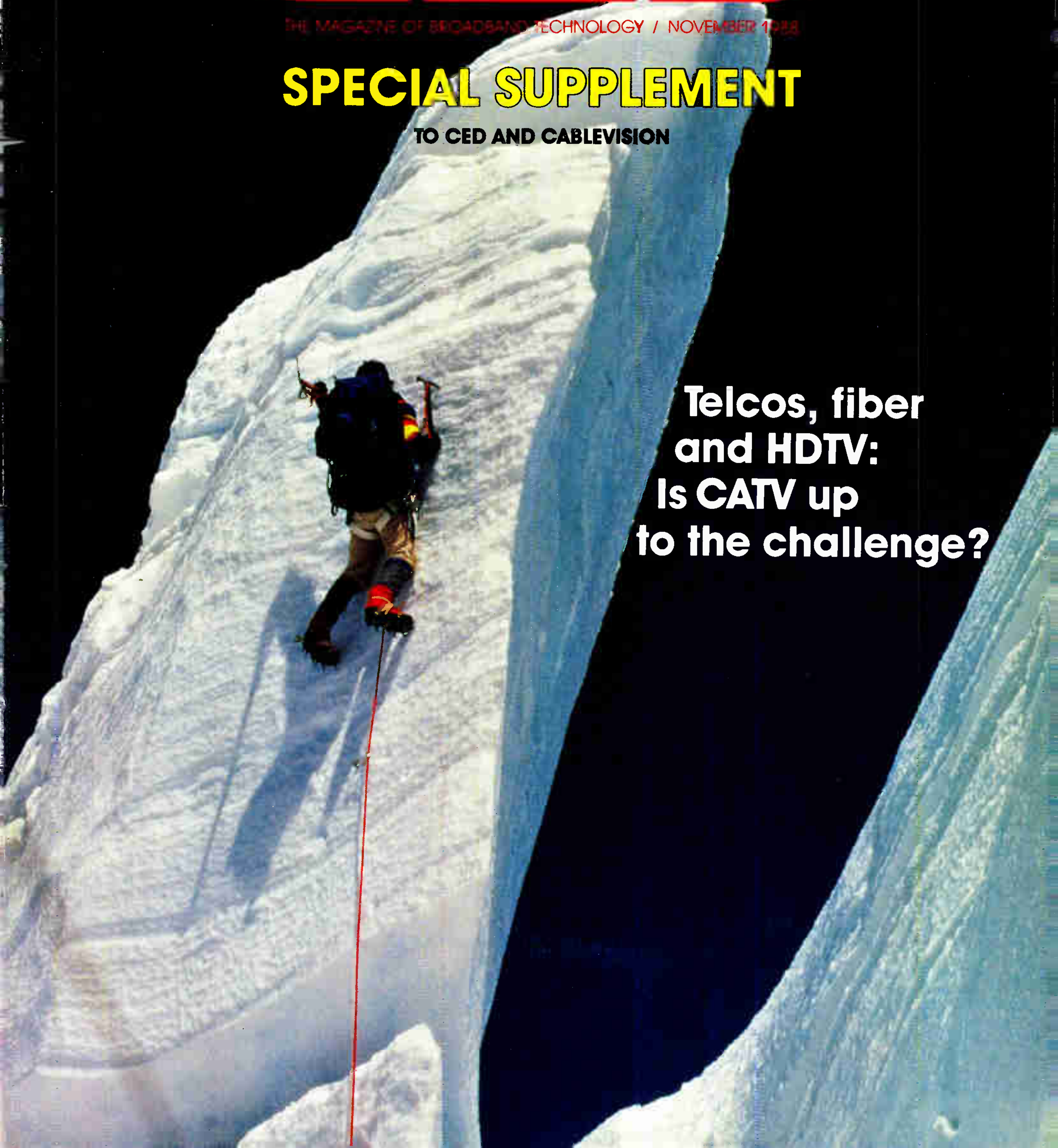
CED

THE MAGAZINE OF BROADBAND TECHNOLOGY / NOVEMBER 1988

SPECIAL SUPPLEMENT

TO CED AND CABLEVISION



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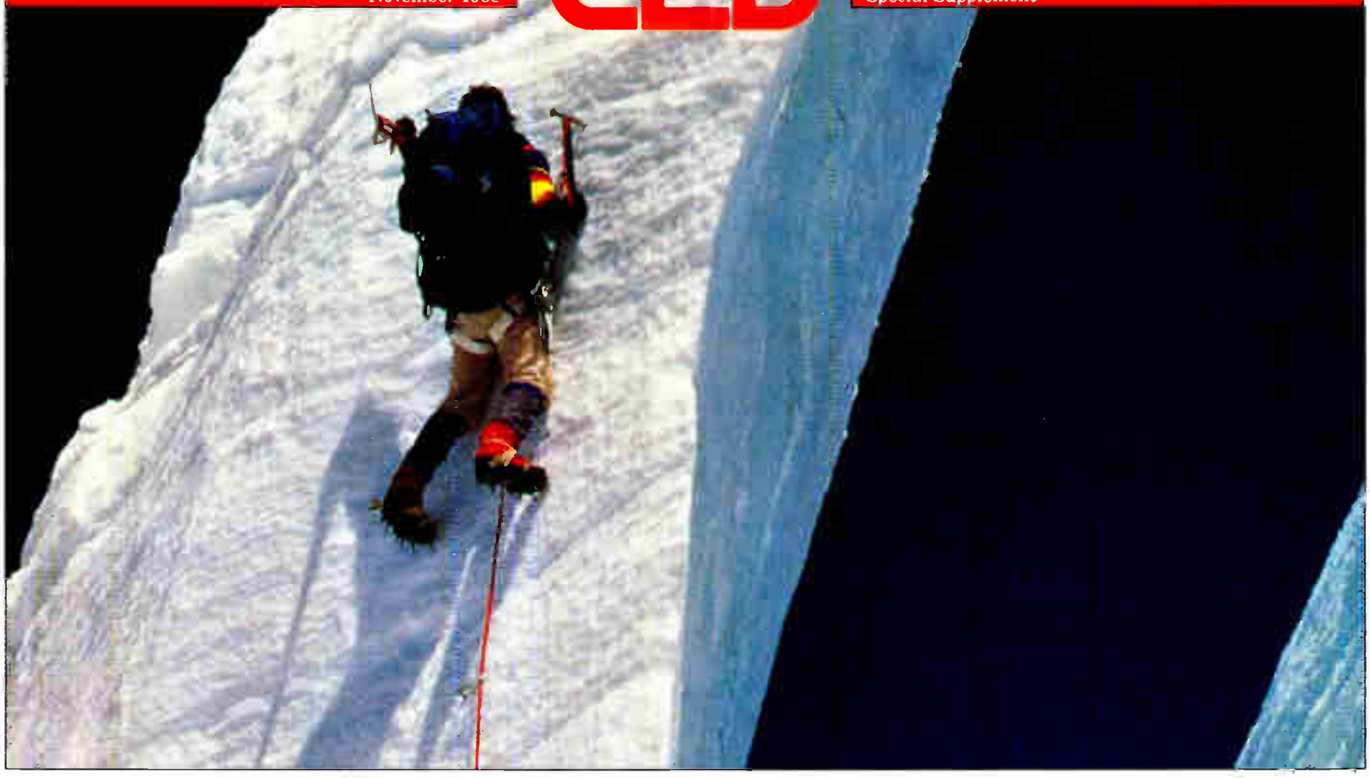

About the Cover:
Telephone companies threaten to enter the CATV market while fiber optics and high definition television pose technological hurdles that must be overcome to meet competitive pressures. Is the industry up to the challenge? Can it reach the crest in a complex competitive environment?

DEPARTMENTS

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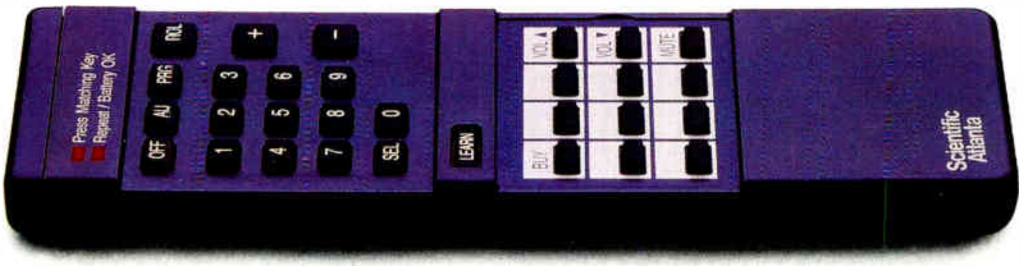

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Reader Service Number 4

Are you ready for the 1990s?

Will you prosper from the gale-force winds of technical change and competition that will wash over you industry in the 1990s?

Optical fiber, HDTV and telco competition are three of the most important challenges facing the industry in the next decade. Are you ready for these challenges?

Why are the issues important? What do they portend for your business? What's the competition up to? How soon will the telcos be in the video delivery business? What do you need to know about fiber optics and HDTV? How can you use them to your business advantage?

Those are the issues this special edition of *CED* magazine will help you answer.

We urge you to read it carefully and discuss it with your co-workers. It was put together to help non-technical executives in marketing, programming, sales, finance and operations understand the implications of new technology.

You may wonder why an engineering magazine would put together such an issue. The simple answer: Never before has it been so important that business technologists talk to the rest of the CATV industry.

And make no mistake, this issue was put together by business technologists—not engineers. It doesn't tell you how things work. Instead, it explains how new technology can help you preserve your franchise.

Like it or not, the 1990s will be unkind to you if you ignore the business implications of new technology and new competition. The contributors to this issue have something important to say. We hope you'll find them engaging. We hope you'll want to hear more. Are you ready for the 1990s?

Gary Y. Kim
Editor/Publisher

Make no mistake—IPPV is big business. Even systems using phone ordering schemes have pulled in pay-per-view revenues of over $1 million in a single month. Now the equipment needed to *fully* tap this potential gold mine is at last available: Oak's Automatic Self Authorized Purchasing system—*SIGMA ASAP.*

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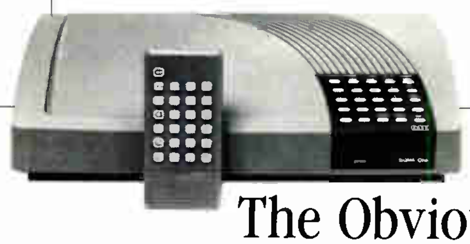

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Reader Service Number 5

HDTV and fiber optics

Managers, financial personnel, marketing people and investors need to know three things about HDTV (high definition TV) and fiber optics:

1. Is it necessary?
2. How much will it cost?
3. When will we have to face it?

Before the turn of the century, less than a dozen years from now, many people will be looking at a new advanced type of television with crisp, clean, wide-screen pictures beyond belief. It remains to be seen whether the new HDTV will be broadcast by terrestrial TV stations, by MMDS relay, directly from satellites, viewed on advanced videocassette tape players, delivered on telephone company fibers, or all of the above.

For the present, details are clouded in uncertainty as to what form the new advanced standards will take, or when they will be decided, if at all. We can only guess when HDTV receivers and home video tape equipment will be available to the public, and at what price. More important, we have no idea when the producers will release programs and video tapes to the public in the new format.

By Archer S. Taylor, Senior Vice President, Engineering, Malarkey-Taylor Associates Inc.

Fiber optics

What does optical fiber have to do with HDTV? Forget about the enormous bandwidth of optical fiber, its small size and light weight, freedom from leaks and ingress, and its security from signal theft. These are real advantages, and there are others.

The important fact about optical fiber is that it can be used to transmit many television signals over a distance of 10 miles or more with no amplifiers or repeaters between. This is why fiber is necessary for distributing HDTV. Each of the cascaded amplifiers required to force TV signals through long coaxial cable networks degrades the picture just a little until the cumulative effect finally renders the picture unusable. What an enormous advantage to be able to deliver headend quality pictures to mini-hubs only a few thousand feet from the subscriber premises; and to do this with less maintenance and other expense than is normally associated with coaxial trunk amplifiers and power supplies.

Of course, it is not quite that simple. There are some problems; not with the fiber itself, but with the light sources and detectors used to transmit signals in the form required for conventional TV sets.

Hybrid systems

Development work is actively in progress on hybrid systems, based on optical fiber trunks between the headend and separate mini-hubs for groups of 200 to 500 subscribers, with short coaxial stub trunks, coaxial feeders and coaxial service drops for the last few thousand feet. The hybrid system permits sharing the facilities for converting the optical signals to the proper form for the TV set. Without such sharing, the cost of conversion would be too great to be supported by individual subscribers. The goal, of course, is to achieve a balance between minimizing the shared cost and obtaining the maximum benefit of the fiber optic technology.

ATC has fashioned its "fiber backbone" so that it could readily be retrofitted into an existing coaxial network without totally rebuilding. Cost projections vary, naturally, depending on the particular circumstances. Based on ATC projections, the incremental cost for retrofitting a 375-mile plant might be between $1,000 and $1,600 per total plant mile. An additional $300 to $500 per total mile in labor cost may also be required for reversing some trunk amplifiers and removing others, depending again on the particular circumstances.

Lasers need work

Development is still in progress to produce a laser light source capable of transmitting up to 60 or more channels on the ATC fiber backbone with low enough noise and distortion. Several suppliers express confidence that it can be done. At the present time, however, high quality performance is limited to about 40 channels per fiber.

ATC expects to complete its first actual retrofit in October, in Oahu, Hawaii. This will provide actual data on costs and performance, as well as the problems or advantages encountered in installation.

A more robust technology, using frequency modulation rather than VSB amplitude modulation, is also under development. Frequency modulation is characterized by substantial improvement in noise and distortion performance, using readily available optical sources and detectors.

The problem is cost. At each hub, both an FM demodulator and a VSB/AM modulator are required to make each channel compatible with conventional home TV sets. Dr. James Hood of Catel claims that the cost can be reduced to $250 per channel, but is dubious about further reductions. At that rate, for 60 channels, in an FM hybrid network similar to the ATC fiber backbone, the comparable incremental cost would be between $3,000 and $5,000 per total aerial plant mile. Moreover, each hub, probably serving only about 400 to 1,000 passings, might require some sort of kiosk, street cabinet, or equipment space in a nearby building, not needed for the ATC concept.

Future uncertain

It is too early to predict which technology will ultimately prevail, or at what cost. But it does seem safe to suggest that the incremental capital investment required to retrofit a recently completed 450 MHz to 550 MHz aerial plant will probably lie somewhere between 20 percent and 50 percent of the cost of the conventional plant. ■

Telcos in the cable business?

Do the Regional Bell Holding Companies (RBHCs) really want to get into the cable TV business? It is clear that neither the 1984 Cable Act nor the Federal Communication Commissions rules prohibit an RBHC from purchasing and running a cable business outside its regulated telephone areas. Thus, if PacTel (Pacific Telesis) Inc. did purchase, with United Artists Telecommunications, the U.S. cable operations of Rogers Communications, it could not operate any of the California franchises. To operate a cable-TV franchise, the regional company will have to obtain a waiver from the rulings of Judge Harold Greene, who oversees the continuing breakup of the Bell System. Indeed, a waiver from Judge Greene will be one of the crucial steps required if the RBHCs wish to go into the provision of video programming to the home over their regulated network—a broadband fiber optic network yet to be built.

By Tom Hargadon, Telecommunications Consultant

It is this promise of fiber with its almost unlimited bandwidth that fuels the appetite of the telephone companies and the concerns of the cable operators. The telephone companies are proceeding apace installing fiber links for long distance and distribution loops throughout the nation. They are beginning to provide fiber links between major computer centers such as the Rio Grande Corridor project linking the major governmental laboratories in New Mexico. Soon they will be providing their largest customers switched multi-megabit data service whose typical applicatioins, according to Howard Sherry of Bell Communications Research (Bellcore), include "Local Area Network (LAN) interconnection, high-end workstation to host communication, host-to-host communications and LAN-like performance across a metropolitan area." (See Figure 1.)

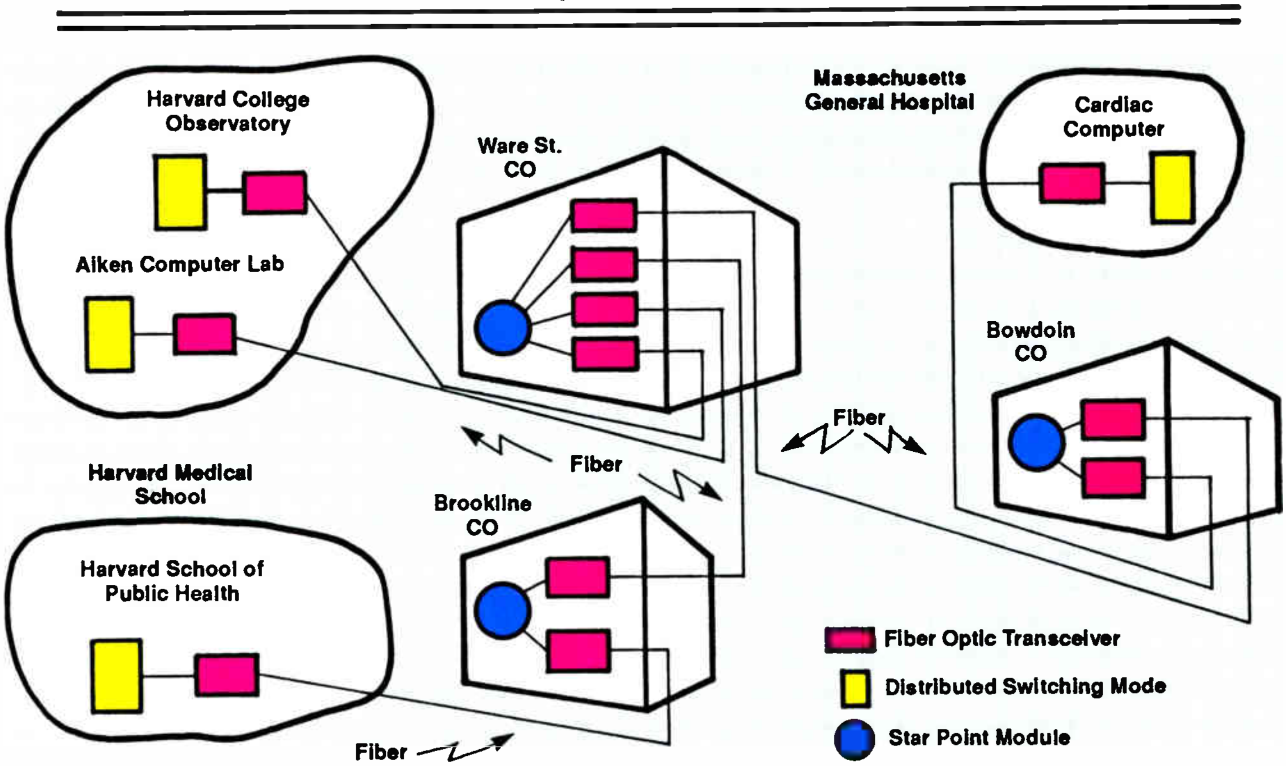
Ken Phillips, vice president of telecommunications policy at Citicorp, gets more specific. "Driving the bandwidth requirements up will be high-resolution graphics based on analytical programs, real-time modeling and simulation applications, multi-channel high quality (stereo) audio channels, HDTV in whatever form that will eventually take, information "browsers" and "zoomers" which allow the user to pursue multiple information sources using Boolean modifiers and trace back his browsing, respectively, and of course digitized traditional multiple voice and data channels."

Demand is there

There is a broadband demand in the business telecommunications market-

Figure 1

Metropolitan Area Network Trial



- First Phase: Private, 10 Mbps, DARPA IP
- Later Phase: Public, Higher Speed, ISO Protocols

Table A-1

U.S. FIBER TO THE HOME PROJECTS (MARCH '88)

Company	Location	Services	Technology	Status	Size (Homes)
Southern Bell	Hunter's Creek, Florida	Video	Digital, ATT	Ongoing Planned	80-250
Southwestern Bell	Leawood, Kansas	Voice	Digital, Singlemode, ATT/ SLC Series 5	Fall '88	50-100
Bell of Pennsylvania	NA	Voice/Video	Multimode-Analog Video	Planned	100
Illinois Bell	NA	POTS/Data	Singlemode	Planned-1988	NA
Mountain Bell	Phoenix-Foothills	Video/Voice Security	Digital, Video	Planned	6500-7000
General Tel. of California	Cerritos, California	Video/Data Voice	Analog/Digital, Copper/Fiber	Waiting for FCC Waiver	5000
United Cable Television Corp.	Alameda, California	Video	Multimode, Analog Video	Complete '84	8700
Southern Bell	Heathrow, Florida	Voice/Data	Digital Singlemode, Northern Tel.	Planned '88	250
Contel	Eastern Region	POTS/Alarm	Digital	Planned 4Q '88	600
Contel	Western Region	POTS/Alarm	Digital	Planned 4Q '88	400
New Jersey Bell	Princeton Gate, N.J.	Voice Only	Digital Voice, ATT/ SLC Series 5	Planned Summer '88	104
South Central Bell	Memphis, Tenn.	Voice Only	Digital Voice, ATT/ SLC Series 5	Construction Jan '88	99

place; the source of most income and almost all the profit of the telcos (58 percent of Southwestern Bell's revenue comes from only 1 percent of its customers, according to one estimate). It is a demand they will meet and, in the process, will have laid the backbone for fiber to small businesses and to the home.

The many fiber-to-the-home trials are more engineering testing of various technologies than marketing efforts. There are just too many technologies being tried to be effective as sales or marketing projects (See Figures 2 and 3). The telcos know that fiber and its attendant electronics will come down in cost so that it matches or is close to the cost of copper twisted pair and/or coaxial cable in the home (See Figure 4).

Technically, what is needed is a cost effective way to get from the central office to the poles outside the homes and the digital switches to send from 150 megabits per second up to 2.4 gigabits per second. Raychem's fiber optic cable system for the local loop, announced in mid-July (see Figure 5), brings the fiber loop to the pole at a cost as cheap as copper. BellSouth, the most aggressive of the RBHCs in promoting fiber to the home and small business, is investing $25 million in Raynet, the Raychem subsidiary producing the systems, and the German PTT is investing $30 million. Since the Raynet system keeps the copper twisted pair in place in the home, it is not, as yet, a direct competitor to cable. The most bandwidth possible on twisted pair is 1.54 mb/s (T-1) which can handle only compressed video signals.

PUCs will scrutinize

If BellSouth and other RBHCs use the Raynet system only for newbuilds or regularly scheduled modernizations, there will be little or no regulatory controversy. If, however, any of the telephone companies wish to move rapidly with installation throughout their network, they will have to show to their state Public Utilities Commission (PUC) that the expenditure is justified and should be paid for by subscribers and not shareholders. One can reasonably expect one or more of the RBHCs to make that assertion, probably by asking to change the depreciation on the local loop from its present 20 years to the 5 years allowed on switching equipment.

> The PUCs may turn out to be the most important stumbling block to any telco intrusion into the cable market.

The PUCs may turn out to be the most important stumbling block to any telco intrusion into the cable market. The Vermont Public Service Board recently rejected a proposal that would have deregulated some services and the freezing of some basic-service rates. The proposal of Pacific Bell to provide a measure of competition and modernization in exchange for some deregulation has received a cool response.

Neither the PUCs nor the FCC, conditioned for years to move toward payment on a measured basis for a specific service, seems ready to handle the implication that broadband technologies may be so integrated, so user-controlled, that what one can charge for is access to an amount of bandwidth—a flat fee—not measured service. Flat fee will restructure regulatory practice and telco revenues. It means a movement back to the monopoly model of regulation and the keeping of the monopoly provider out of the programming business. (For a controversial look at this radical restructuring of regulation, see "ISDN: User Arbitrage and the Flat Rate Solution"

Table A-2

FIBER TO THE HOME PROJECTS (OUTSIDE USA)

Company	Location	Services	Technology	Status	Size (Homes)
French Gov.	Biarritz, France	TV, Video-Phone, Telemetry	Analog Video	80-84	1500
Alcatel French Gov.	St. Cloud, Mantes, France	Video/Videotex	Analog Video, Freq. Switch	Ongoing	300,000
Velec-Pirelli, French Gov.	Montpellier, France	TV, FM Radio, Voice	Analog Video, Space Div. Switch	Ongoing	30,000
NTT	Tokyo, Japan	TV, Voice	Analog, Video, Freq. Switch	Ongoing	3,000
Canadian Gov.	Elie, Canada	Voice TV, FM Radio, Videotex	Analog Video, Digital Voice	81-84	150
British Gov.	Milton Keynes	Video	Space Switch, Analog Video	80-82	18
German Gov.	Bigfon, Germany	TV, Voice, FM Radio	Analog/Digital	80-86	Unknown

by Anania and Solomon, a paper presented at the International Telecommunications Society, July 1, 1988.) If technology and regulation moves in this direction, it would have the most profound implications for the cable industry.

Telco programmers?

Beyond the pricing and tariffing regulatory matters, there is the question whether the telcos can be in the business of providing video programming to the home. The 1984 Cable Act prohibits them in their regulated areas. The National Telecommunications and Information Administration of the Department of Commerce would allow the telcos to provide a "video dial tone"—transport, maintenance and billing services—but not other information services. Obviously, from the negative reaction of the telcos, they see more money in the ability to provide value-added information services in whatever form is profitable.

The FCC recently followed with a discussion, not yet even an inquiry, that suggested that, if the telcos were allowed into the cable business, the Open Network Architecture (ONA) program which allows access to the telephone network innards in an equal access way was working and could work in this area too. The present reality is the promised access to crucial aspects of the network have not been clarified and, in many instances (such as co-location of facilities), has been denied.

In the future, ONA is an arena that could allow the cable industry access to important parts of the telephone network that it will require if it is to become technologically sophisticated and efficient—most notably the telco billing system and digital switches. It is fairly clear that this year's FCC is moving toward asking Congress to lift the ban on telcos in the cable business. But the decision will be years in the making. The telcos will then ask Judge Greene to modify his order and allow

In the future, ONA is an arena that could allow the cable industry access to important parts of the telephone network.

telco entrance. At this time, it is unlikely that Judge Greene will allow full implementation of the telco dream. He would probably restrict them to the video dial tone of NTIA as he has with other aspects of information services provision.

Look at the public good

Even the content/transport distinction so beloved of regulators and politicians may fall under the impact of the new broadband technology. As Tony Rutkowski, chief, Telecommunication Regulations and Relations between members division of the International Telecommunications Union says in a speech on the Global Information Fabric, the attempt to maintain boundaries based on computing versus telecommunications or value-added from basic services is "very imperfect at the outset and rapidly becoming difficult judgmental exercises as ever more numerous and close cases arise. Such boundaries appear to make little sense today. Virtually every manufactured active electronic product is operated by a microprocessor with associated memory under the direction of stored programs. This is a world of digital intelligence interconnected with other digital intelligence through defined protocols...Today nearly everyone is axiomatically in the information services business. The real question for policy makers is how to employ and foster the technology and facilities for the greatest public good."

Figure 4

Fiber Price Trends

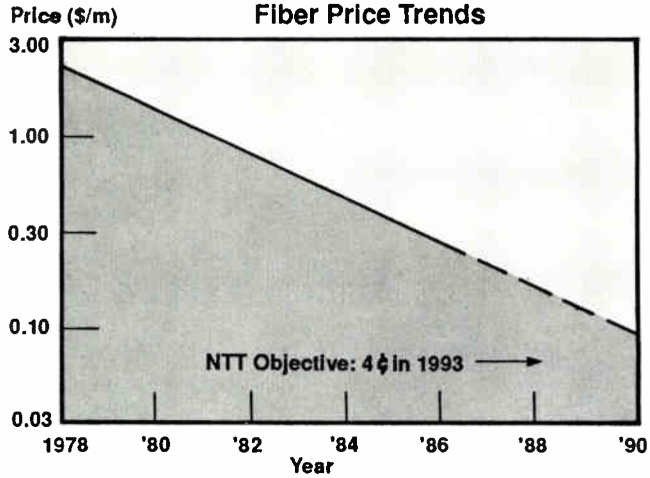
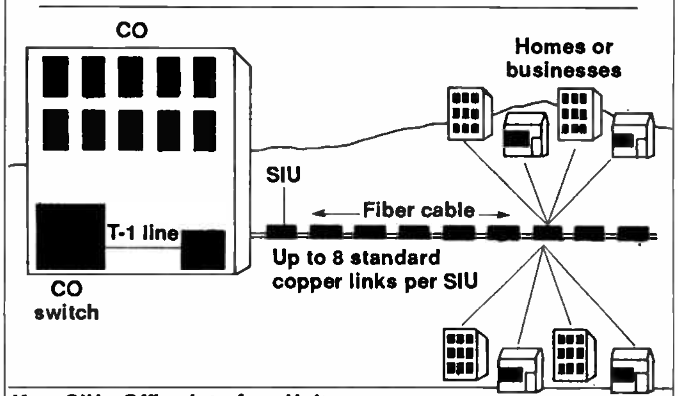


Figure 5

Raychem's fiber-optic cable system for the local loop



Key: OIU—Office Interface Unit
SIU—Subscriber Interface Unit (up to 24 possible per 4 km. of fiber cable)

Equally important is the setting of adequate standards and building the hardware needed to switch information at the tremendous speeds required (135 mb/s for HDTV). Until divestiture, standard making was easy. Fundamentally, AT&T dominated the U.S. standards committees and got its way more often than not in international circles.

With divestiture, the RBHCs and the PBX manufacturers such as Northern Telecom participate as full members of the T1 committee of the Exchange Carrier Standards Association. Technical assistance comes from many sources including Bellcore—not just the labs of AT&T as heretofore. It is from Bellcore that came the first standard since divestiture, the SONET (Synchronous Optical Net), which sets a rate of 155.52 megabits per second for lightwave transmission in the public network. Presented to the worldwide community through the State Department's Bureau of International Communications, the official agency for the United States in these matters, the SONET standard was accepted by the CCITT of the International Telecommunications Union in February.

Hardware being developed

To use the SONET standard requires hardware. Bellcore has developed prototype SONET switches which the RBHCs are testing. Only BellSouth has been visible with the technology and seems poised to use these switches when the software and required coding is finished. This is no trivial task. Estimates on when beta test product will be available range from 18 months to five years.

The switches themselves are not the $5 million to $15 million ESS5 switches now being put into place by the RBHCs. They only have to handle the switching of packet headers and thus can be small mini-computers that cost less than $100,000 and placed remotely, closer to subscribers, very much like cable headends now.

The RBHCs may require a waiver from Judge Greene to do experiments with equipment not yet being manufactured. The RBHCs are not supposed to be in the R&D or manufacturing business.

The technical innovation and standards making required to make fiber optic networks competitive and in place has increased enormously over the past

Only BellSouth has been visible with the technology and seems poised to use these switches.

several years and is worldwide in scope. One has to know not only about the FCC and the PUCs to stay current. You must also be aware of the T-1 committees, the IEEE committees on fiber optics and Home Bus (three different standards—two Japanese, one Dutch), the new European Telecommunications Standards Institute and similar activities in Japan including much of the HDTV discussion.

The regulatory, judicial and political aspects seem to be moving more slowly. What is not quantified is the will of the RBHCs to in fact install fiber to the home. They have substantial problems with their obsolete ISDN technology in all areas—standards, regulatory and political. They certainly do not look ready for a total transformation of their organizations which this technology may require.

This leaves opportunities for the Europeans as they become more coordinated and unified, the Japanese with their Information City experiments and willingness to spend money to get quantum leaps in capacity and even Third World countries such as China, now just coming into the telecommunications arena.

All may move more quickly to a fully-implemented fiber optic network and the suppliers to those nations (probably not American) will have a step up on supplying telcos and cable companies later. ■

Investing today can be a frightening experience. But, it doesn't have to be.

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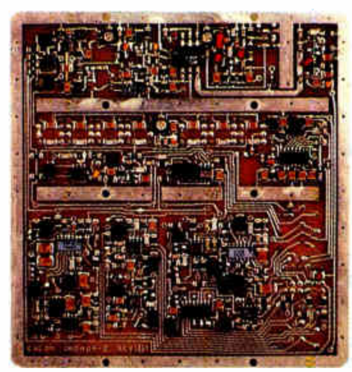

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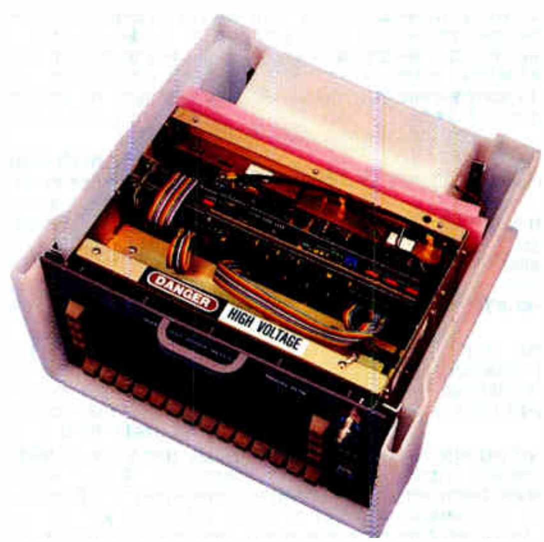

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Telcos in cable—overbuild or acquisition?

Renewed focus on potential telco entry into cable television, instigated by both individual telephone companies such as Pacific Telesis and GTE, and FCC announcements calling for re-examination of the subject, has raised significant questions in the cable industry.

Many of these questions center on how telcos would enter the cable market should regulatory barriers be removed. The two probable approaches of telco entry would have dramatically different impacts on the cable TV industry. This article will not address the regulatory barriers or the likelihood of their removal. Instead, it is our intent to determine how telcos would enter the cable market if and when those barriers are removed.

The first, and more obvious, approach would be through acquisition or major investment in existing cable systems.

The second, and far more ambitious approach, would capitalize on the already existing telco network base and their ability to build off that base using advanced technology (fiber optics) which would give them apparent significant technological advantages over existing cable plant.

Obviously, if telco entry is predominantly through acquisition, one would expect competition by well-capitalized companies to drive up the price and value of systems. On the other hand, construction of "shadow" or parallel networks would have the exact opposite effect of decreasing the value of cable systems.

The impact of which direction telcos will follow clearly will have a dramatic effect on cable television.

Telco history

In proposing entry into cable television, the telcos have broached the subject of fiber optics delivery to the home. Fiber has proven to be a high speed, high capacity, low attenuation, reliable, low maintenance medium for long-haul point-to-point digital telecommunications.

By Dave Robinson

The ISDN question

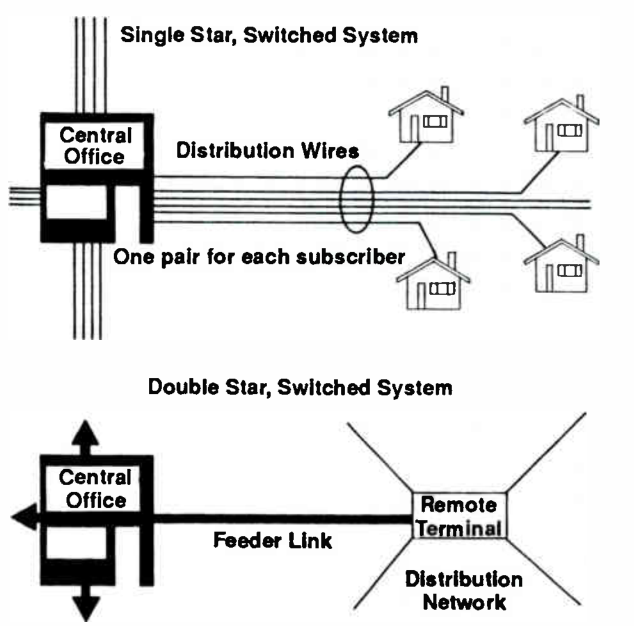
Telcos hope to extend this success into the local loop through worldwide plans for an Integrated Services Digital Network (ISDN). Under discussion for over a decade, the ISDN standard today is stabilizing and trials are under way for narrowband-ISDN (N-ISDN), with an initial marketing thrust toward the business segment. Broadband-ISDN incorporates video services and is the long-term goal.

N-ISDN does not handle video. The largest N-ISDN building block, the "primary rate interface," carries only 1.5 megabits of information per second (mb/s). A standard NTSC video channel transmitted digitally requires a rate of over 100 mb/s uncompressed and typically 45 mb/s in a compressed form. HDTV will require a transmission rate of perhaps 150 mb/s compressed (NHK's HDTV takes about 1.2 gigabits per second [gb/s] uncompressed).

B-ISDN, which incorporates video, is now basically structured around a 150 mb/s discussion standard that still needs to be fleshed out. Although some telcos talk of early-to-mid 1990s implementation, many feel it will be the year 2000 before standards and economics allow B-ISDN a chance of being rolled out commercially.

At the present time, fiber to the home is still in an experimental stage in the telephone industry. Telcos have used twisted copper pairs as their drop transmission medium since the turn of the century. Their current technology "pipe" into the home is limited to no more than 50 kHz—enough to handle one voice channel or limited data, but generally insufficient to handle a video channel and about 1/20,000th the capacity of the broadband coaxial cable drop.

Figure 1



Jumping over broadband

Realizing the limitations of their pipe, the telcos have suggested that with fiber optics they could leapfrog existing broadband technology, despite the fact that the full capacity of coaxial cable is not nearly being utilized. They do possess an architectural advantage over existing broadband video distribution systems for real-time, two-way voice and narrow-band data communications—the switch.

The telco architecture, with a switch at its center and dedicated lines out to individual locations, is known as "star" or "switched-star." Switchboards, started as a manual operation serving a limited local area, later were hard-wired to other local exchange switchboards, and inter-exchange, or long distance communications ultimately were conducted through a worldwide network of switches. (See Figure 1.)

The switches evolved from manual

to electromechanical and then to electronic; dials and key pads were added to remotely direct the switching. With the need for manual switch operators minimized, local exchanges established satellite switches or "remote terminals" that fed into the exchange's main switch via a trunk or "feeder" line capable of carrying multiple voice channels at once.

The switched-star architecture remains optimal for point-to-selectable-point voice and narrow-band data communications.

Over time, switch-to-switch trunk capacity expanded as fiber optics became the norm for inter-LATA (local access and transport area) or long-distance carrier lines. AT&T initiated the use of fiber optics for heavy-traffic long-distance routes in the 1970s; MCI accelerated long-distance fiber optics deployment with major builds in the early 1980s; and now U.S. Sprint advertises the near-100 percent use of fiber optics in its long-distance network.

Telcos routinely deploy optical fiber for the longest links in their local distribution system—from the central office to the remote terminal or local service area hub. For example, Southwestern Bell now chooses fiber optics over copper when the distance exceeds 15 to 17 kilofeet. BellSouth says its breakeven "feeder" distance is as low as 6 kilofeet.

Fiber trials: addressing economics

Outside of trials, the telcos have not yet taken fiber beyond the remote terminal or to the "last mile" of the system.

Of all the regional Bell operating companies (RBOCs), BellSouth has gained the most attention through its pioneering fiber-to-the-home projects in Orlando. In the 300-home Hunter's Creek project, the fiber optic cable TV system is separate from the standard twisted pair "plain old telephone service" (POTS) system. Cable TV service, which began in November 1986, consists of one-way delivery of 36 compressed (45 mb/s) digital video signals over single mode fiber to a neighborhood sub.

What about cost?

Exact costs of the Orlando trials have not been made public, but industry analysts have estimated them to be over $10,000 per home. Traditional two-way, interactive, 82-channel coaxial cable TV systems can be constructed for significantly less than $1,000 per subscriber, and a review of recent proposals from Jerrold's System Design Department showed that the cost of rebuilding an existing system for 82-channel delivery with impulse ordering capability is generally less than $500 per subscriber. Current copper POTS newbuild cost estimates are in the $1,000 to $1,650 per sub range.

Other telcos with announced plans to test last-mile fiber optic video signal distribution include GTE in Cerritos, Calif., Bell of Pennsylvania in Perryopolis, Pa. and NYNEX in yet unspecified locations. A few hundred homes are involved in each of these tests; expenses would be prohibitive for systemwide testing. Analog video distribution will be employed, as the telcos back away from initial insistance upon an all digital network in search of workable economics.

Another RBOC, Southwestern Bell, has presented a financial analysis indicating that the 1991-93 time frame is the "best case" economic crossover between fiber and copper for POTS-only new construction. Absent a "broadband trigger," Southwestern Bell sees a long, slow transition to fiber optics.

Based on what is known today, the economics realistically show the possibility of new fiber optics POTS construction by the mid to late 1990s. Some telcos may incorporate aggressive maintenance savings in justifying fiber optic construction before state regulatory agencies; but the residential newbuild market segment is relatively small, perhaps two million access lines per year, and most of these "new" builds are actually extensions of existing systems.

Expensive alternative

The economics look further out in the much larger rebuild segment. With more than 80 million existing twisted-pair drops to residences, and an estimated average aerial construction cost of $150 for replacing each drop with fiber, the total cost for replacing residential drops nationwide would be over $12 billion (excluding the incremental cost necessary to rewire the inside of a residence with fiber or, alternatively, to install a new "network interface unit" to convert light to electronics).

This is not likely to occur based on POTS-only needs. The cost of installing copper lines is estimated at $40 per aerial drop, mostly for labor.

Other than experiments, telco experience with fiber optics remains limited to longer point-to-point links. Cable TV operators similarly use fiber optics in their longer point-to-point links, known as supertrunks. In both cases, the bulk of installed plant is in the "last mile" of distribution. Current economics for drop, or "last foot" replacement are a dramatic indication of the staggering investment that would be required to replace the entire last mile of telco plant with optical fiber to provide competing broadband video distribution.

Proposed broadband switched-star fiber optic systems have yet to come anywhere close to the coax tree-and-branch system economics—especially in rebuild situations—but technologies are advancing and fiber optics costs declining. Obviously the potential exists for telco-controlled "last-mile" fiber optic distribution systems to approach economic viability sometime in the future.

Time and scale

If the fiber optics technology breakthrough and regulatory waits ended tomorrow, in what manner and time frame would telcos enter into broadband video operations?

Overbuilding existing cable TV systems with an integrated voice, video and data fiber optic telco system, would be a long, slow process. Telcos depreciate their newer plant over a period of 15 to 20 years, with older plant depreciation schedules of 30 years or so not uncommon. Although individual telco plant rehabilitation can occur before equipment is fully depreciated in case-by-case situations, regulations typically impose strict state-by-state limits on such "out-of-cycle rehabs."

The large scale of existing telco businesses relative to cable TV MSOs may mandate wholesale acquisition if participation in broadband video is to be more than a minor, diversionary effort. Total 1987 cable TV operator revenues were approximately $11.3 billion. BellSouth and NYNEX revenues each exceeded those of all cable TV MSOs combined in 1987. The RBOCs together have over six times the revenue of all cable TV operators.

RBOCs control about 77 percent of all telco local access lines. Adding the next three telcos—GTE, United Telecommunications and Contel—over 90 percent of telco access lines are accounted for by companies with annual

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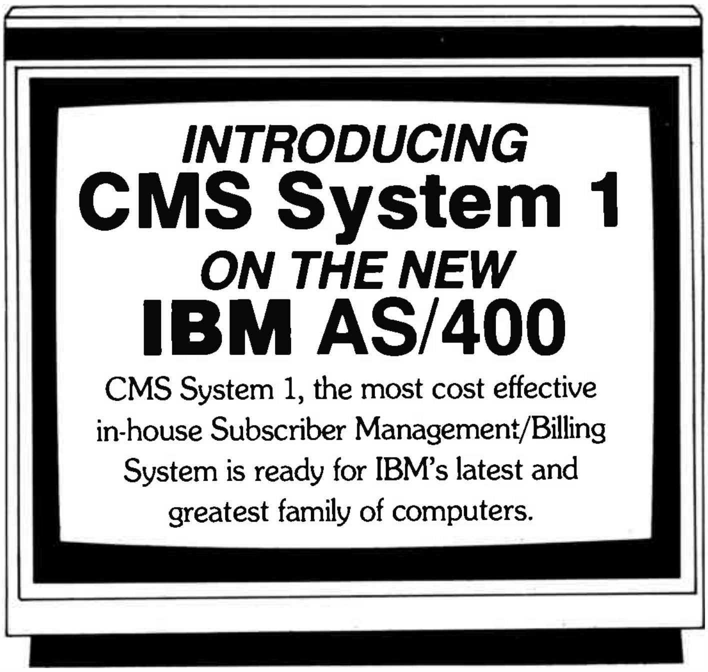

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revenues each significantly exceeding those of the largest cable TV operator.

Competitive factors: telco offense

Despite its smaller size, cable television is no longer an entrepreneurial industry. It is an entrenched part of American society. At the present time, approximately 47 million homes, or about 53 percent of total U.S. TV households, subscribe to cable. As the last remaining urban newbuilds are completed over the next few years, the number of subscribers can be expected to reach and exceed 60 percent of all TV households. Goals of 70 percent to 80 percent penetration are not unreasonable as the industry continues to foster new programming services, improve customer service and deploy advanced technologies for new service applications.

So, on what unique basis can a telco compete against an entrenched cable TV operator and take significant market share?

Price is out, at least for the near term. Upgrading telco switched-star distribution plants to handle broadband video would place the telco at a large cost disadvantage versus the existing cable TV operator. The cable operator has an inherent cost advantage for "broadcast" video delivery in its tree-and-branch coaxial cable distribution plant.

Telcos do not have a lock on fiber optics technology. As the technology advances such that economics become favorable for further deployment, the cable TV operator has the option to upgrade his own plant.

CATV is using fiber

Cable operations are already using fiber optic supertrunks as one element to increase system channel capacity while improving picture quality and system reliability. Fiber optic trunking, such as that proposed in ATC's innovative fiber backbone model, shows promise of further facilitating increased channel capacity, two-way services, quality and reliability.

Can the telco compete by offering more system capacity and more services? Faced with the prospect of telco overbuilds, the cable operator has a significant arsenal for competition. Today, the operator can take full advantage of readily available 550 MHz two-way distribution technology, offering 82 channels of programming to consumers, including impulse pay-per-view and other interactive services.

Most of the "enhanced" services (home security, home banking, remote meter reading, etc.) just being tested in telco broadband fiber-to-home experiments are currently in active use or have previously been tested in various cable TV systems. In fact, existing 550 MHz technology provides the cable operator with sufficient capacity to add new services when such services become viable.

Research being conducted on HDTV and other advancements of the future at locations such as the newly established Cable Labs industry consortium and Jerrold's Applied Media Lab promise further additions to the cable TV industry portfolio.

Quality of service is sometimes mentioned as a potential telco competitive advantage. Regarding the plant, the cable TV operator can readily improve picture quality through system upgrades using existing technology. Cable operators, no longer preoccupied solely with system construction, have also begun to place a new emphasis on upgrading their marketing and customer service efforts.

Rate-of-return regulation has allowed telcos to invest heavily in their service forces. However, such regulation does not always mean that the service operations are efficient at the level demanded by the market. Should telcos compete against cable TV operators, the cable TV operator can be expected to respond with higher quality levels of service without needlessly sacrificing cost advantages.

Competitive factors: telco defense

The assumption most make in terms of the competitiveness of the telco versus the cable operator is that the telco is a deep-pocketed, well-capitalized entity. Following this assumption, it is assumed that the ability to compete against the "entrepreneurial" cable operator is weighted in the telco's favor. What also must be recognized is that the potential for future local loop deregulation opens up the possibility that some other deep pocketed player may acquire the local cable operator and finance the technological advances, i.e. switched fiber optics, necessary to compete on an even level with the telcos.

Power companies and other utilities, with financial resources, distribution plant construction/operation expertise, and strategic expansion goals similar to telcos offer one immediate possibility. Existing cable TV operators, especially if infused with resources from other large companies, could add switches to their plant faster than telcos could build entire new broadband distribution plants.

Houston Lighting and Power, with its Paragon Communications cable TV operation (owned 50 percent with Time Inc.'s ATC) and recent acquisition of the Rogers U.S. cable systems, is the best, but not only, example of large utilities running broadband video operations.

The telcos may not be able to take a chance that allows another deep-pocketed company to gain its own pre-emptive integrated voice, video and data distribution system.

Telcos' only choice

Although unfettered telco entry may never be allowed, if the regulatory changes do occur, the likely initial major entry will be through acquisition of existing cable TV operators. The telco could then upgrade systems more gradually with fiber optics and other improvements, perhaps ultimately evolving into integrated voice, video and data communications.

Overbuilding existing cable TV plant, in direct competition with today's cable operators is a less attractive option for telco entry for four reasons:

1) Switched fiber optic technology is insufficiently advanced to compete economically with existing broadcast coaxial cable technology in delivery of broadband video to the "last mile" of distribution.

2) The large relative scale of major telcos compared to cable TV operators combined with a lengthy telco plant "rehab" schedule would render telco broadband video participation through overbuild a minor, yet prolonged, diversionary effort.

3) Telcos have no cost, service or quality advantages that the entrenched cable TV operator cannot respond to in head-on competition.

4) The threat of another deep-pocketed company using cable TV operations as a base to deploy its own pre-emptive integrated voice, video and data distribution system may force telco acquisitions of cable operators for defensive purposes.

The telcos' most likely method of entry into broadband video delivery, allowing for the removal of all present barriers, would be the purchase of existing cable TV MSOs. ■

What does CATV need to carry HDTV?

Seven years ago, CBS Inc., in conjunction with several Japanese television industry companies represented by NHK, the Japanese broadcaster, put together a presentation exhibit of a new television technology called High Definition Television and took it on the road. The exhibit toured the U.S. several times and was viewed by the general as well as the trade press, television industry leaders, engineers and technicians. Everyone was suitably impressed, especially when the exhibitors placed, side-by-side, a HDTV display unit and a NTSC display unit, each showing the same video material.

"A lot has happened in seven years," says Bill Thomas, formerly director of engineering and technology with American Television and Communications (ATC), now vice president of engineering and technology with Nielson, "but I'm not sure the consumer is that much closer to true HDTV as a mass marketed, affordably priced item."

Standard(s) politics

Things have progressed at least to the point that today the first order of business is the establishment of HDTV transmission standards. Much has been written, in these pages and elsewhere, about the technical specifications and relative merits of the leading proponent systems. The political groundwork is now being laid for the engineering community to begin initial testing and evaluation of those proponents.

Several industry associations, including the Electronic Industries Association, IEEE, National Association of Broadcasters, and the National Cable Television Association, have set up committees to look into HDTV, and several companies and academic laboratories have been contributing technical information. The Canadians, with 85 percent penetration by cable, have set up the Canadian Advanced Broadcasting Committee (CABC) which may spearhead much of the North American testing of HDTV.

But, it's the FCC's interim report on HDTV that has set the stage in the U.S. for the next important act, which is the testing of broadcast transmission systems by the newly formed, and broadcast industry funded, Advanced Television Testing Center (ATTC). "Cable has to become active in the standards selection process that is currently going on," advises Paul Heimbach of HBO. "It's encumbent on cable to make sure that the formats being looked at by the FCC and the broadcasters are cable compatible," he adds.

By George Sell, Contributing Editor

Cable's challenge

Nick Hamilton-Piercy chairs the NCTA Engineering Committee's subcommittee on HDTV. "I think it's a non-disputed fact that whether it's HDTV or improved definition television of some sort, we do know the cable industry has to provide better quality pictures from current NTSC to whatever standards for subscribers," he says.

Hamilton-Piercy is centering immediately on quantifying the performance specs of existing CATV distribution networks. "When we know what works right now and their potential," Hamilton-Piercy says, "we can feed the sensitive parameters back to the proponents who may well be able to change slightly their design concepts and standards so it won't be so delicate for its transmission through these impediments."

Hamilton-Piercy and most other engineers involved believe there will be a thorough exchange during the standards establishing process, at least on the level of technical information. "I would say, regardless of any political posturing between broadcast and cable, at the engineering and scientific level there is one approach," Piercy reports. "I've seen unprecedented exchange of engineering measurements and information and dialogue with this issue. This is a very close engineering community regardless if it is broadcasting or cable," Hamilton-Piercy claims.

While good engineering communication may be occuring, nevertheless the final resolution of the standards ques-

David Sarnoff Research Center's ACTV-I.

tion is several years away. In the meantime, the telephone companies are pushing forward with fiber optics to the home and fully digital transmission. If the Japanese TV set manufacturers could expect a digital transmission delivery system to be in place at the time HDTV is commercially viable in North America, their problem with standards could be solved.

A wary eye

The telephone industry has long believed that its integrated services digital network (ISDN) transmission to the home for voice, data and video is the wave of the future and that's the direction their long range planners have taken. Bill Thomas keeps a wary eye on what interests the telcos in HDTV. "Their claim is that none of these analog approaches are going to deliver the kind of consistant quality to the home that you need to really have HDTV. Cable's got it's problems, broadcast's got it's problems, and DBS just has inherent problems anyway. The only way it's going to happen is that if you can share the resource from a massive digital pipeline into the home," Thomas says.

'It's not heavily publicized," Thomas goes on, "but I'm pretty sure that there is a joint project going on between Bell Labs (the Bell system's central R&D facility) and NHK," Thomas reports. "At least, the Japanese want to understand very closely what's happening with the telephone companies and their digital concepts." According to Thomas, Bell Labs has the largest concentration of HDTV production equipment anywhere in the world outside of Japan.

Walt Ciciora of ATC points out, "While that's possible, the one predominant issue with Japan is to keep the factories humming and the NTSC products now have been so cost reduced and the technology so dispersed that the Koreans and the Taiwanese and the other less developed countries are coming in with extremely low priced, good quality receivers. That has caused the Japanese factories to be idle or have excess capacity. So, it is rather urgent for them to have something else to fill the factories and that has to be something technologically advanced to the point where the Koreans and the Taiwanese can't copy."

Sarnoff Center's ACTV-II shows improved resolution.

Multiple standards and Multiport sets

Most cable experts looking into HDTV believe the outcome of the standards process will be a multiplicity of technically viable standards. In fact, some hold that a single standard would place CATV at a disadvantage. Ciciora urges, "We have to resist some of the broadcaster's attempts to get an 'open' universal standard. In fact, a universal standard is a myth, it's impossible." A universal standard would not only have to include over-the-air and cable, but also pre-recorded media such as videocassettes and discs, source material production, FM delivery by DBS, and digital delivery via fiber. According to Ciciora, "The technologies are so diverse that they are just not amenable to a universal standard, therefore my strongest opinion is that cable must not be straightjacketed and prevented (by regulation) from competing adequately with those other media."

Built-in solution

Many suggest the solution to multiple standards can come from the HDTV set manufacturers. One concept is the "open architecture" set in which the set houses circuitry that converts the incoming format to the format acceptable by the display circuitry. Hamilton-Piercy rejects this approach as "too damned complex." He says, "The fully intellectual one that electronically adapts to whatever standard that's put to it is a scientist's conception and dream more than a consumer electronics reality."

Multiport TV sets, on the other hand, would have inputs for various standards. "I think there's a better alternative for the TV set manufacturers and that's to create a multiport TV set," Paul Heimbach claims. One port would be for NTSC. "Then, instead of saying, 'This is a XYZ format HDTV set,' limiting what the TV set can receive and display, what they should say is, 'Here's a TV set that has a port on the back of it,' " Heimbach suggests. "Whether it's an RGB input, a Y/C input, or whatever, that port allows you to get to the basic display circuitry so that if there is a format that develops for cable, the decoder is housed in a separate box that sits behind the TV set, maybe similar to the IS-15 connector, that transcodes the cable, or broadcast, or VCR format into a format appropriate to that TV set. That gives the TV set manufacturers the ability of relatively painless evolution.

"That's an idea I support," says Ciciora. "The manufacturers are nervous about doing that because it begins to lead the way for their product being merely a monitor or display device.

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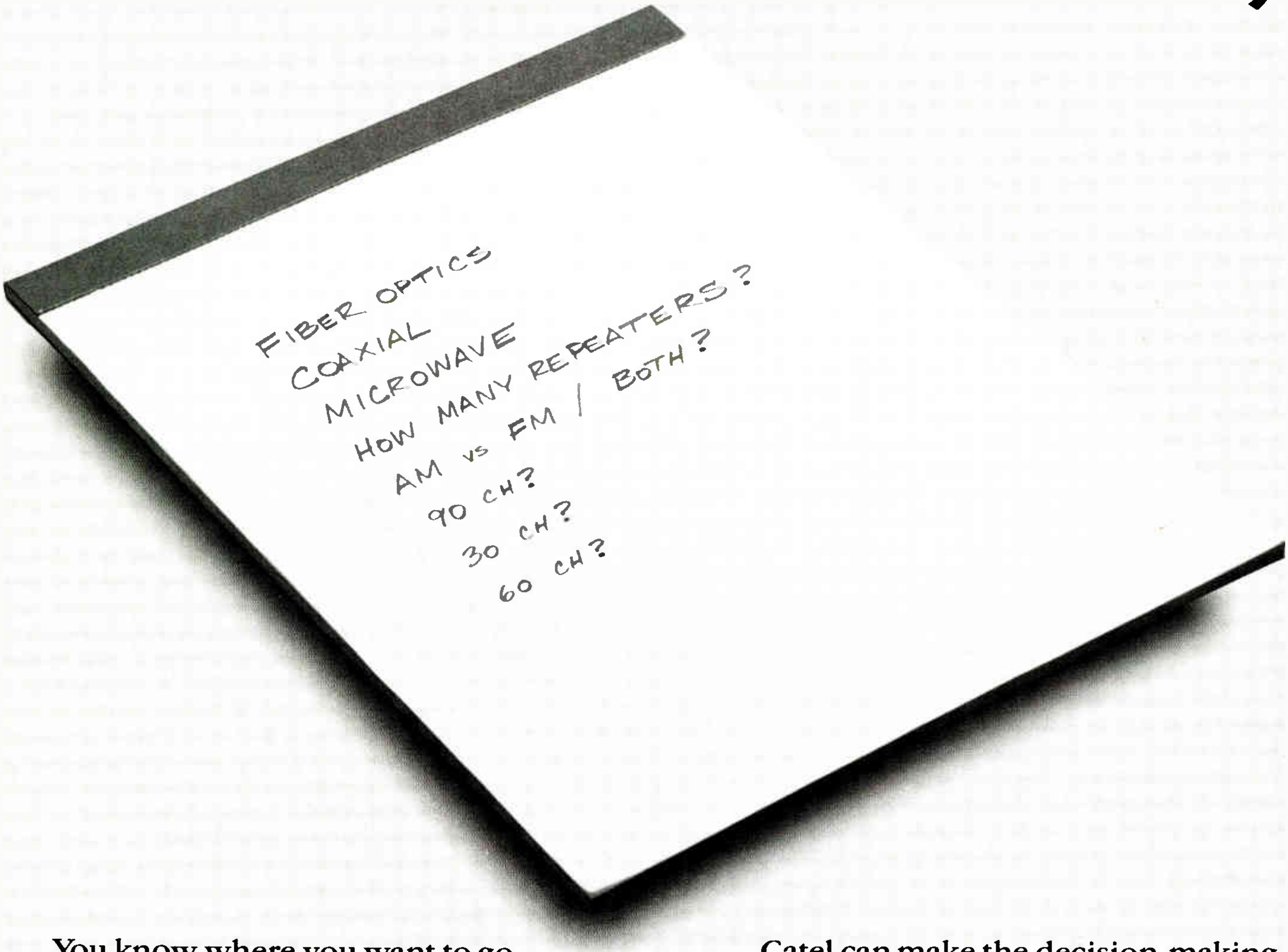

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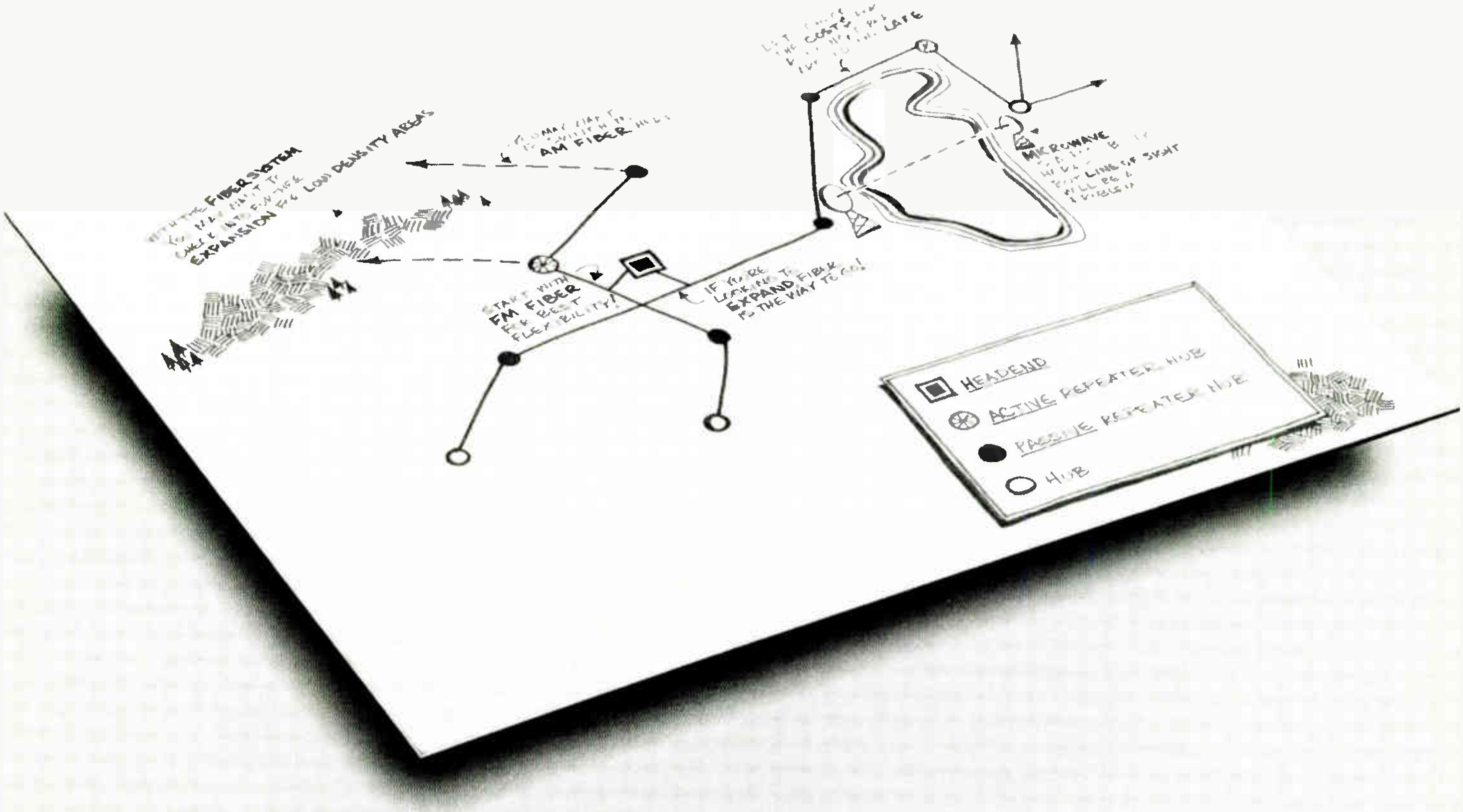

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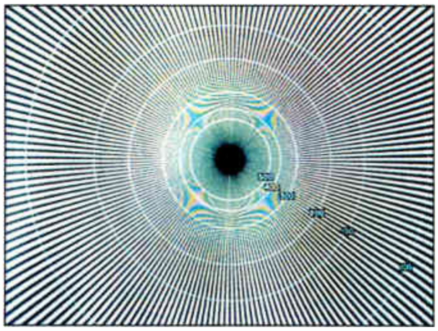
Getting better pictures now

All this talk about high definition, enhanced definition and other forms of advanced television is great for the future, but what's available today for cable operators who want to improve the pictures they send to their subscribers?

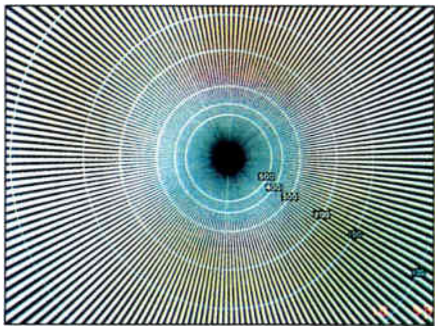
Plenty. Faroudja Laboratories and High Resolution Sciences, both California-based video hardware manufacturers, offer low-cost encoders and/or decoders that can be used to eliminate some of the more annoying NTSC artifacts commonly found today.

Faroudja's system, dubbed SuperNTSC, consists of both an encoder at the headend and a decoder in the TV or VCR. However, it's a single-ended system, meaning picture improvements can be seen after installing just the encoder. The system is presently being tested in two TCI cable systems in California.

High Resolution Sciences also claims its encoder will offer picture improvement—and there's no need for any modification to home TVs or VCRs. That system is also presently undergoing testing in several as yet unidentified cable systems, according to Kevin Schine of HRS.



Cross-color and it's effect.



Cross-color reduced by High Resolution Sciences.

In essence, what the Faroudja system offers is an NTSC signal "free of cross-color and cross-luminance components," according to the firm's data sheet. This is done by prefiltering the luminance and chrominance information prior to mixing those two ingredients, avoiding spectral overlap and artifacts.

If the decoder is used in conjunction with the encoder, the result is a picture so clean and sharp it's hard to differentiate from an RGB signal, Faroudja says. It is expected the decoders could be manufactured and included inside TVs, VCRs or cable converter boxes for a minor incremental cost.

The HRS system also claims to eliminate chroma crawl and reduce cross-color to provide noticeably better pictures—especially when rich, saturated colors are being shown.

HRS doesn't plan to manufacture the equipment (its an R&D house), but instead wants to license it to others. To date, no one has purchased a license, but Schine says he anticipates a sale "soon." ■

—Roger Brown

Continued from page 29

But, in fact, if there are going to be a variety of transmission standards, and I believe there will be, the consumer's going to demand it and some manufacturer's going to provide it."

Others remain skeptical. Thomas puts it this way: "All the talk about open architecture recievers and multiple standards is healthy, but from a real practical sense, I'm not convinced that there won't be one standard or a combination standard, that we've not even seen yet, that doesn't put it all together."

For Thomas, the cost factor to the consumer is what militates against it. With current estimates of the cost of a HDTV set around $5,000 and a HDTV VCR around $1,500, "There's a lot of sentiment that the thing's expensive enough already," he advises. "We really can't expect the customer to buy a different $500 module to plug into his TV, one for cable, one for broadcast, one for the VCR, etc. I'm not completely convinced this whole multiple standards thing will be the long term solution, although there are people who argue that there's no other way to solve the problem and that's how it's going to go."

Forward thinking on compatibility

Whether there will be multiple standards for the cable operator to deal with or one standard, he will still have to deliver a NTSC-compatible version of the HDTV source material. HBO is working on a CATV format for HDTV with Massachusetts Institute of Technology's Advanced Television Research Lab. Heimbach offers an approach that HBO has been studying. "What we say is, the cable operator, in the confines of the cable system, can choose a format that is appropriate or optimized for him."

Assuming a possible 12 MHz terrestrial standard is established for HDTV, the cable operator is faced with devoting two cable channels for each HDTV channel. "If he wants to maintain backward compatibility, let's say HBO is in high definition," Heimbach suggests, "he may take the NTSC version of HBO coming down from the satellite and put it on channel 22 and he may then take the HDTV version of HBO and put it into his cable optimized HDTV format on channel 48 on the cable system. He's maintained compatibility by using 12 MHz, but of two isolated channels, whereas the over-the-air broadcasters are looking at compatibility in terms of 12 MHz with two channels that are tied to each other, one the compatible channel and the other a helper channel.

"One of the benefits of looking at the compatibility provided by two isolated channels is, at some point in time the need for the NTSC channel will go away," Heimbach says. "So, you throw away that channel and you continue to carry that HDTV channel. If you have people still requiring NTSC, you give them a converter box. So, you've essentially increased your channel capacity."

Besides standards, compatibility and channel capacity problems associated with carrying HDTV signals on cable systems, other technical problems seem to be emerging.

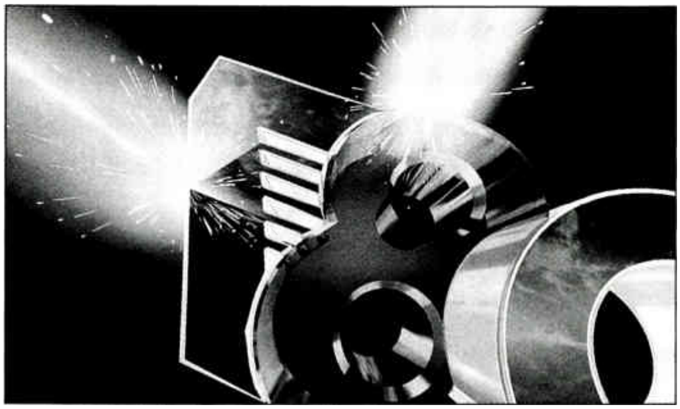
According to Thomas, "The other major issue people are concerned about is the general smearing of the signal that seems to occur in our plant that a lot of people have attributed to the so-called microreflection problem." This phenomenon is somehow generated by factors in the way the physical plant is built and cannot be solved by putting in better cable and connectors or upgrading the electronics. "The problem seems to be where you're dealing with 100-foot lengths of things—and that's your drop or wiring inside the house," Thomas suggests.

"Another problem that is being investigated is phase noise. That's

Mitsubishi has demonstrated its HDTV VCR.

received a lot more attention so far than microreflection," Thomas says. "Phase noise is something that can effect NTSC quality. Not a killer, but there are a lot of things that degrade the signal. But we don't proclaim the signal unusable." In a HDTV environment, phase noise may have to be taken more seriously.

"You have to line up a lot of things to have that happen, but there are systems out there where they have those elements lined up. Phase noise comes out of various pieces of equipment we put into the plant," says Thomas, "processors at the headend, baseband converters, modulators or whatever. You can solve the problem by having higher quality pieces of electronics."



HDTV promises resolution comparable to 35mm film.

A format wish list

What has been acceptable for cable transmission of the NTSC signal may not pass for HDTV transmission. The point of all enhanced definition systems is clearer, crisper, truer to life video display. As Hamilton-Piercy says, "It doesn't matter which standards, the undisputed fact is that better pictures are required."

Anything that would interfere with enhancement runs counter to the main quality benefits of the technology. "It's damned hard to measure some of these things because, while they degrade the NTSC picture, they are not killers," Thomas points out. "And so, the test equipment that we all have isn't necessarily designed to look for these rather small degradations until they're extreme on the NTSC signal. We are even more hamstrung when it comes to trying to look at what a HDTV signal will have."

Thomas sees HDTV as a mandate for improvements in test equipment. "Absolutely, in fact, if you look at the new Tektronix video test set, the VM-700, while it's not specifically for HDTV, it does incorporate a lot of enhancements such as signal averaging, an ability to look at complex wave forms, heavy local calculation. It's an indication of what's going to be needed."

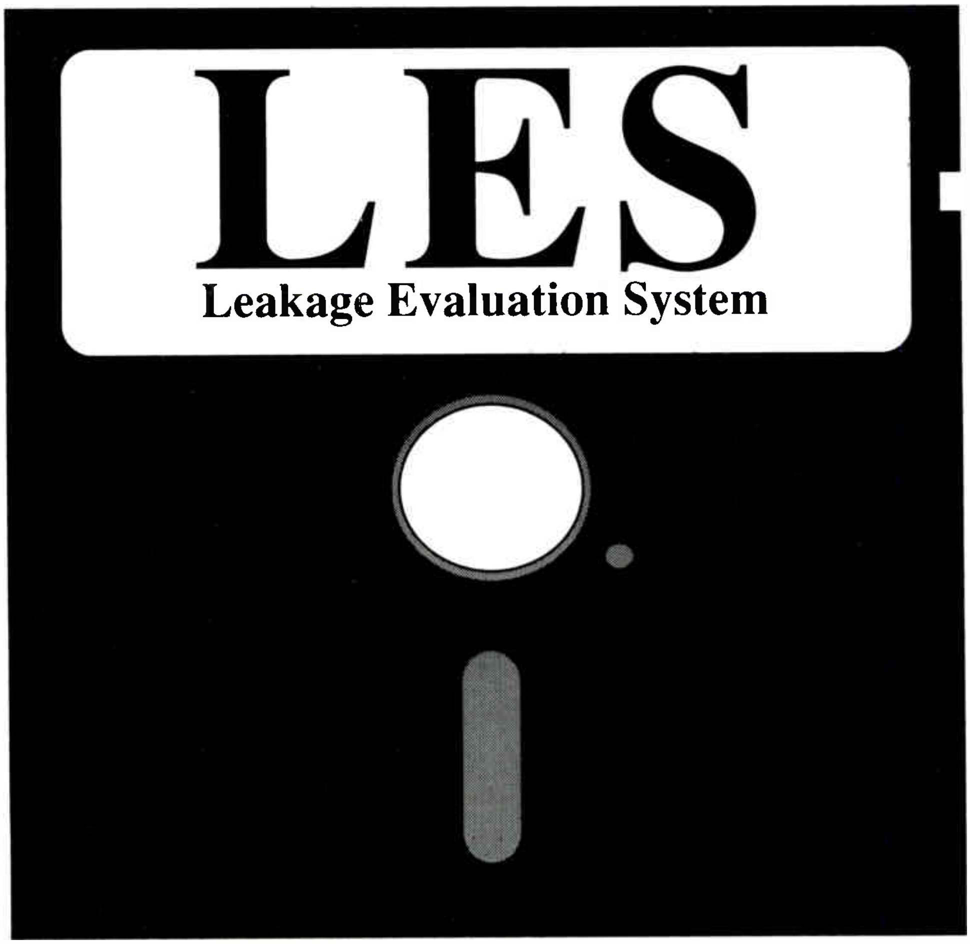
Walt Ciciora would like to have features incorporated into a HDTV format that would meet the given needs of CATV operation. He would like to have addressability and scrambling built into the format, "rather than have these things added as Band-aids later on. They should be implemented as part of the system and considered in the fundamental system design, so that we end up with truly secure scrambling, addressability and delivery via satellite to cable headends.

"If I could create a wish list, I would also wish I could control whether the signal could be videotaped or not," Ciciora muses. "That way I could allow certain things to be tape recorded and certain other things, like early window movies, to not be tape recorded. That way I'm in a better position to get impulse pay-per-view material."

And he wants more. "It would be great if the people who design the system understood the way signals go through cable systems and attempted to design a very rugged system that was tolerant to some of the problems we have in cable systems."

With HDTV sets not commercially available in North America until around the fourth quarter of 1990, and without a specific HDTV system that you can test over a variety of cable plants, much of what CATV engineers necessarily have to deal with concerning technical aspects of HDTV is conceptual in nature. The actual daily realities of HDTV more often than not revolve around politics, regulations, meetings and conferences. But that's the stage of HDTV development in North America.

As Bill Thomas puts it, "You write an entire story and in the last sentence you'll say, 'By the way, the general consensus is that you will need 50 dB carrier-to-noise and you will need to figure out how to improve the microreflection problem and, hey, we just got technical.' " ■



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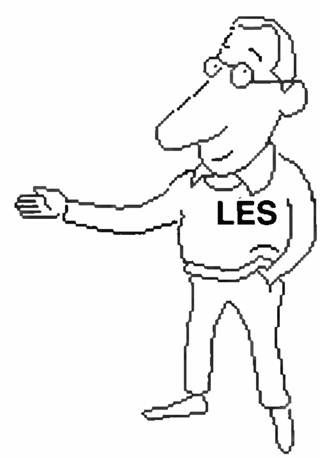
Ron Wolfe
CED, October 1987



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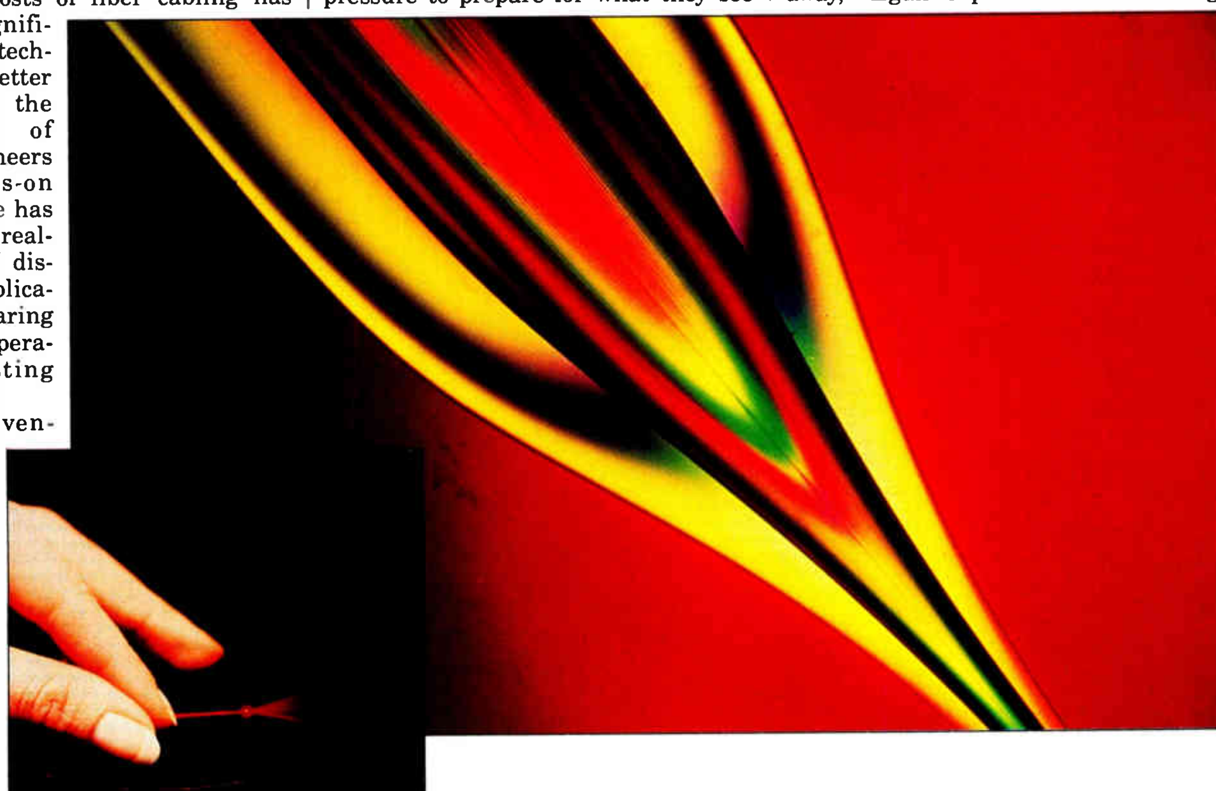
Reader Service Number 21

The fiber evolution—what vendors are doing now

Lightwave transmission of CATV signals through glass fiber cables has been the dream of many in the industry for over a decade. With its significant advantages, low maintenance, imperviousness to EMI and RFI, long life and low loss factors when run point-to-point, fiber optics now seems to have reached a stage of development where the gap between the dreamers and the realists has narrowed. Costs of fiber cabling has dropped significantly, the technology is better understood, the population of CATV engineers with hands-on FO expertise has grown, and real-world CATV distribution applications are nearing the field operations testing stage.



CATV vendors, mindful of the need to anticipate market shifts, are now more attentive to fiber optic developments. Companies heretofore not known in the cable TV arena have appeared on the scene. Many long-time industry vendors have recently begun to establish a presence in that market in a big way. Some hedge their bet by carrying another vendor's fiber optic line while continuing to supply their coaxial clients. Others simply mark time.

Larry Nelson, executive VP at the Comm/Scope Division of General Instrument, exemplifies the cautious approach of many CATV vendors. "With the low volume, it doesn't make economic sense for us to be in the manufacturing business in fiber cable, so we are private labeling fiber cable," Nelson reports.

By George Sell, Contributing Editor

Is FO critical to CATV's future?

While most CATV manufacturers see FO somehow figuring in the future of the industry, many feel limited pressure to prepare for what they see as a distant commercial marketplace. Whether fiber is critical to cable's future economic viability, Nelson responds, "I'm not sure anyone knows the answer to that."

Nelson thinks technologies should be used where and when they're useful. "Fiber optics has demonstrated a limited usefulness to date in long haul transport of video. There's a lot of activity to introduce fiber further down into the architecture. Whether or not that's successful is yet to be determined." He adds, however, "There are a lot of exciting possibilities. But I don't think anybody at this moment can give you a really accurate entry point. To the extent that fiber is important in CATV, then it is a critical issue to Comm/Scope as a vendor."

John Egan, president of Anixter, is more enthused, "There's no question that fiber optics is critical to the future of cable TV. There needs to be a graceful way to evolve to a FO network. You con't just throw this stuff (coax) away," Egan explains. As a leading equipment supplier, Anixter is moving quickly into the CATV fiber optic market. They now carry the full line of AT&T FO cable connectors and apparatus, and recently showed off the Laser Link AM system.

"We have been working with AT&T to modify some of their existing lasers to be able to function in an analog AM transmission mode," says Egan. "This will be a transmission system that will be very cost competitive and provide the multiple channel distance transmission that we've been looking for." Egan claims the device will deliver 60

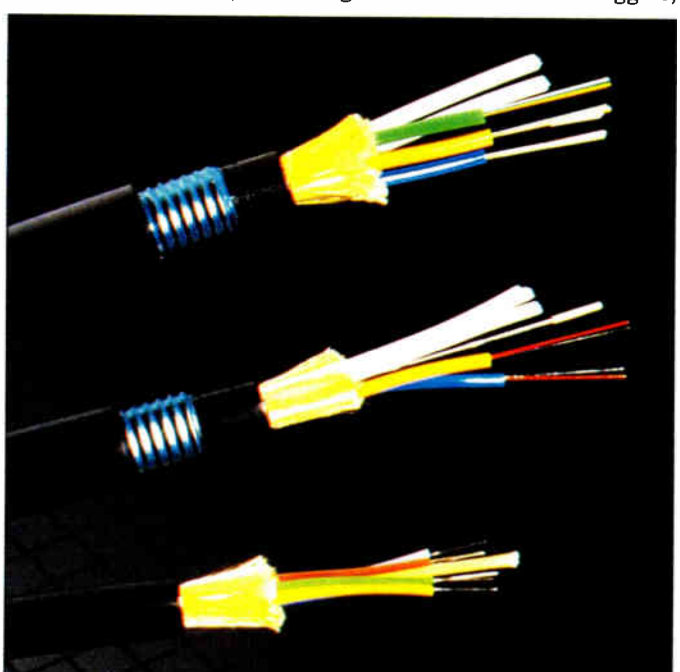
AM modulated channels up to 18 kilometers.

Why the current interest

John Holobinko, vice president for sales and markerting at American Lightwave Systems, whose predecessor company, Times Fiber Communications, Systems Division, pioneered fiber optic FM supertrunking for CATV in 1979 and introduced the Mini-Hub concept seven years ago, believes FO is hot again due primarily to rebuilding cycles, mergers and the technical limits of coaxial plant. "It's a time of rebuilds," Holobinko states. "The trend in the industry is toward consolidation. Now that we are tying so many headends together, we are looking for more effective ways of doing that."

"We see further demands on our systems and see that we've come up against some technology barrier that isn't easily satisfied by pushing the coaxial electronics just that one more step," Holobinko says. "That's been done incrementally so many times that we're starting to get toward the end and systems get more complex; and problems associated with coaxial-based systems grow a little bit more. It's getting to be the time to look for some alternatives," Holobinko claims.

"One of the things that heated it back up was the ability to produce single-mode fibers, but that's not really the driving factor. The driving factor right now is a lot of hype," states Tom Polis of RTK. "There's a number of people in the industry who are pressing the issue as a result of franchise renewals, overbuild competition and a lack of over-the-air space for microwave interconnects when you are talking about rebuilding a system to 550 MHz and you're locked into AML feeds. When you're locked into those, what are your alternatives?" Polis asks. "One alternative is coaxial supertrunk, which is very costly, noise-wise. The other alternative is fiber."



"The other two areas where we are doing further developments are in systems that attack the cost factor of FM systems and provide an FM to AM conversion," Holobinko says. "The other area of development that we continue to do research and hold some of the early patents on is AM over fiber." Holobinko claims ALS takes a conservative approach to announcing product developments. "We tend to announce after the pilot system has been installed, is running and we're ready to go to production. When we announce it, it's pretty much bullet-proof."

Holobinko is skeptical of claims that a mass produceable laser capable of consistant, reliable AM transmission is ready. "The concept is sound but there is no device available in the marketplace today, period." While he feels R&D efforts are getting closer, "It's nowhere near the point where a customer can say, 'Here it is. Here's my off-the-shelf item. Distributors are stocking it and delivery is 30 days and I want 150 of them.' It's not there," Holobinko claims.

Evolution, not revolution

Irving Kahn, a leading advocate of fiber optic use in CATV since 1969, asked rhetorically in this publication seven years ago, "Why go from a literal horse-and-buggy to a Stanley Steamer, when you can readily see a jet sitting on the runway?" While cable systems of seven years ago could hardly be thought of as horse-and-buggies, and today's best 600 MHz coaxial systems are more like a 1989 Caddie, the fiber optic vision Kahn saw then was more a prototype mock-up sitting on a system designer's bench, than a jet about to take off into the blue sky.

"You can't be revolutionary," advises Bill Lambert, the new president and GM of Texscan, "because at that point everything is going to come out. The converters, the amplifiers are going to come out and a whole new system is going to come in, from the headend all the way to the customer's set. You're going to put a box in there to change whatever format is coming down that fiber to get converted to go into the TV. That's going to bet your company," he says. "If you are rebuilding a major system with 200,000 subs, would you set out to bet your company to do that? So, effectively you're stuck, you're going to have to go about it in an evolutionary way."

Texscan presently has no fiber optic product activity underway. But Lambert sees promise in the current work being done in the area of hybrid fiber and coax systems designs. "AM on fiber converted to conventional amplifiers saves the amplifiers, the coax and the converters. And, if you can lick the problems of pushing AM and the lasers, you're evolutionary in nature."

According to Bert Henschied, Texscan's VP of R&D, "We are looking ahead to the optics-to-electronics interface. We think that would be where our niche would be if we do anything close to the optics. Otherwise, we would expect to modify some of our equipment to be compatible in the overall system design if something like the ATC system came about."

First stage: Hybrid 'backbone' systems

A CATV system that delivers signals from the headend to the home using fiber all the way is so far off in the future that most vendors cannot foresee it as a commercial possibility for them. However, almost all who are watching the FO market agree that the fiber 'backbone' concept being developed by ATC shows possibilities. Nelson of Comm/Scope says, "I think it has a lot of pluses. If you look at the needs of the CATV systems from an architecture standpoint, and the difficulty that you have, it is cheaper to provide CATV with a broadcast-type architecture, a tree and branch."

But attenuation in coax means there is a need for amplifiers. "But you can use fiber point-to-point and, in essence,

Converging technologies impacting CATV

(and related economic and political factors). Present to 12-year time frames

- CATV plant (refranchisings, rebuilding, upgrading)
  —present cycle
- Telco plant (aging of copper wire system, cost of copper, shareholder earnings)
  —now
- HDTV display sets (Japanese factory excess capacity)
  —ca. 1991
- HDTV VCRs (available at intro of HDTV sets)
  —ca. 1991
- HDTV transmission (broadcast, cable and DBS)
  —ca. 1993
- Large-screen sets (70-inch diagonal flat wall units)
  —ca. 1993
- Digital reception (HDTV display sets capable)
  —ca. 1995
- Fiber optics/CATV (hybrid systems: FO trunk, coaxial from detector nodes to homes)
  —ca. 1995
- Fiber optics/telco (fiber to home in switched system: video, voice, data)
  —ca. 2000
- Digital transmission (ISDN with intro of telcos' FO-to-home)
  —ca. 2000 or later

—George Sell

distribute your headend via fiber and use the advantage of fiber for low loss to reduce your cascades and still use coax for the broadcast architecture." He adds, "You are using the better parts of both media. Inherently, it has a lot of appeal."

Walt Ciciora of ATC believes the advantage of the backbone approach is the shortening of amplifier cascades. "Our limits are not the cable itself, but the long cascades of amplifiers. So, it's really an ideal approach and it's extremely cost effective—under $50 a subscriber to implement. In fact, we have the capability of a truly broadband two-way approach to the home in relatively short order, much shorter than the telephone companies."

According to Tom Polis, "The biggest problem is to be able to AM modulate a laser with a broad spectrum of channels, up to what we are supplying today over coax, 80 some channels." Polis believes the day is not far off. "I think we'll see it (soon) because there's enough pressure being put on that now. If they are going to sell in the CATV market, and that's a big marketplace, they're going to need that."

Holobinko seconds that. "The bottom line is, if these devices are to be implemented in cable TV systems, they have to be available in large quantities with a high degree of confidence such that these systems can literally come off-the-shelf in a similar way an amplifier is an off-the-shelf item, which means not only performance but confident, repeatable, consistent performance." He adds, "I think we are still a little bit away from that."

FO test instruments

Traditional coaxial cable test equipment manufacturers seem to be waiting to see what develops in CATV fiber optics before they move into that area. Bill Harris, marketing manager with Wavetek, says, "Most people in the real world are still testing before and after translation."

Bill Dawson of Texscan Instruments see the market as, "Very limited. It's in an experimental field trial stage with the MSOs and until there's some volume, there really isn't a business there."

Laser Precision is a fiber optic test instrument company with extensive experience in the telephony market that has recently entered the CATV arena and is advertising in cable trade journals. While the response has been limited, according to Fred Bednar, "It's not that important. We are the leading manufacturer in this type of equipment. We are just planting seeds for the future," he says, referring to CATV. But Bednar is confident about that future. "It should start to take off around 1992 as a significant market for us. By the mid-1990s, you should have your crossover point."

That kind of confidence should make proponents of fiber optics happy. ■

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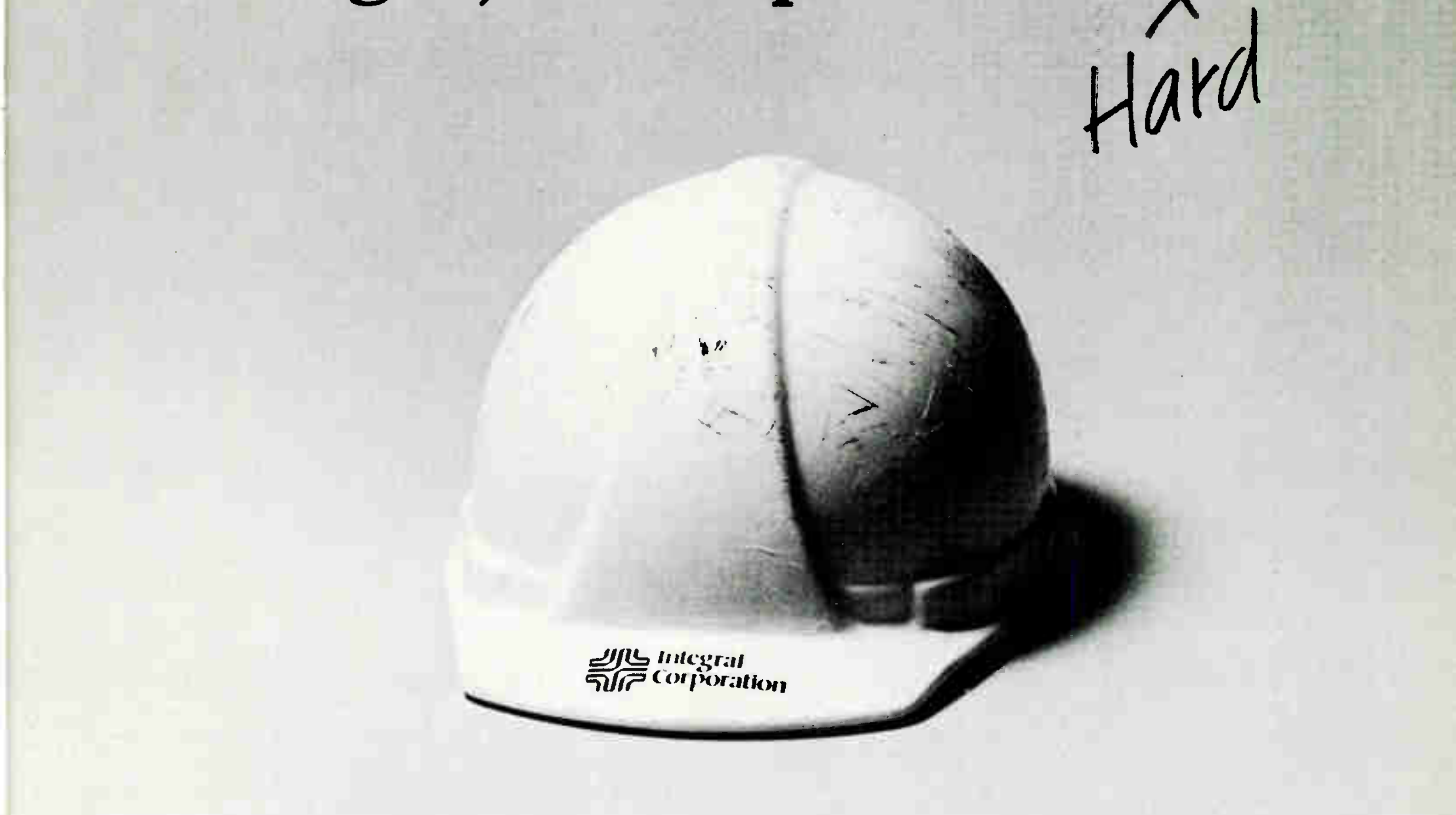

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Reader Service Number 25

CATV network design considerations

Planning an upgrade or a new build can be the single most important process in determining the future of your CATV system. Considering the wide range of factors involved, it can also be the most complex.

Prior to planning an upgrade or new build, it is important to remember that no two CATV systems are alike. A variety of intangibles, (i.e. geography, project budget, community requirements, right-of-way, etc.) make each system unique. While one system may be best served by a fiber optic based network, another may achieve its objectives through use of microwave or coaxial cable. Still others may be best suited by a hybrid network using a combination of any or all of these technologies. Simply stated, no single technology can address the wide range of needs for all systems.

Determining the ideal CATV system, therefore, is choosing the "right technology" and it involves striking a good balance between network requirements and design objectives.

Planning for an upgrade or a new build is a process that can be broken down into three basic steps:

1. Identifying the network requirements within your design objectives.
2. Understanding the interdependency (trade-offs) of the design objectives (i.e. cost vs. performance).
3. Evaluating the design objectives as they apply to the CATV distribution technologies of today.

Identify network requirements

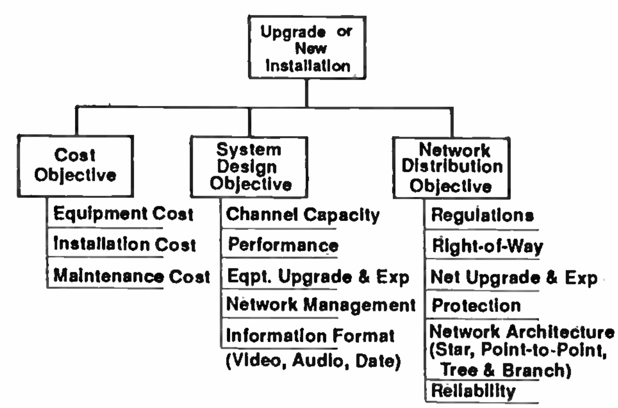
Identifying network requirements is the most complex and time consuming part of this process, but it is also the most essential. It can be greatly simplified by breaking down each objective to its simplest form (See Figure A). What follows is a broad overview of all the elements that exist within each of the three objectives.

By Stefhan R. Sherman, Manager of Special Systems, Catel Telecommunications Inc.

The cost objective. In many cases, the number one consideration in this decision-making process will be the cost objective. There are three factors to consider within the cost objective: equipment cost, installation cost and maintenance cost.

Equipment cost includes the purchase price of modulators, demodulators and transmission equipment. Outside plant equipment such as microwave towers, cables and amplifiers are all part of the installation cost. Other factors to consider when pricing installation are: property acquisitions (right-of-way, pole space and tower sites), manpower, and construction permits and licenses. Maintenance costs involve test equipment, outside plant repair and service personnel.

Figure A



To achieve the overall cost perspective, the three elemental costs (equipment, installation and maintenance) are combined into what typically is referred to as a life cycle cost analysis. In most cases this analysis tends to support fiber optic technology.

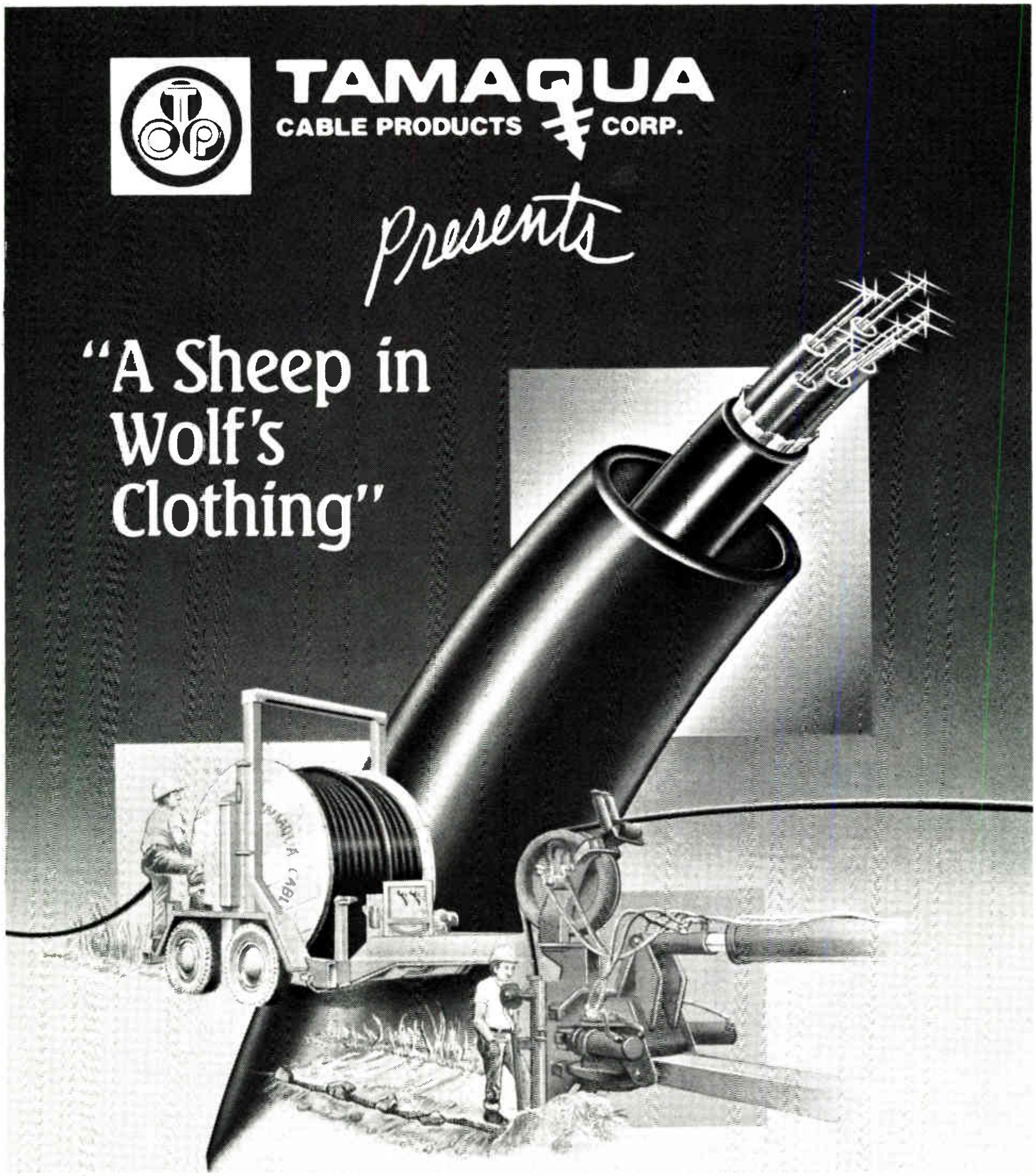
The system design objective. Channel capacity, performance, upgrade and expansion, network management and signal format all fit under the heading of system design objectives.

When considering channel capacity, one must take into account the bandwidth limitations of the equipment as well as the transmission media bandwidth limitations. Transmission media limitations can involve FCC licensing (for microwave systems) and coax and fiber cable attenuation.

Performance can generally be measured with two criteria, equipment noise figures and transmission media noise figures. The equipment performance is typically not the performance limiting factor, the transmission media is. Because fiber optic cable exhibits very low attenuation characteristics and the media is not time varying a fiber optic system provides superior performance to other transmission media.

Determining equipment upgrade and expansion involves considering horizontal integration (building beyond an existing service area to extend the network) and vertical integration (building on to an existing network in order to expand it). Horizontal integration is a function of signal retransmission and the associated noise accumulation. This is directly related the method of signal modulation. Both FM and digital modulation offer performance characteristics suitable for retransmission but cost typically prohibits digital implementation. Vertical integration is directly related to bandwidth availability. Only fiber optic cable offers a virtual unlimited bandwidth for CATV transmission applications.

When considering a system's signal format, one is faced with a variety of industry standards to choose from. Information considerations include: video type and capacity (clear, scrambled and HDTV) and audio type and capacity (clear, scrambled and BTSC). Other signal format considerations include data types and capacity (RS-232, T1, T2 and T3). The single most critical item in a network's ability to support the multiplicity of signals formats is not the modulation equipment but the transmission media's ability to support it. The performance requirements of the network to support a signal format can typically be the limiting factor in the channel capacity that it can sup-



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port. Channel capacity is a function of bandwidth availability and again this favors fiber optic cable deployment.

Network distribution objective. The Network distribution objective involves strategic network planning issues. Matters that call for examination within this objective include: regulations, right-of-way, network upgrade and expansion, protection, network architecture and reliability.

Local, state, and even federal regulations are a fact of life for any CATV system. Construction permits for local and state building codes must be obtained in most situations. Emission certification, both RFI and EMI, must also be taken into account for coax cable distribution. In the case of microwave systems, FCC licensing also must be considered.

Right-of-way is another important issue within the network distribution objective. Right-of-way access factors for fiber an coax systems include the use of existing poles, new aboveground usage and installation of underground plant. Microwave systems have their own set of right-of-way issues, including physical line-of-sight and frequency availability.

Protection switching and redundancy issues to consider include: alternate routing in case of cable cuts for fiber optic and coax distribution; grounding and bonding and surge protection in the case of lightning damage for coax and microwave distribution; and diversity techniques in the case of microwave path outages.

There are generally three network architecture formats to choose from: point-to-point for microwave installations; distributed (star) for fiber optic installations; and bus (tree-and-branch) for conventional coaxial installations.

The final consideration for the network distribution objective is the reliability (outage elimination) factor. This can be accomplished by installing redundant paths into the network, purchasing redundant equipment and, in the case of microwave systems, diversity techniques.

Objective interdependency

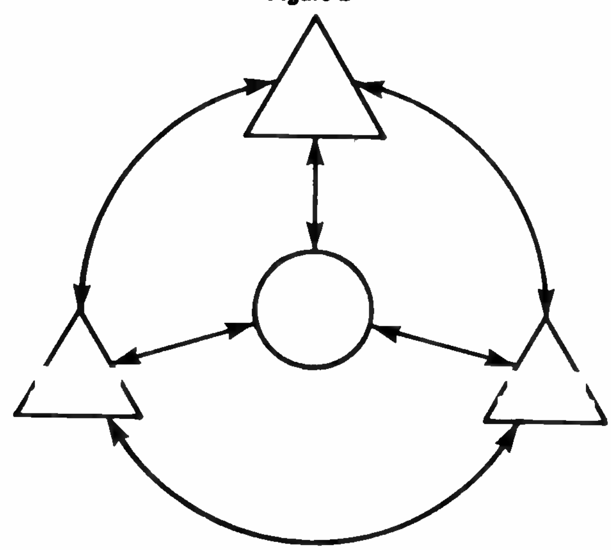
It is important to realize that the three main objectives discussed are interdependent. That is, each has a direct affect upon the other two (See Figure B).

For example, equipment costs within the cost objective are directly tied to the performance criteria in the system design objective. Lower equipment cost equates lower performance and vice versa.

Likewise, network upgrade and expansion within the network objective is directly related to equipment channel capacity within the system design objective. Network channel capacity is dependent upon network and equipment bandwidth.

It is crucial, therefore, to take a broader view when making a decision

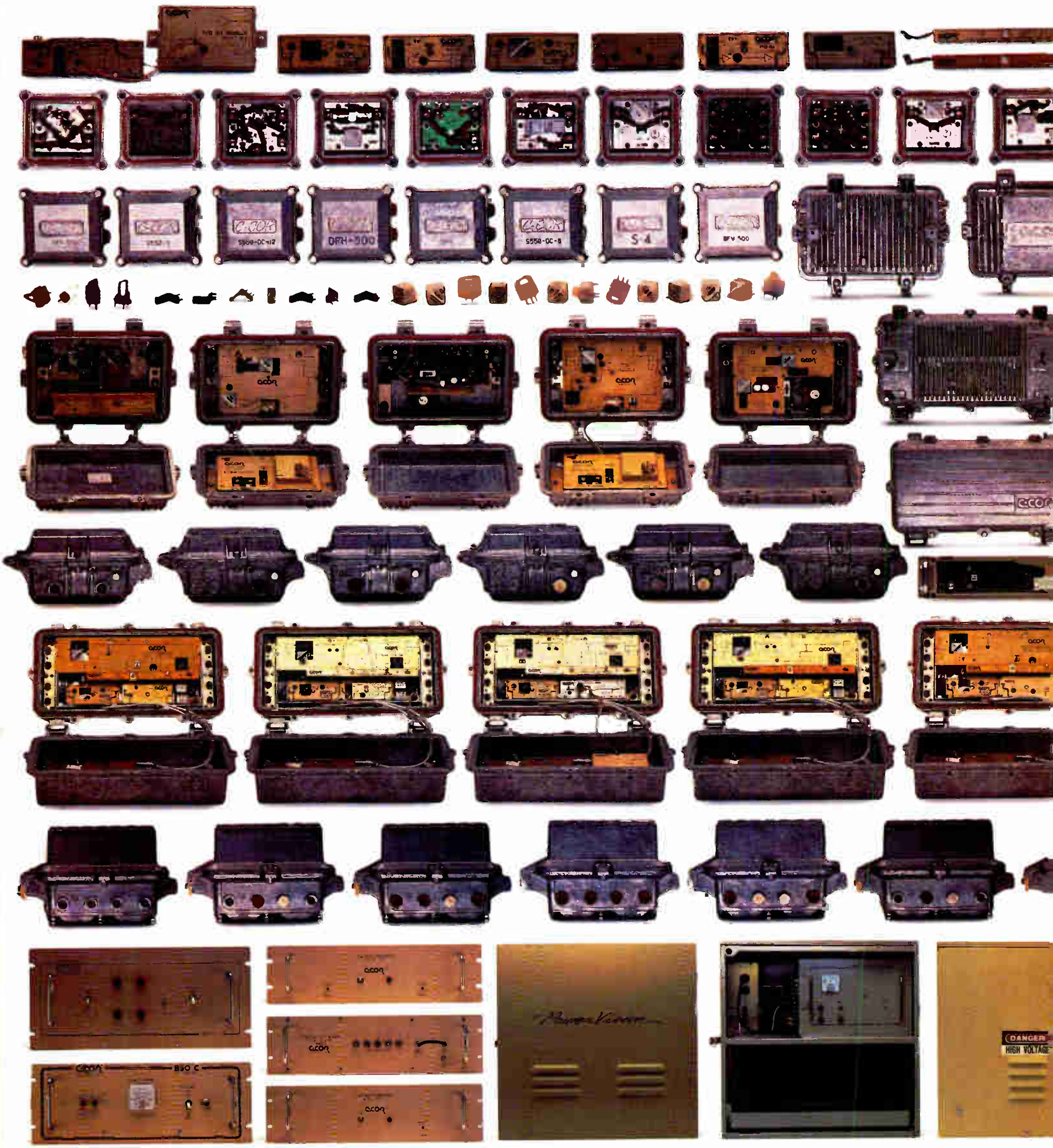
Figure B



on any single element. One seemingly minor decision could greatly affect the end results.

The technological advances of today reflect the growth of the CATV market and the services that it can provide. Fiber optics offers a significant contribution to the development of the CATV market. However, even with the introduction of fiber optics we have yet to see a technological advance that addresses all requirements in all situations. It is crucial, therefore, to identify network requirements and understand their interdependency.

This three-step planning process gives CATV system operators the ability to plan for the requirements of today—and the expansion for tomorrow. ■



Architecture alternatives for employing fiber optics

Fiber optics technology is drawing attention for a variety of cable television applications. The technology supports transmission of bandwidths in excess of 1 GHz, twice as much as state-of-the-art coax-based CATV systems, and offers extremely low loss—0.2 dB to 0.4 dB per kilometer (km) independent of bandwidth—when compared to the best coaxial trunk cables—33 dB per km at 550 MHz.

This low loss reduces or eliminates active devices in the distribution system, which can reduce system noise and distortion associated with cable TV amplifiers and result in improved system performance and better picture quality. Finally, fiber optics avoids transmission of signals in the radio frequency range, yielding immunity from ingress and radiation, providing better pictures and allaying concerns about FCC leakage regulations compliance.

A television signal, as transmitted on a cable TV system, has the spectrum shown in Figure 1. It consists of video, audio and color information to comprise the received picture and sound.

Unfortunately, upon transmission, the signal is subject to degradation, the most significant forms of which are noise (usually expressed as C/N, carrier-to-noise ratio), intermodulation distortion (beats) and cross-modulation distortion. In a conventional cable TV system, the primary contributors to signal degradation are the amplifiers, whereas in a fiber optic system the main contributors are the light source and receiver.

Frequency modulation

Frequency modulation (FM) uses changes in frequency to convey information. In Figure 2 the distances between the peaks of the FM waveform vary with time, signifying information transmission. These distances are not readily affected by noise and intermodulation or cross modulation distortion, giving FM its good immunity to

By Geoff Roman, Vice President Marketing, Jerrold's Distribution Systems Division

Figure 1 Cable TV Channel Format

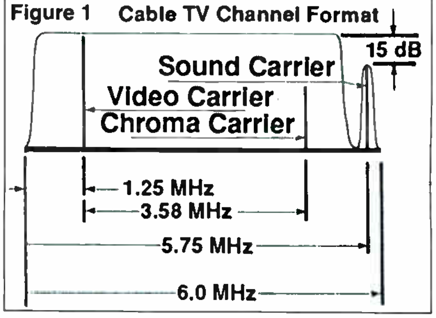


Figure 2
Modulation Techniques

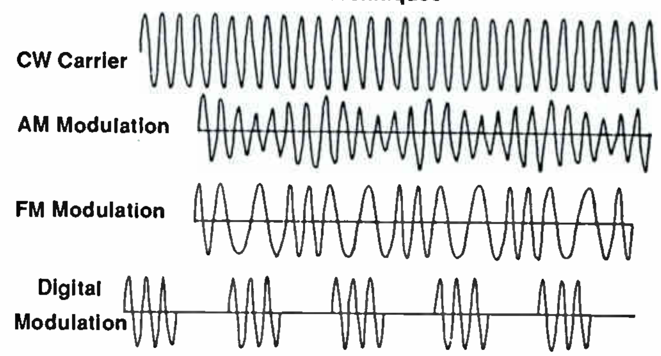


Figure 3

AM Fiber Optic Link Performance

Reach: 7.5 kilometers

Channels	Level	C/N	CTB
10	44 dBmV	53 dB	70 dB
20	44 dBmV	53 dB	64 dB
40	41 dBmV	49 dB	59 dB

noise and distortion. The threshold of visibility of such signal degradation is approximately -19 dB relative to the signal level. The price for this immunity is bandwidth (typically 18 MHz to 40 MHz to transmit the 6 MHz CATV channel shown in Figure 1).

In addition, the signal must be converted to the FM format for transmission and converted back to AM for television set reception. The equipment necessary to perform these conversions add complexity and cost to the network.

FM can be employed using components that exist today. The basic FM technology has matured and experienced significant cost reductions in recent years because of increasingly widespread use of satellite television transmission. FM's resistance to signal degradation allows the use of readily available lasers and detectors with satisfactory performance.

Today's FM hardware easily supports distances of 40 to 80 kilometers with 16 channels per fiber. Typical system performance for FM includes a C/N of better than 30 dB and distortion performance of -26 dB, well below the -19 dB threshold of visibility. This performance on the FM link yields better than 60 dB C/N and -60 dB distortion performance for the recovered video waveform. This yields an essentially transparent link.

Digital transmission

The simple digital modulation scheme in Figure 2 shows information transmission as the presence or absence of a signal. Since this on-or-off condition can be so easily sensed, even in the presence of severe noise and distortion, the threshold of visibility for signal degradation is a very high -6 dB to -10 dB. The signal quality is very good, but requires transmission rates of 45 Mbps to 140 Mbps depending upon compression scheme and resolution of the digital conversion. Compression significantly reduces the transmission data rate, but the cost of the required processing equipment is very high.

Fiber optics, as employed by the telephone companies and long distance carriers, is a digital technology. Thus, the multiplexing equipment and optical components required are readily available, however, even the highly compressed 45 Mbps television signal

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requires the data rate to be equivalent to 700 telephone conversations. This higher data rate requires more bandwidth and more complex digital conversion equipment which has not been fully developed.

The equipment needed to perform the digital conversion is much more expensive than that needed for FM conversion. At this time it is only affordable for long-haul applications where the cost can be amortized over many users.

Amplitude modulation

Amplitude modulation transmits information as variations in signal level. The level is affected by noise and distortion, making AM transmission the most sensitive to signal degradation. Thus, the threshold of visibility of undesired effects is -57 dB relative to signal level. However, AM allows transmission of the complete television signal in 6 MHz of bandwidth—much less than both the FM and digital approaches. This signal is compatible with existing plant, set-top converters and television sets, which eliminates the need for the conversion hardware associated with the other system options.

The performance of a typical high quality laser diode transmitting AM television signals over a 7.5-kilometer link is shown in Figure 3. The C/N and composite triple beat (CTB) distortion degrade as the number of channels increases. The signal level is reduced in the 40-channel case to prevent overloading of the laser diode. This performance is considerably below the 60 dB C/N and -60 dB distortion reading obtainable with FM or digital systems.

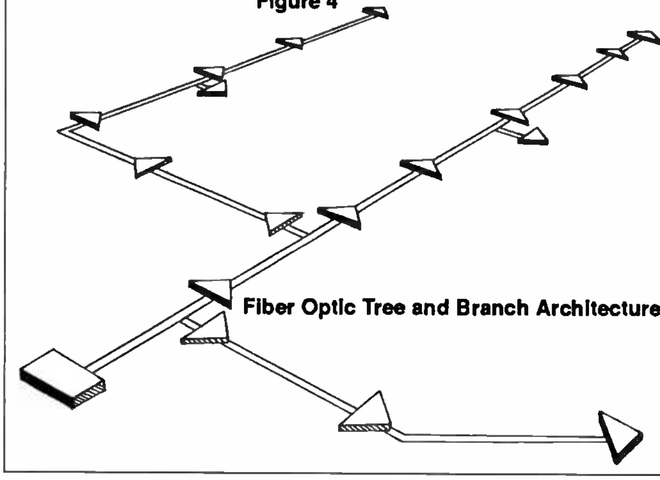


Figure 4

Fiber Optic Tree and Branch Architecture

Supertrunking

Today, fiber optics replaces microwave and coaxial cable links in supertrunking applications. Fiber optic supertrunks in virtually all cases use FM with 16 or fewer channels per fiber. The performance level in such links is shown in the first line of Figure 3.

Using fiber optics in supertrunks frees the cable operator from weather interference and outages often experienced with microwave links. Fiber provides significantly improved signal performance and sidesteps the logistical complications of installing microwave towers. Compared to coaxial cable alternatives, fiber optics supertrunks require no amplifiers and yield higher reliability and improved performance.

Tree-and-branch has become the dominant mode of coaxial cable distribution for cable television. Its directional coupler architecture offers flexibility while its broadband capability permits it to simultaneously deliver a large number of channels into the home.

Implementation of the tree-and-branch architecture using fiber optics could replace coaxial cable with optic fiber and amplifiers and passives with their optical counterparts, as shown in Figure 4.

However, optical passive devices cost at least 10 times as much as their RF counterparts and optical amplifiers are, at best, a laboratory curiosity at this time.

Although the optical amplifier required for analog (AM or FM) transmission does not yet exist, the regenerative repeaters do, permitting digital transmission with the tree-and-branch approach.

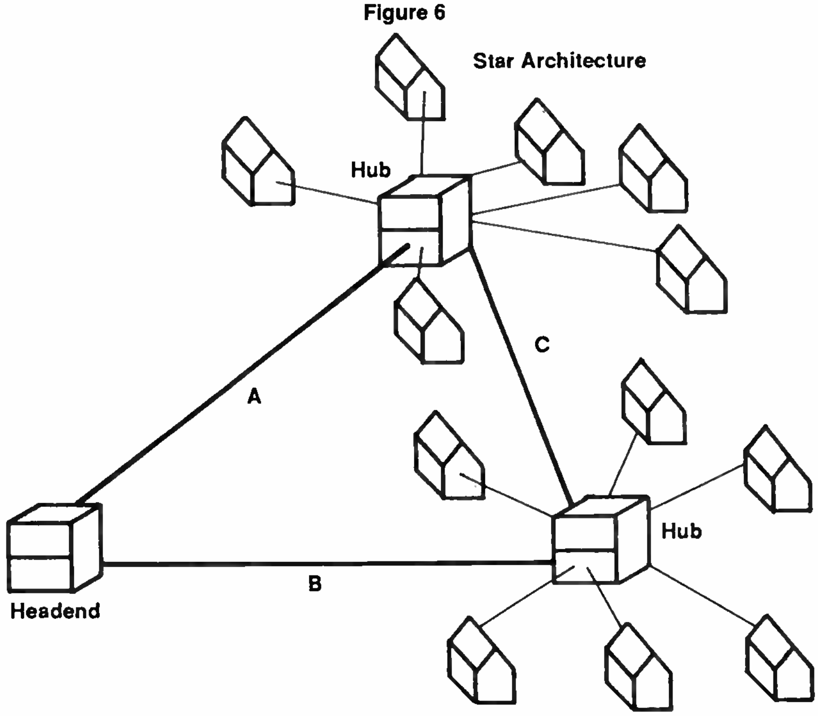
Broadband transmission to 40 television channels in digital format, however, would require a data rate of approximately 4 Gpbs. Conversion equipment for such data rates is prohibitively expensive and not likely to become economical in the next decade.

Figure 5

AM Backbone Alternative

Example No.	**1**	**2**	**3**	**4**	**5**
CATV Amplifiers					
Trunk	10FF	4FF	4FF	4PD	1PD
Bridger	1PD	1PD	1PD	1PD	1PD
Line Extender	2PD	2PD	2PD	2PD	2PD
Levels Trunk	38	38	38	32	32
Levels Feeder	47	47	44	44	44
C/N	51.8	55.4	55.0	50.2	56.4
CTB	56.5	57.4	62.7	62.5	62.9
Fiber Link					
C/N	51	49	49	52	49
CTB	95	95	64	64	64
Total System					
C/N	48.4	48.2	48.1	48.0	48.1
CTB	56.4	57.3	57.4	57.3	57.5

Figure 6



Backbone architecture

The backbone concept was developed within the MSO community, notably at ATC, as a means of implementing fiber optics in an evolutionary manner in cable TV systems. This approach transports signals from the headend to the general vicinity of the subscriber using fiber optics. A conversion device at the end of each optical link is required to change the signals from the optical to RF domain. This approach reduces the cascade of conventional cable TV components serving each subscriber and offers the subscribe potentially improved picture quality and greater reliability.

Both FM and AM techniques have been applied to the backbone architecture in laboratory and field trials. The high quality transmission capabilities of FM result in virtually no picture degradation between the headend and the conversion node. Performance at the subscriber location is essentially that of the reduced cable TV cascade. The price for such high picture quality is the complex conversion equipment necessary for every channel at every node: an FM demodulator and an AM remodulator. The AM remodulators are subject to the same frequency accuracy and stability requirements that the FCC imposes on conventional cable TV headend and distribution systems, putting pressure on system cost.

The AM backbone approach avoids the FM to AM conversion cost and complexity and requires only an optical receiver at the conversion node, but the susceptibility of AM transmission to degradation requires an extremely high quality laser and optical receiver.

The configuration examples summarized in Figure 5 employ the AM fiber optic backbone. The goal of each example is to deliver the 66 channels of a 450 MHz cable TV system with 48 dB C/N and -57 dB CTB distortion at the subscriber television set. This performance criteria was established for the purposes of example only. The performance for the conventional CATV portion of the network is calculated for the configuration and levels shown in each example.

The first example consists of 10 26-dB gain feedforward trunk amplifiers, a power-doubled bridger and two power-doubled line extenders. The performance of cable TV cascade barely meets our design criteria for distortion, thus requiring a nearly transparent fiber optic link with respect to distortion. Such an AM link is not likely to be available in the near future.

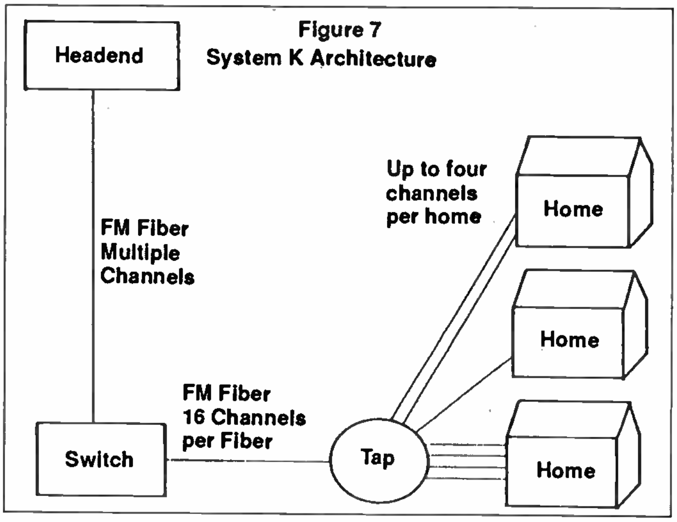
Example 2 shows the performance with the trunk cascade reduced to four amplifiers, but levels kept constant. This results in improved C/N performance but little improvement in distortion because the dominant cause of the distortion is the unchanged feeder portion of the network.

For Example 3, the equipment configuration is unchanged but feeder levels are reduced. Implementing this backbone in existing systems would require tap replacement and relocation of line extenders, but the performance goal can be met.

The fourth example employs four power-doubled trunk amplifiers, a power-doubled bridger and two power-doubled line extenders. Meeting the required system performance is accomplished with a slightly better laser.

Example 5 shows the backbone concept carried to its extreme—the entire trunk system is replaced with the fiber optic backbone. The performance requirements can be met with a realizable laser and no subscriber has more than four active RF elements between his home and the headend.

Figure 7
System K Architecture



Star architecture

Much of today's fiber technology originated in the telephone environment. While the cable television industry has evolved an architecture based upon tree-and-branch, the telcos have employed a star architecture. A possible star configuration is shown in Figure 6. Supertrunks are employed to each hub from the central headend using techniques previously described and each home is then connected to the hub with a dedicated fiber optic path.

This approach requires the conversion of FM to AM in the home to interface to the television set. It further requires the development of a low-cost splicing and splitting technique if fiber optic cable is to be successfully implemented within the home.

To carry the star architecture a step further, a switch could be employed to control subscriber access to programming, as opposed to the distribution of a broadband signal into the home. Allowing program selection through the set-top converter, the switch would perform as the central office switch does in the telephone environment.

System K

There have been several field trials of the fiber-to-the-home concept. Among these approaches is "System K," being jointly developed by Jerrold and Corning Glass Works as a proof-of-concept for an economical implementation of fiber optics in cable TV applications. The system consists of FM supertrunks to a hub containing a switch. From the switch, a dedicated fiber carrying 16 channels runs to the tap location shown in Figure 7.

The tap performs the signal conversion from optical to RF for the drop to the home on a conventional cable TV-type coaxial cable. The FM to AM conversion is performed inside of a set-top converter which is also the control interface with the switch for channel selection. The architecture allows independently selected channels on four televisions/VCRs to be simultaneously viewed in each home. Since the architecture has a dedicated path from the home to the switch, the addition of switching voice and data transmissions is feasible.

The promise of fiber optics is presently having more impact on cable TV than any other technological issue in the history of the industry. However, with the exception of supertrunking, there has yet to be any economically justified implementation which achieve the technology's promise. But the state-of-the-art is far from standing still. ■

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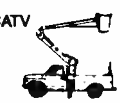
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DESCRIPTION: Complete line of cable TV products including fiber optic links and matching coaxial amplifiers, earth stations and receivers, headend electronics, distribution products, taps and passives, addressable and non-addressable set-top terminals, and status monitoring and IPPV systems. Scientific-Atlanta can show you how to turn a rebuild into a less-expensive upgrade through fiber optics and enhanced coaxial electronics.

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Fiber optics: Through a glass successfully

For many systems, large and small, the daily operation of a fiber optic link is routine. Contributing Editor George Sell reports on what chief engineers in such systems think about fiber optics, here and now, and what applications are working well, today.—Ed.

In the late '70s and early '80s, most people in the cable industry still thought fiber optics to be a "blue sky" proposition for consideration sometime in the future. But while most shied away from glass, others took a closer look at its possibilities and found that it met their needs, and installed fiber. Some systems have been operating fiber optic links for nearly a decade with success.

With the introduction of single-mode fiber optic cable and improved photoelectronics, the cost has come down while capabilities have increased. Virtually all systems currently operating fiber optics are in agreement that fiber works well for almost any application involving point-to-point signal transportation.

While most will agree the industry is not at the point where it is ready to run fiber to the home, many are closely watching developments of, or already laying plans to install in the near future, a headend-to-multiple nodes distribution trunking system (a la the "backbone" concept) and the various possibilities of FM/AM/FM conversion schemes.

"I had AT&T in here twice and they laid out a (headend-to-multiple nodes distribution trunking) system for us," says Bob Ritchie, vice president of engineering for Suburban Cablevision, the McLean-Hunter system in East Orange, New Jersey. "We've done a lot of work in the last year on it ourselves, looking at what's feasible for us." Ritchie has not yet decided to implement any plans but is actively investigating the latest vendor demonstrations.

Ritchie's system, a 204,000 subscriber operation, activated a six kilometer-long digital TVRO-to-headend link in 1985 and is sold on fiber optics. "This digital system has been excellent," Ritchie reports. "We had some bugs in it when it was installed, but after that it's been running well."

Fiber phobia

Few systems that have installed fiber report any difficulties with construction. In fact, most will tell you that it was a real eye-opener to them that fiber optics was easier and less complex to install than coaxial cable.

"It's real simple and there's nothing to it," says Jim Shultz, chief engineer with Rogers Cablesystems of Minnesota, which serves the Minneapolis area. While the Minneapolis system does not operate the common-carrier telephone link within its boundries, it was involved in its construction.

"It's hard to mess up without knowing it," Shultz adds. "I feel the technology is easier to understand than normal coaxial cable and amplifiers." Back in the winter of 1986, when Shultz's system began construction of the four-mile link, it was more difficult to obtain training. "There wasn't a good learning bed for it,' Shultz points out. "But now, you've got courses in the vocational/technical schools and, of course, all the manufacturers will come in and give seminars."

Jim Dryden, chief engineer at Buckeye Cablevision, serving Toledo, Ohio's 109,000 subscribers, operates a fiber optic distribution trunking system running from the headend to three hub sites. "When we started with fiber, we treated it very carefully and then we realized, 'Wait a minute, we're working with this stuff easier than we are with cable,' " Dryden says.

Typical applications

Since 1983, Comcast Cablevision of Maryland, serving Baltimore County, has operated the world's largest analog video fiber optic system. According to chief engineer Tom Gorman, their 33-mile application involves the interconnection of four headends via multimode fibers. Rebuilding this system is currently in the discussion stages.

"Maintenance is ever increasing," reports Gorman. "It's hard to find lasers that meet specs. The laser life is about three years for this system, so we are replacing lasers fairly regularly now. There are about 70 lasers and the total system has eight repeaters."

But rebuilding this system will differ from the original build because the technology has advanced since then. "As far as I can see," Gorman says, "this system cost $670,000 to build in 1983, and I can rebuild and duplicate it for half that, right now. I suppose that's because I won't need repeaters. I can eradicate eight repeaters in this thing by putting in a single-mode, 1300-nanometer system. I can put all the channels I carry (40) on a single fiber, where right now I have them spread across five fibers."

Gill Cable of San Jose, California, now owned by Heritage, has a five mile headend-to-headend supertrunk interconnect. Installed last year over a four-week period, the single-mode link only carries three video channels and eight audio signals. "Coaxial cable would have been cheaper for the channels we carry on it," says chief engineer Mark Bisenius, "but we would have higher maintenance and would not be in a position for future technologies." Bisenius adds, "We are pleased with what we have in here."

The use of fiber optics is not limited to large or even mid-sized systems. Tom Mack, the chief engineer at Tekstar Cablevision, operating several systems in the rural resort areas of Lake Michigan, employs fiber to interconnect three headends. Feeding 12 video/audio channels by one-way interconnect from one headend, the fiber link goes out eight miles to a headend serving 200 subscribers, and that headend, in turn, passes the signals via fiber out another seven miles to a headend that serves only 150 subscribers.

"We're rural, very small," Mack says, "our largest system, which is Detroit Lakes, has 3,000 subs. Some of our towns have 80 subs in them and less."

Tom Foster, Director of Engineering for Greater Rochester Cablevision West, the 161,000 ATC system in northern New York state, transports 16 channels 20 miles from a hub site to the headend via single-mode fiber. The system also employs fiber for a 300-foot run within the headend facility building, for commercial insertion, from master control to the headend operations area. Foster asserts, "Fiber gives you so much flexibility down the road, limited only by the electronics. And, the need is there and continues to push the technology.'

The United Artists Entertainment (formerly Daniels and Associates) system in Baton Rouge, La., transports 15 video channels and an FM band 11 kilometers from one headend to another headend. Installed in 1986, using three bundled single-mode fibers, the link is used for commercial insertion. "One fiber is running 13 video channels. The second fiber is running two more channels and the FM band. We have a third fiber in the bundle and it's just there for expansion," relates Dave Matthews, the chief engineer for the system.

The flexibility and adaptability of fiber, not only for future expansion, but for the solution of many of today's problems, is demonstrated by the experience of United Cable TV of Eastern Connecticut, which serves the 150,000 subscribers in West Hartford and Plainville.

The system runs an 11-mile single-mode fiber link from the headquarters office to the headend, which they installed in 1986. But four years prior to that installation, the system operated a multimode link, carrying four channels per fiber, between a remote earth station and the main headend, which has since been moved.

Consider the alternatives

Dryden considered the alternatives. "We looked at single-channel FM microwave, AML, FM supertrunking, and feed-forward technologies, from all of the different manufacturers, and the only thing that we kept coming back to was fiber," says Dryden.

Gorman, in Baltimore, says, "With AML, we couldn't get zoning for some tower space." For their four headend interconnect, "The other option was to go with the standard CATV architecture, which would have been just too noisy with too many amplifiers."

For Ritchie's East Orange, New Jersey system in the densely populated New York City environment, "Microwave was not feasible. We were already facing microwave congestion in the metropolitan area. We couldn't get any more channels put in. We didn't want to go FM because of the amplifiers. We looked at an analog system but we got a good price on the digital system because there wasn't much we had to play around with. It either works or it doesn't."

Cost vs. performance

In many cases, the fiber option presents an up-front installation cost that exceeds all other options. "But, the curve turns when you start looking at maintenance," says Dryden. "We haven't lost an amplifier, because we don't have any. We haven't lost a power supply, because we don't have any. We haven't had a car/pole accident knock an amplifier out, because we don't have any."

And performance is satisfying. "We have measured the signal going in and coming out...and we are very pleased with it. When we analyzed the total cost for the project, we realized that it (fiber) was going to cost more than anything. But then, as we operated it, we found that the operating costs were so low," Dryden concludes.

Future planning

It seems that once you've experienced fiber operations, it becomes the method of choice for many future applications. Matthews says, "Right now, we are looking at a major rebuild of the system. We are looking to go multi-hubs and we are looking at pricing for either microwave or fiber. With my experience, I'm leaning toward fiber," says Matthews, "but, at this point, it looks like microwave would be less costly."

But Matthews has other fiber optic applications in mind. "We've been approached by the city to do some traffic light synchronization. Banks are looking to CATV for cheaper prices to run data. We've got a bid from the city to put a fiber optic line in so they can take the county prison and arraign suspects from the prison without having to transport them back and forth to the judge's chambers. They want video and audio both ways and I mean some dynamic specs. We couldn't use conventional RF because they are looking for 99.99 percent reliability."

Like so many others in the industry, Scott is watching the development of AM over fiber. "I still feel that we need good fiber AM transmission and that seems to be really the hold up. If you can get a laser that will transmit a good AM signal, we've got it made." ■