Irving Kahn, a cable industry pioneer, now president of Broadband Communications, called Pacific's proposal an attempt "to get a telco foot—a *big* telco foot—into cable television's front door." Citing the telco interest in cable as "the stirrings of a dinosaur," Kahn continued, "Once one of them gets this kind of project off the ground, what we will have is a dinosaur up on all fours, breathing fire. And it is the status quo cable television industry that is going to get burned" (Kahn 1983b). The California Cable Television Association has vowed to fight Pacific's attempt to displace cable companies as owners and operators of video distribution networks (Schley 1984).

Yet while aggressively pursuing its Palo Alto proposal, Pacific has also sought to offer an olive branch to cable operators. At the Western Cable Show in December 1983, Pacific Vice President Al Boschulte called for partnerships with cable operators:

> We're seeking alliances, not adversary relationships . . . . Sometimes from very bad beginnings great friendships have sprung, and I want to pursue that very vigorously. (Paul Kagan Associates 1983a)

Pacific's Manager of CATV/Wideband Services, Kare Anderson, has met with cable companies to reiterate that theme. Ms. Anderson suggests that Pacific and cable operators work together to develop "hybrid" approaches to pay-per-view and other interactive services, using telephone lines for upstream signaling and cable for downstream video distribution. Pacific also proposes to use its regional video transmission facilities to interconnect cable systems "for joint marketing efforts."

Telephone and cable companies thus see each other as likely competitors as well as potential partners (Pepper 1983; Yankee Group 1983). Both views are probably correct. This paper explores the evolving relationships between them in light of changes in underlying video distribution technologies, costs, and regulatory rules. It begins by describing the technological requirements for multichannel video transmission and the alternatives offered by coaxial cable and fiber optic systems.[2] The next two sections deal with current plans and likely strategies of the telephone companies for local and regional video distribution. Prospects for hybrid cable/telco services are then discussed. The final section offers possible scenarios in the next ten years for competition and/or cooperation between telephone companies and cable system operators for video distribution systems in the United States.

II. TECHNOLOGICAL CONSIDERATIONS FOR WIRED VIDEO DISTRIBUTION

Technologically, the future of wired video distribution is clear: it will be all-switched, all-digital, and all-fiber. Today, however, cable systems transmit video to the home over tree-and-branch, analog, coaxial cable networks. The evolutionary paths and trade-offs among these three aspects of video distribution technology are discussed below.

A. Tree-and-Branch vs. Switched System Architectures

Cable television systems in the United States are basically broadcast distribution networks using coaxial cables. They distribute video signals to subscribers one-way from a central headend through trunk, feeder, and drop cables (figure 6.1a). Large urban systems (figure 6.1b) have several interconnected subheadends, or hubs, and each hub may serve multiple trunks, but the basic system architecture remains the same. All video channels are sent simultaneously to each subscriber, who then chooses which one to watch.[3]

In contrast, the switched telephone network provides each subscriber with a dedicated wire pair (loop) running to the local telephone central office (figure 6.1c). A switched or "star" system offers each subscriber access to any signal coming to the switching center, but only one signal at a time is transmitted on the dedicated subscriber loop. Two-way, point-to-point voice and data communications require a switched network architecture.

Even for one-way distribution, switched systems often appear esthetically more pleasing and "efficient" to the nonengineer. It seems inherently wasteful to distribute 50 or more video channels to each television receiver, when a viewer can watch only one at a time. A similar argument sometimes is heard about information and advertising in a large daily newspaper. Delivering 100 pages of newsprint to the door may appear wasteful when a typical reader scans less than 10 percent of the paper's articles, features, and ads. Yet publishing economics make it far more efficient to print and distribute a large general-purpose newspaper than a smaller, special edition for each subscriber.

A tree-and-branch video distribution network is less costly today than a switched network for distributing 100 or fewer program sources to a large number of subscribers. Estimates of the cost differential range from under 35 percent—United Cable's estimate for Alameda, California—to more than 100 percent—Bell of Pennsylvania's estimate for Philadelphia (Yankee Group 1983). But over the long term, cost and performance trends will likely favor a switched network for video as well as for voice and data. As Israel Switzer, a leading designer of cable

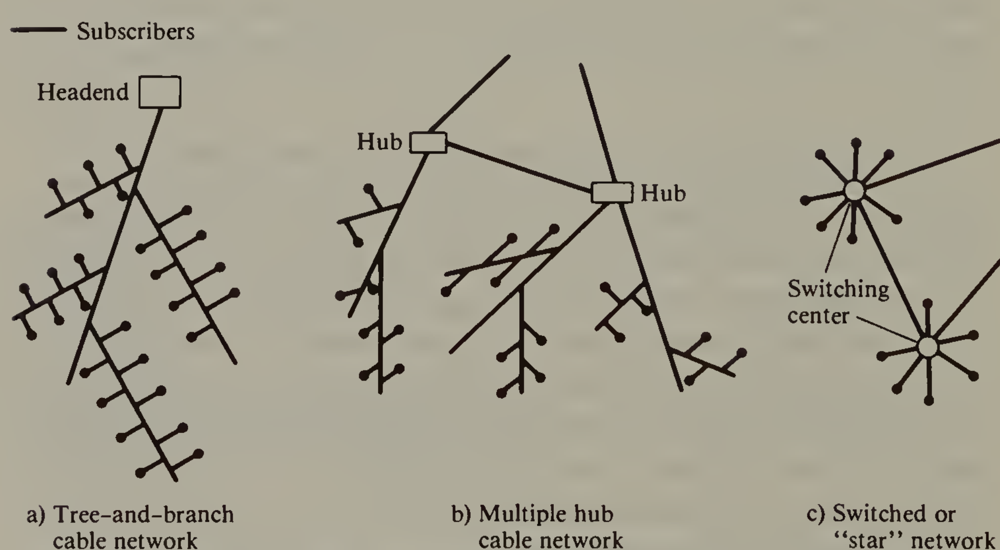

Figure 6.1. Video Distribution Network Architectures

systems in the United States and Canada, stated in a speech to the British Society of Television Engineers:

> The cable systems we build today will never be able to provide "television on demand"—the provision of the "program of choice" to every individual subscriber. Such a capability will ultimately be provided by an advanced version of the "star configured" telephone system. A future upgrading of telephone system bandwidth will ultimately provide individual, switchable video pathways into each home and office. In my view this capability is still some years away (probably the end of this decade). (Switzer 1983)

Technical field trials of switched video systems have been under way since about 1980 in North America, Europe, and Japan (Asatani et al. 1982; Fox et al. 1982; Chang and Hara 1983).

B. Analog vs. Digital Transmission

Television distribution systems, as well as the voice telephone network, have been designed for continuous wave, analog transmission. Analog transmission of television in the U.S. standard (NTSC) format requires a 6 Megahertz (MHz) channel bandwidth, some 1500 times greater than the bandwidth needed to transmit a telephone voice conversation. From a communications bandwidth perspective, then, one picture is worth considerably more than a thousand words.

Computers have brought digital transmission concepts to commercial telecommunications networks. Digital transmission results in less distortion, greater security, and more flexibility than analog transmission. These advantages come at the cost of greater bandwidth requirements, however. For digital transmission, computers sample the analog wave at a rapid rate and send the resulting information as a series of digital bits over the network. Using straightforward digital encoding techniques, voice transmission requires 64,000 bits per second (64 *K*bps), while NTSC television demands 90 million bits per second (90 *M*bps). Most other communications services to the home require much less than the 64 Kbps data rate for voice (table 6.1).

Additional processing of the source information can reduce the data transmission rate—a process known as data compression. By eliminating redundant elements of voice and video signals, data compression factors of 2–4 are technically feasible today without noticeable sound or picture degradation. Pictures that do not move rapidly can be compressed significantly more. Head and shoulder video shots, where lip

Table 6.1. Digital Data Requirements for Home Communications Services

Service	*Uncompressed data rate (kbps)*
Telephone	64
Alarms	0.1
Utility metering	0.1–1
Energy management	0.1–1
Videotex	
1984	1.2
late 1980s	4.8–64
Electronic mail	1.2–64
Home computer networks	
1984	0.3–1.2
late 1980s	1.2–64
Slow scan video	1.2–64
Video teleconferencing	1,500–6,300
Television (NTSC)	90,000
High definition television (HDTV)	200,000 and up

movement is the most prominent moving feature, can be compressed from a nominal 90 Mbps to standard telephone transmission rates of 6.3 or even 1.5 Mbps. Such compression may be perfectly acceptable for teleconferencing, but not for fast-moving entertainment television such as sports events. Transmitting a touchdown pass at 6.3 Mbps would either blur the receiver's hands out of focus or show a jerky series of movements, like a parody of old-time movies. Even with continuing technical improvements, compression to rates much below about 20 Mbps seems unlikely for NTSC entertainment television (Koga et al. 1981). The data rates necessary for high definition television (HDTV) are, of course, several times greater.

C. Coaxial Cables vs. Optical Fibers

Technology has steadily increased the effective video bandwidth of coaxial cable systems. In the past thirty years, state-of-the-art systems have progressively moved from carrying 3 to 12, then 20, 36, 54, and now more than 70, 6 MHz channels on each cable (table 6.2). Although cable is considered a mature technology, there is every reason to expect further technical improvements. Systems capable of carrying 90 or more 6 MHz video channels per cable seem likely by 1990.

Table 6.2. Video Channel Capacity Trends in Coaxial Cable Systems

Year	*Number of 6MHz Video Channels Per Cable in State-of-the-Art Cable Systems*
1950	3
1960	12
1970	20
1980	54
1990	90 (est.)

Today's fiber optic systems generally carry one digital video channel per fiber. Although analog fiber optic links have been designed to carry up to twelve video channels per fiber, the medium is inherently better suited for digital transmission. Optical fiber links being installed today in the telephone distribution plant carry 90 or 135 Mbps, enough for only one uncompressed NTSC video signal. The Olympic Games were televised in the summer of 1984 over a 90 Mbps, one-channel-per-fiber Digital Television Lightwave System installed in Southern California by AT&T, Pacific Bell, and GTE.

Fiber optic performance continues to advance impressively. AT&T is now installing fiber pairs for intercity transmission with 180 and 270 Mbps capacities. A 432 Mbps link is planned for commercial introduction by the end of 1985, and fibers capable of carrying more than a billion bits per second (1 Gbps) appear almost certain by 1990. AT&T has already successfully tested a 1 Gbps fiber system at Bell Laboratories (Rubin 1984).

At a billion bits per second, a single fiber could carry 11 NTSC television channels without compression, or some 25 to 50 channels with data compression. Multiple fibers can be bundled together to distribute larger numbers of channels. But for tree-and-branch distribution systems, installing several optical fibers directly to the home does not appear to be economically competitive with one coaxial cable. Fiber optics are much more likely to enter the home as part of a switched system.

D. Mini-Hubs and Other Transitional Steps

Video distribution systems incorporating elements of both tree-and-branch and switched architectures have been available from Rediffu-

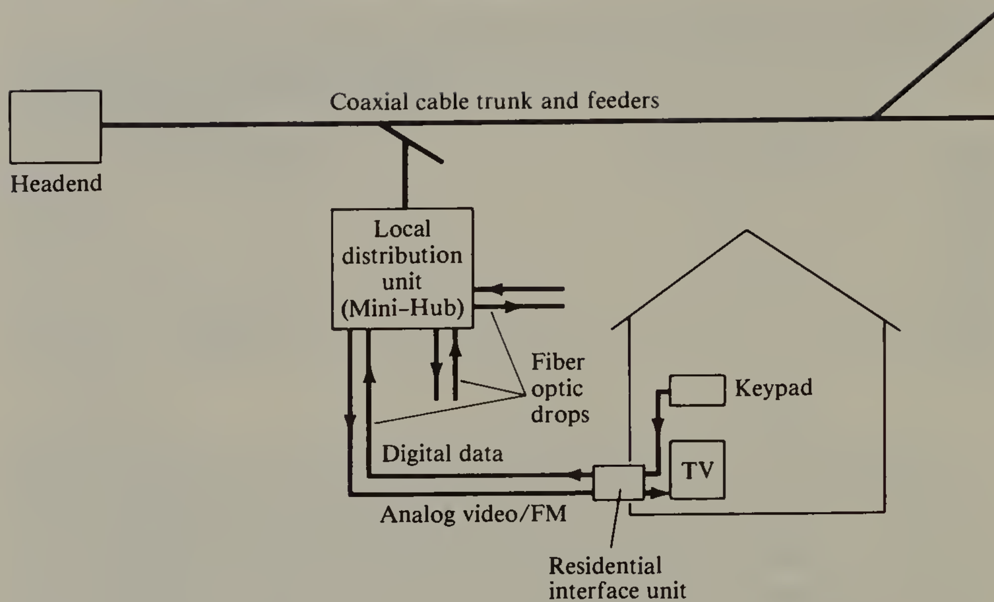

Figure 6.2. Schematic of Times Fiber Mini-Hub System

sion, Ltd., a U.K. company, for more than a decade. Two years ago, Times Fiber Communications, Inc., introduced a similar architecture using both coaxial cable and fiber optic elements. The Times Fiber Mini-Hub system distributes up to 54 video channels over conventional tree-and-branch coaxial cables to "local distribution units" (Mini-Hubs) serving up to 24 subscribers (figure 6.2). A pair of optical fibers runs from the Mini-Hub to each subscriber. The downlink fiber can carry two analog video channels or one video channel plus FM audio. The uplink fibers transmits digital signals from the subscriber's keypad to the Mini-Hub to select the program desired.

Mini-Hub systems were designed for high density "vertical" applications such as large apartment buildings with relatively short subscriber drops. Optical fibers are particularly attractive for these applications since they take up less space than coaxial cables and can often be installed in places where building codes do not permit cables or wires carrying electrical signals. Cable industry interest intensified when United Cable won the Alameda, California, franchise with a Mini-Hub design for the entire community of 24,000 households. United Cable is currently installing the system, and while some technical problems have arisen, the company expects it to be fully operational in 1984.

The Jerrold Omnitel™ system offers a different approach to video distribution with some switching capability (figure 6.3). Originally developed by the Manitoba Telephone System for its "Project Ida" field

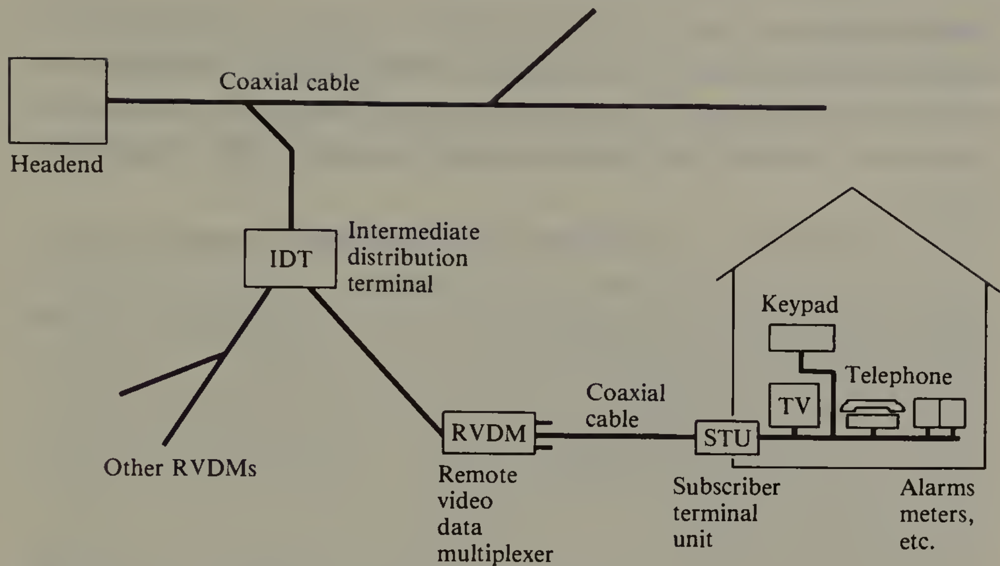

Figure 6.3. Schematic of Jerrold Omnitel System

trial in 1980-1981, the Omnitel system combines analog video with digital voice and data on a single coaxial cable. Television program selection is controlled from a "remote video data multiplexer" outside the home. Equipment at the headend and at "intermediate distribution terminals" assigns digital voice and data circuits to subscribers on a shared 2 Mbps data stream. Manitoba Telephone has licensed the technology to the Jerrold Division of General Instrument Company, which plans to market it principally in Europe.

The Mini-Hub and Omnitel technologies are sophisticated examples of "off-premises converter" systems designed to provide more secure and reliable television service to cable subscribers. They are primarily television distribution systems, although they have some two-way transmission and switching capacity for other services. Both technologies have been field tested in relatively small systems serving a few hundred subscribers. Their performance and cost for carrying interactive, non-video services among large numbers of subscribers have not yet been operationally determined. Nevertheless, they represent first steps toward "distributed intelligence" and switching in television distribution networks, a trend likely to accelerate later in this decade.

III. CURRENT TELCO ROLES IN VIDEO DISTRIBUTION

The telephone and cable industries have locked horns over most of the past twenty-five years. In the 1940s and early 1950s, telephone companies largely ignored the small-town CATV operators who distributed two or three television channels on coaxial cables. Although policies differed from telco to telco, most permitted fledgling cable companies to lease space on telephone company poles for annual rates of one or two dollars.

In the late 1950s, as cable's technical capacity increased to 12 video channels, telcos became aware of the expanding television distribution business and of CATV companies as potential competitors. The Bell System Operating Companies introduced the concept of "channel service," in which the telephone company built the cable distribution plant and leased it back to an independent CATV operator. By the mid-1960s, 18 of the 22 Bell Operating Companies had filed tariffs for channel service (NCTV 1983).

But the cost of channel service leaseback was high. The telephone companies built cable distribution systems to telco standards and used conventional telco accounting and revenue requirements to set rates. Cable operators preferred to build their own distribution plant, using telephone company poles or underground conduits. Battles between cable operators and the telcos for pole attachment rights heated up, with cable operators charging that the telcos refused access to their poles in order to extend their telephone monopolies to video distribution.

In 1967, the FCC began an investigation into telephone company channel leasing policies, pole attachment rights, and related cable service issues. Three years later the commission adopted an order prohibiting telephone companies from directly or indirectly providing cable service in their telephone franchise areas. The Commission concluded that the public interest would be best served

> by preserving, to the extent practical, a competitive environment for the development and use of broadband cable facilities and services and thereby avoid undue and unnecessary concentration of control over communications media by existing carriers. (FCC 1970)

Although this cross-ownership ban has been in effect since 1970, telcos are still very much involved in video distribution. This section describes their current roles, including:

— Telco operation of cable systems outside their telephone franchises
— Rural telephone/video distribution systems
— Regional video interconnection of cable systems
— Video distribution within local area networks
— Construction and leaseback of video distribution facilities.

The following section discusses Pacific Bell's ambitious video distribution plan for Palo Alto. It also outlines the recent proposals for cable systems in the United Kingdom, which move in the direction of combining television distribution with other switched services.

A. Cable Service Outside Telco Franchises

A few telephone companies have diversified by acquiring cable systems outside their telephone franchise areas, which is permissable under the FCC cross-ownership rules. Centel Corp. (formerly Central Telephone and Utilities Corp.), for example, has purchased 120 cable systems with 235,000 subscribers and continues to seek additional cable acquisitions. Centel owns conventional cable systems in small towns and suburban areas. The company has not sought to push the technical state-of-the-art in its systems, nor has it bid for large urban cable franchises. However, Centel has pioneered in developing a regional video interconnect system (see below), as well as participating in one of the first commercial U.S. videotex services.

Pacific Telecom owns 94 percent of the cable system serving Anchorage, Alaska, in addition to several smaller systems in Alaska, Minnesota, and Wisconsin. The company's principal business is operating small telephone companies in the Pacific Northwest and Alaska, as well as providing long-distance telephone services in Alaska. Pacific Telecom's cable acquisitions are part of its strategy to diversity into other communications businesses.

With these and a few other exceptions, telcos generally have stayed away from cable operations since the FCC adopted its cross-ownership rules in 1970. The Bell Regional Holding Companies (RHCs) undoubtedly have considered buying cable systems outside their telephone territories, but none have made overt moves as yet. With competing demands for capital and their lack of conventional cable operating experience, it seems doubtful that the RHCs have their sights set on acquiring existing cable systems as the route toward becoming major factors in local video distribution.

B. Rural Telephone/Video Services

The FCC rules expressly provide for waivers of the telco/cable cross-ownership prohibitions upon showing "(1) that cable service demonstrably cannot exist except through a CATV system related to or affiliated with the local telephone common carrier; or (2) that other 'good cause' for waiver exists" (Fogarty 1980). The commission has taken the position that independent cable operation is infeasible in rural areas with densities of fewer than 30 households per mile. More than 50 such waivers have been filed since 1979, most of them unopposed by cable interests (Wheeler 1981).

Telephone and Data Systems, Inc. (TDS), a company with telephone interests in 22 states, has sought authority to provide video as well as telephone service in its small-town and rural franchises (Burrill 1981). TDS serves its more than 12,000 video subscribers via conventional cable systems, not physically linked with its telephone facilities.

During the 1970s, the 3M Company developed equipment to provide both telephone and video distribution over a common, coaxial cable facility. 3M aggressively marketed its "Total Communications" package to REA-financed and other rural telephone companies. Costs remained high, however, and after the first trial installations failed to bring large-scale orders, 3M quietly abandoned the project. The company remains actively interested in regional video interconnection among cable systems in major markets (see below).

Although the rapid development of fiber optic systems has rekindled interest in combining telephone and video distribution in rural areas, it already may be too late. Direct broadcast satellite (DBS) systems soon will offer several additional channels of movies, sports, and other popular video programming to rural households. Although DBS may find rough going in the major markets, it should be very cost competitive with other video distribution technologies in low-density areas. For rural America, integrated telecommunications services on optical fibers may be another example of a future technology whose time is past.

C. Regional Video Interconnection Of Cable Systems

Several telephone companies have shown interest in providing video transmission facilities to link cable systems within a metropolitan area or region. Cable systems seek interconnection for two principal reasons: to aggregate audiences for regional sports events and other programming not available by satellite and to sell advertising on a regional basis.

Cable system fragmentation places cable companies at a competitive disadvantage with broadcast stations and newspapers for national and regional advertising. Advertisers much prefer to make a single placement that reaches most target households within the market than to deal separately with multiple cable operators. A regional interconnect among cable headends permits advertisers to make one buy and to deliver one tape that can be shown simultaneously to subscribers in all participating systems.[4]

Centel Videopath, Inc., a subsidiary of Centel Corp., is completing a microwave network interconnecting cable systems in the Chicago metropolitan area. The 3M Company has similar plans for cable interconnection in the New York metropolitan area and in other cities.

Cable operators themselves can join forces to interconnect regionally, as Viacom and Gill Cable have done to establish the Bay Area Interconnect around San Francisco. However, it may be easier for an independent third party—whether a telephone carrier or another company—to build the regional interconnect and to offer services to individual cable operators.

D. Video Distribution Within Local Area Networks

Among the first applications for integrated video, voice, and data services will be new office buildings, hotels, and commercial centers. More and more developers recognize the importance of building an advanced telecommunications infrastructure in their new projects in order to attract tenants and to generate additional revenues. A building owner can offer tenants such services as video security monitoring, teleconferencing, high speed data channels, shared word processing, and satellite television distribution—all carried on a coaxial cable or fiber optic local area network.

Some developers are joint venturing with communications companies to design and operate local area networks. Olympia and York, one of the largest developers in North America, recently formed such a joint venture with United Telecommunications. Satellite Business Systems, itself a joint venture between IBM and Aetna, has formed SBS Real Estate Communications Corp. (RealCom) to provide advanced communications services to office space developers and owners. Ameritech will provide communications equipment and services to RealCom.

AT&T and United Technologies have also announced a joint venture to offer communications services to commercial building owners and tenants. Other similar joint ventures are likely to be announced this year.

Spurred by the threat of "bypass" by AT&T and other long distance carriers, the RHCs, GTE, and other telcos are moving quickly to serve new commercial facilities with high-speed digital lines. Optical fibers are now the technology of choice for many new business installations. By 1990, a substantial fraction of large business customers will have direct fiber optic connections to telco switching centers for integrated voice, data, and video communications.

E. Construction and Leaseback of Video Distribution Facilities

The current FCC cross-ownership rules do not bar telcos from building video distribution plant and then selling or leasing it back to a cable operator. Several Bell Operating Companies, including Wisconsin Telephone, Michigan Bell, Illinois Bell, Bell of Pennsylvania, and Chesapeake and Potomac (C&P) have announced their interest in seeking out such arrangements.

Wisconsin Bell has entered into a construction/leaseback arrangement with TeleNational Communications, a relatively small cable operator, for the cable system serving Brookfield, Wisconsin. The telco will build a 54 channel coaxial cable system with two-way data capability and addressable, off-premises converters. Wisconsin Bell will keep control of the bandwidth for two-way services but has announced no plans to integrate these cable services with its telephone operations.

In 1983, Michigan Bell contacted city officials in Detroit about building a $150 million cable system for the city. The company also joined with Bloomfield Associates, a local group, to bid for two suburban cable franchises outside Detroit. Michigan Bell proposed to construct a conventional tree-and-branch system with dual cables providing more than 100 video channels plus two-way interactive capacity. The telco planned to lease the video channels back to its cable partner, but would maintain control over the two-way services. The franchises, however, were awarded to other applicants.

In February 1984, C&P Telephone agreed to construct and maintain a cable transport system for District Cablevision, Inc. (DCI), in the event

DCI is awarded a cable television franchise by the District of Columbia government. DCI is one of three applicants for the District of Columbia cable franchise. C&P proposes to construct a tree-and-branch dual coaxial cable distribution system with eight interconnected hubs. The first cable will employ newly developed 550 MHz cable amplifiers providing more than 70 downstream video channels. The second cable will be held in reserve for future growth. The proposed system represents state-of-the-art coaxial cable technology, but its design does not seem easily upgradable to switched video service, nor does it appear to be a step toward integration of voice, data, and video communications on a single telco facility.

IV. PROPOSED TELCO VIDEO DISTRIBUTION PROJECTS

A. Pacific Bell's Palo Alto Proposal

Pacific Bell's plan to build a wideband distribution network in northern California differs from other telco construction/leaseback proposals in several key respects:

— It includes substantial fiber optic facilities, as well as coaxial cable for video distribution.
— The sytem includes a switched fiber optic institutional network that integrates video, voice, and data services.
— The distribution system is linked with Pacific's regional network.
— Pacific will not lease the entire network capacity to others but will retain substantial bandwidth for current and future services.

1. Fiber Optics for Video Distribution

Pacific proposes to build a fiber optic supertrunk from the headend on Stanford University property to the two hubs serving Palo Alto subscribers. The supertrunk bundles 40 separate optical fibers, each carrying one digital television signal. At the hubs, the television signals are converted from digital to analog and inserted onto coaxial cables for distribution to subscribers.

The Pacific proposal does not extend optical fibers to the home, nor does it integrate video with voice and data services for residential subscribers. Subscribers would still have two separate wire facilities—

coaxial cable for video and a standard telephone wire pair for voice and data. Not by coincidence, however, the video distribution hubs are located at the telco central offices serving Palo Alto. Pacific Bell would thus have the basic system architecture in place to integrate all residential services on fiber optic loops when technology and costs permit.

2. *Integrated Services on the Institutional Network*

Pacific's plan for the institutional network serving Palo Alto and surrounding communities does integrate services over switched fiber optic facilities. Pacific proposes to install three fiber optic pairs, each with digital data capacity of 135 Mbps, to Stanford University and more than 60 other businesses, government offices, and schools. The institutional network could handle 250 video teleconferencing channels at the 1.5 Mbps (T1) data rate, as well as digital voice and data services.

Pacific sees the institutional network as a natural extension of its present services to business and government customers. The Palo Alto video proposal provides Pacific with an opportunity to upgrade existing facilities and market new services such as video teleconferencing to its institutional subscribers.

3. *Regional Interconnection*

Pacific's proposal also calls for direct interconnection of the video distribution and institutional networks to the company's regional facilities. Technically, this is readily accomplished by co-locating the cable distribution hubs at the telco central offices. Like other telcos, Pacific has a substantial fiber optic interexchange network in place that can carry communications to and from the Palo Alto system.

The regional interconnect could be used, for example, to transmit educational video programs from Stanford University to homes, businesses, and schools throughout the Bay Area. Pacific also emphasizes its use for regional advertising sales on cable systems—an application that would compete directly with the microwave Bay Area Interconnect run by cable companies. But voice, data, and other nonvideo business services constitute the chief interconnect applications. By tying the institutional network with Pacific's other facilities, the telco can offer its business and institutional customers a complete range of services fully interconnected with the outside world.

4. Telco Control of Bandwidth

Perhaps the most important distinction between Pacific's proposal and other telco construction/leaseback arrangements is the carrier's ongoing control of system bandwidth. In other proposals, the telcos have leased the full capacity of the system to a cable operator. Pacific has no such idea in mind. It will make available 80 channels to the city of Palo Alto and other local governments so that they can seek "competitive bids from organizations wishing to manage the 80 channel system. Then the group they choose will sublease channels to competing service providers" (Pacific Telephone 1983). Pacific, however, will retain control over capacity beyond these 80 channels, specifically including the institutional network and any interactive services offered on the subscriber network.

Pacific thus would maintain control over any two-way services offered to business and residential customers. Moreover, it would control the video bandwidth over and above the 80 leased channels. Although the FCC cross-ownership rules now prohibit telcos from providing video programming services, the current climate of deregulation has spawned proposals to relax these rules and permit telcos to compete directly with cable operators (Noam 1982b). While Pacific has not indicated any intent to do so, the system it has proposed for Palo Alto gives it the technical capability to offer competitive program services if the regulatory rules change.

B. Video Distribution Systems in the United Kingdom

Many of the newly planned video distribution systems in the United Kingdom include some degree of telco participation and consequently deserve mention here. In December 1983, after years of government study commissions, "white papers," and false starts, the British Department of Trade and Industry awarded eleven cable franchises covering more than one million homes (table 6.3). British Telecom (BT), the government telecommunications authority slated to be privatized in late 1984, holds equity in five of the eleven winning applicants. Two U.S. cable companies (Time Inc.'s American Television & Communications subsidiary and Comcast Corp.) and three U.S. equipment suppliers (Jerrold, Scientific-Atlanta, and Oak) are also involved in winning proposals.

Table 6.3. Cable Systems in the United Kingdom

Area	*Households*	*Cable Operator*	*Type of System Proposed (Supplier)*
Aberdeen	75,000	Aberdeen Cable Services (British Telecom and American TV & Communications (ATC) are major shareholders)	tree-and-branch upgradable to star (BT)
Belfast	100,000	Ulster Cablevision (20% owned by BT; 20% owned by Thorn-EMI)	switched star (BT)
Coventry	100,000	Coventry Cable (100% owned by Thorn-EMI)	tree-and-branch upgradable to star (BT)
Croydon (London)	98,000	Croydon & Cable TV (20% owned by Racal-Oak)	switched star (Plessy-Scientific Atlanta (SA))
Ealing (London)	100,000	Cabletel Communications (20% owned by Comcast)	switched star (Plessy-SA)
Guilford	22,000	Rediffusion Consumer Electronics	switched star (Rediffusion)
North Glasgow	100,000	Clyde Cablevision	switched star (Plessy-SA)
South Liverpool	100,000	Merseyside Cablevision (30% owned by BT)	switched star (BT)
Swindon	53,000	Swindon Cable Service (majority owned by Thorn-EMI)	tree-and-branch upgradable to star
Westminster (London)	73,000	Westminster Cable (BT, Plessy and ATC major shareholders)	switched star (BT)
Windsor, Slough, and Maidenhead (London)	84,000	Windsor Television (GEC is major shareholder)	switched star (GEC-Jerrold)

The U.K. proposals appear technically more advanced and more adventurous than their U.S. counterparts. Eight of the eleven winning applicants proposed switched video systems of new design. Most called for fiber optic/coaxial cable hybrids. Most proposals also discussed integrating data and other interactive services with video distribution.

The proposed U.K. systems carry with them substantial technical risk, however. Israel Switzer, in a speech to the British Society of Cable Television Engineers, commented:

> If you are willing to wait a few years, and if organizations exist willing to invest several hundred million dollars in developing and proving brand new technologies, you can have radically new and improved telecommunications systems truly fulfilling all of the promises that have been spewing from the publicists' word processors for the last year or so.
>
> I am not against new technology development. I ask that such development be regarded realistically in terms of its cost and time scale. If Britain wants new cable services now, it will have to use modest extensions of existing technologies. If it is prepared to wait a while, Britain can have a completely new generation technology.
>
> I have the impression that the task—time and money—involved in the widespread construction and commissioning of radically new cable systems in this country is being seriously underestimated. (Switzer 1983)

In most countries outside the United States and Canada, government Post, Telephone, and Telegraph (PTT) administrations will play major if not dominant roles in the development of video distribution systems. The PTTs may prefer to wait for switched video systems and all-digital integration of services rather than build today's state-of-the-art cable systems. As a government agency scheduled to go private, British Telecom occupies an interesting middle position between PTTs and U.S. telcos. If the switched systems designed by BT and others prove successful in the United Kingdom, they will provide both technical and business models to U.S. telcos considering active roles in video distribution.

V. TELCO/CABLE HYBRIDS FOR INTERACTIVE SERVICES

Despite enthusiasm for interactive services on cable, fewer than two percent of U.S. cable subscribers have access to operating two-way cable services. Warner Amex's Qube systems, the most visible of interactive cable projects, have failed to generate substantial revenues and no longer serve as models for two-way cable development. Yet service such as pay-per-view (PPV) movies, sports, and special events appear attractive to cable operators if subscribers can order them easily, on impulse, and at the last minute before the program begins. Without two-way cable, the most obvious way for a subscriber to request a pay-per-view program is to place a telephone call.

The hybrid cable/telephone concept involves using the cable system for downstream television program distribution and the telephone network for upstream data requests (figure 6.4). The concept is particularly attractive because the technical requirements are so asymmetric in the two directions. Delivery of the television program downstream requires a full 6 MHz channel, while the upstream request can easily be accommodated within the normal telephone bandwidth. Moreover, since virtually every household has telephone service, there is no need to develop two-way cable communications for pay-per-view or other services with low upstream data requirements. Alarm services, transactions, videotex—essentially all the services listed in table 6.1 except those requiring two-way video—can in principle use a hybrid approach.

Hybrid telco/cable services thus appear attractive for both partners. For the cable operator, they provide a relatively inexpensive return link for interactive services such as pay-per-view. The cable operator need not invest substantial capital in two-way cable communications that

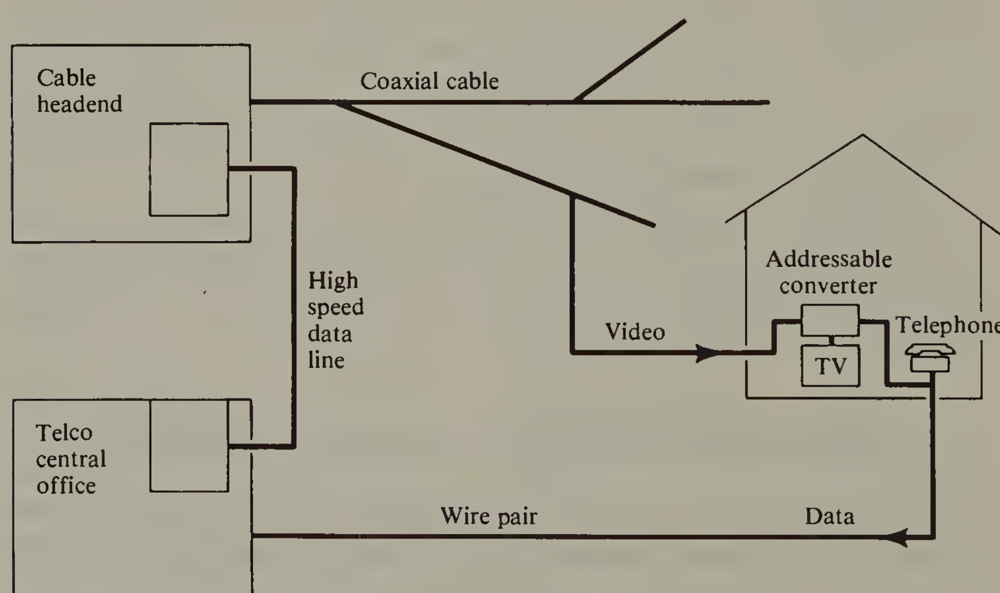

Figure 6.4. Telco/Cable Hybrid Services

hold at best marginal profit potential. For the telephone companies, hybrid services provide additional revenue from existing plant, as well as opportunities to form constructive partnerships with cable companies. A recent report by The Yankee Group discusses these opportunities in detail (Yankee Group 1983).

If the hybrid concept has such great appeal, why have telephone and cable companies not yet eagerly embraced it? Several obstacles presently stand in the way of successful partnerships:

— *Subscriber equipment.* Hybrid services require a touch-key telephone or a modular link from the cable converter to the phone. Systems designed to accommodate dial pulse phones are generally more expensive and cumbersome. Today only about half of U.S. households have touch-key telephones. Other households would have to purchase one for about $20. Cable converters with modular links to the telephone line have been designed by Zenith and other companies, but very few are actually in place.

— *Central office and headend equipment.* Although the hybrid concept is technically straightforward, equipment to implement it has not yet been installed in telco central offices or cable system headends. Hybrid pay-per-view systems must handle large numbers of incoming calls in the final half hour before a premium program begins. Equipment at the telco central office must receive the subscriber's call, record the necessary information, and pass it on to the cable headend, which will then signal the subscriber's converter to receive the requested program. Several prototype systems of this kind have been developed, but few are yet in operation.

— *Uncertain revenues from pay-per-view.* Although pay-per-view appeals to subscribers in concept, cable operators have had mixed results from their early experience with it. Some PPV programs, such as the movie version of "Pirates of Penzance," have drawn few paying customers and consequently have taken some of the luster from the PPV star. This may be due in part to a lack of marketing commitment by cable operators to PPV or to a dearth of programming attractive enough to command continued subscriber interest. Better marketing and programming may well make PPV an important source of cable revenues in future years. Today, however, PPV remains an attractive possibility for cable systems that has not yet turned into a clearly profitable reality.

— *Cable's suspicion of telco partnerships.* Some cable industry leaders still question the wisdom of forging alliances with telephone companies which may represent their principal future competitors. This attitude is by no means universal among cable operators, but it certainly acts today to restrain enthusiasm for hybrid joint ventures.

Still, with the telcos now actively seeking new businesses, we may expect to see several hybrid telco/cable ventures in the next several years. The Bell Regional Holding Companies are actively considering hybrids as part of their near-term marketing plans. And although cable companies are their most logical partners, telcos can also contemplate hybrid arrangements with DBS, MDS, or other video suppliers. DBS systems in particular will need to make arrangements for subscriber sales, installation, service, and billing, all of which the telephone companies are well-positioned to provide. The prospects for telco hybrids with these video distributors depend, of course, on their economic viability, a topic treated in other contributions to this volume. The possibility of such partnerships, however, will clearly influence negotiations between telcos and cable operators for hybrid services.

VI. THE FUTURE OF WIRED VIDEO DISTRIBUTION

A. Telco Scenarios

We are still some years away from the all-switched, all-digital, and all-fiber video distribution systems of the future. The telephone companies do not have video switches or distribution plant in place to deliver video programming to the home. Despite advances in data compression and related digital technologies, engineers do not expect to be able to deliver television-quality video over telephone wire pairs from telco central offices.[5]

If the telcos are to compete directly for video distribution, the key question is how quickly and under what circumstances they can justify installation of fiber optic local loops to the home. This can come about either through continued cost reduction of fiber optic distribution systems or by new consumer demand for high speed data or switched video services. Increased demand for electronic banking, videotex, and similar data services is not enough to justify fiber optics, nor is the planned evolution toward digital voice communications. These services can still be carried on copper wires.

Although fiber optic links to business customers are increasingly common, they are still too expensive today for residential installation. Most observers expect them to be cost justified for new residential customers within five years. Southern Bell reportedly will begin installing fiber optic loops to all new customers in 1985 (Baker 1983). However, it may be well into the next decade before telcos can justify replacing existing wire pairs for residential subscribers.

Nevertheless, many telephone companies appear to be positioning themselves to offer integrated voice, data, and video services to the home by the early 1990s. Their likely steps along this evolutionary path include the following:

— Telcos will move quickly to serve their major commercial customers with digital (principally fiber optic) links. Once in place, telcos can offer wide-band digital services such as video teleconferencing to these subscribers. In most metropolitan areas the telcos will have built switched, digital, fiber optic networks serving their large institutional customers before the end of the decade.

— Telcos will vigorously oppose attempts by cable operators to offer voice and two-way data services over cable. Every indication exists that telcos will seek to force cable companies to provide such services under state PUC regulations. Regulatory proceedings on this topic have been under way in New York, New Jersey, Connecticut, and Nebraska (Lloyd 1983). Even if the telcos are not ultimately successful in placing two-way cable services under state PUC jurisdiction, these tactics add delays and costs to cable efforts to develop interactive services.

— At the same time, telcos will offer agreements to cable operators for hybrid two-way services. Hybrid services add to telco revenues in the short term and keep cable companies from developing their own two-way facilities.

— Telcos will offer regional video interconnection of local cable systems, largely through the fiber optic interexchange facilities they are installing in metropolitan areas.

— Telcos will try to remove or relax the cross-ownership rules that prohibit them from owning cable systems within their service areas. The independent telephone companies have already petitioned the FCC to abandon these cross-ownership restrictions. If successful, this would permit the large independent telcos such as GTE to move aggressively into cable system operation.

— Many telcos will seek to gain experience in the video distribution business via leasebacks or through ambitious projects such as Pacific Bell's plan for Palo Alto. At this time, these projects seem more like targets of opportunity than steps in a well thought through strategy to compete with cable. The telcos are still defining their strategies in the postdivestiture era and have more urgent business priorities, such as protecting their commercial customer base against bypass carriers and moving toward usage-sensitive pricing. However, telcos want to position themselves to play a larger role in video distribution technology when and if regulatory rules allow them to do so.

— The telephone companies will seek to maintain their dominance over switched services to the home by upgrading the voice network to handle data as well. Local Area Data Transport (LADT), developed by Bell Laboratories, provides low-cost packet switching for videotex, networking among personal computers, and other residential data services. Bell South's LADT network in Miami is the first of many such installations planned by the RHCs.

— Installing fiber optic loops partway to residential customers represents the next step in the technical evolution of the telco subscriber network (Bohn, Buchen, and Rao 1983). The SLC™-96 system developed by AT&T Bell Laboratories handles up to ninety-six subscribers on an optical fiber transmission line running from the central office to a remote terminal closer to the customer. The last links to the home remain copper wires. Originally developed for rural applications, the Fiber-SLC systems are now less expensive than copper wires for many new urban and suburban installations.

— As planned at least through 1990, Fiber-SLC systems will carry digital voice and data, but not video, to the home. They fit into the overall telco strategic concept of an Integrated Services Digital Network or ISDN (Kostas 1984; Bhursi 1984; Wienski 1984). The ISDN goal in this decade is to provide every residential and business subscriber with digital capacity up to 144 kbps—enough for all the voice and data services listed in table 6.1, but still insufficient for television-quality video.

— Sometime after 1990 it will prove economically feasible to upgrade the remote terminal to a "remote switching unit" (RSU) capable of handling television-quality video and to install the final fiber link to the home. At that point, the telephone network will have all the technical pieces in place to provide switched, digital video on demand to any home or business customer.

B. Cable Scenarios

Despite some well-publicized financial problems within the cable television industry, cable's basic business of providing video entertainment to the home remains a healthy one. Cable systems in 1983 passed 55 million of the nation's 85 million households and served more than 30 million subscribers (Paul Kagan Associates 1983b). Forecasts for 1990 project cable passing more than 75 million homes and serving more than 48 million subscribers (Paul Kagan Associates 1983b; Yankee Group 1983). Cable's increasing presence makes building a second wired video distribution system to the home less attractive to the telcos or to anyone else.[6]

On the other hand, even after more than ten years of experimentation with two-way communications, cable companies have yet to develop successful businesses from interactive services. Revenues from the institutional cable networks serving New York City, Portland, Oregon, and a few other cities totaled less than $5 million in 1983. Most institutional cable networks are still developmental (Hanneman and LaRose 1983). Nevertheless, some likely technological and regulatory developments should enable cable systems to compete more effectively for nonvideo services in the years ahead:

— New technology for two-way, packet switched data and voice communication on cable will be commercially available in 1985. Two such systems are under development by the Jerrold Division of General Instrument Corp., a leading equipment supplier to the cable industry, and by PacketCable, Inc., a new company in Silicon Valley, California. These systems promise to be far more cost effective for interactive services on cable than were the Qube-like systems of the past.

— Cable operators can profit from the usage-sensitive pricing (USP) plans of the telephone companies. The RHCs and other telcos expect state PUC approval of some form of USP in their franchise areas within the next three years. Residential telco customers will then pay by the call or by the minute for services they now use on flat monthly rates. New data services such as videotex and networking among personal computers could be especially impacted by USP. The cable industry thus may see a real demand for data services on cable once the telcos put usage-sensitive pricing into effect.

— If regulations permit, cable systems can offer bandwidth to long distance carriers to bypass the local telco network. MCI and GTE Sprint have already sought to lease some two-way cable channels for the voice and data services they provide to their customers. Channel leasing represents a tiny business to cable operators today. But as packet switching technology lowers the cost of these services on cable and as the telcos move to USP or otherwise increase their prices, more substantial business opoortunities may open up in the mid- to late-1980s.

— Cable systems will install more fiber optic supertrunks linking their satellite receivers, headends, and hubs.

— Improved technical performance and cost will make cable operators take a closer look at Mini-Hub and similar switched systems employing optical fiber links to the home. By the end of this decade, these systems may well prove cost-competitive with tree-and-branch coaxial cable networks.

C. Integration or Competition?

Cable systems and telcos operate distinctly different businesses today, with different technical facilities. Cable systems have the video distribution links without the switches. Telcos have the switches without the video links. However, it is clear that the technologies supporting both businesses are quickly converging. Certainly by the end of the century video distribution technology will have evolved to switched, fiber optic systems. But this does not necessarily demand a single integrated telecommunications link to the home. There are no technical reasons why two separate systems cannot coexist and compete for services.

Economies of scale appeal strongly to regulators and engineers, but the argument for them is by no means compelling. The principal economy lies in using the same ducts or poles for all video, voice, and data services. The additional cost savings from integrating services on a single switched, fiber optic system seem relatively small for newly built systems and even less if a well-functioning video distribution system is already in place.[7]

The emergence of high definition television (TDTV) in the 1990s does not materially improve the economy of scale argument or change the competitive equation between telcos and cable systems. HDTV requires much greater bandwidth than conventional NTSC television signals and represents an ideal service for digital transmission over optical fiber loops. However, coaxial cable technology is advancing as well (table 6.2) and should be capable of carrying HDTV channels along with conventional video channels in cable distribution systems planned for the late 1980s and 1990s.

The real battle between telcos and cable companies will probably focus on metropolitan area refranchising (and any remaining new builds) toward the end of this decade. By then, the telephone companies will have adjusted to the Bell System breakup, will have begun to implement their new business strategies, and will have gained some experience in video distribution. The cable industry will have wired most of the major cities and will have access to 75 percent or more of the nation's households. Fiber optic technology will be available to both.

In the end, the choice between one or two wideband links to the home will most likely be made on social and political rather than on technical and economic grounds. We may well conclude that the advantages of maintaining competitive systems outweigh whatever costs might be saved by integrating all services on a single fiber. On the other hand, financial problems of cable companies, or telephone companies, or both, may require consolidation under a single organizational entity. It is possible, too, that after years of chaos resulting from the Bell System breakup, society might demand a return to a single regulated carrier (Oettinger and Weinhaus 1983). What is critical to understand is that the technology and costs of wired video distribution support either an integrated or a competitive solution.

Notes

1. On January 1, 1984, Pacific Telephone became Pacific Bell, part of the Pacific Telesis Group, a Bell Regional Holding Company.

2. This paper focuses on "wired" video distribution technologies such as coaxial cable and fiber optics. Over-the-air video distribution via satellite, terrestrial microwave, and other broadcasting technologies is discussed in other papers.

3. State-of-the-art cable systems provide subscribers with addressable converters that can be controlled from the headend to pass or reject individual channels or tiers. Subscribers can then choose among the video channels or other services for which they have paid.

4. Satellite programmers eventually will be able to offer regional buys to advertisers through increased use of satellite spot beams covering smaller geographic areas. This would remove part of the economic incentive for terrestrial interconnects.

5. Single-channel television distribution over telephone wire pairs is feasible over short distances and can serve specialized applications such as some hotel, motel, and apartment installations.

6. A recent report by a well-respected consulting firm concludes that fiber optic installations by electric power utilities could seriously challenge both telcos and cable companies for video distribution (IRD 1983). Although possible, this scenario seems unlikely, given the current financial problems, regulatory constraints, and management styles of U.S. electric power companies.

7. The cost of video switching represents the principal uncertainty in estimating economies of scale for integrated video, voice, and data services. Although very expensive today, video switching equipment costs are declining and could drop markedly through advances in integrated optics and optoelectronics. A full discussion of these costs is beyond the scope of this paper.