COMMUNICATIONS TECHNOLOGY

Official trade journal of the Society of Cable Television Engineers

Cable telephony

and other converging realities

December 1993

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EDITOR'S LETTER

Converging on derailment?

Train wrecks can occur when objects on the tracks cause derailments. But if those objects are removed, then trains can pass with no problem. Unfortunately, I see a couple potential obstructions on the tracks of our industry's future, and if they are not dealt with properly, we could be facing a nasty derailment or two ourselves.

The first has to do with recent mergers between major cable and telephone companies. The issue is not whether such mergers should take place. Indeed, they are inevitable. But a potentially big problem is looming on the horizon: the convergence of the two industries' field work forces.

Consider the outside plant staff of the telephone industry. It is predominantly unionized, highly paid, well-trained, but underproductive. The latter is not intended to be critical. Low productivity has been an unfortunate side effect of decades of operation as a regulated monopoly with guaranteed rates of return.

Now look at the cable industry's outside plant work force. It is for the most part nonunion, low paid, poorly trained, but highly productive. This, too, is not intended to be critical. Cable is simply not well-known for paying high wages, and always seems to cut training programs first whenever the budget ax falls.

Bringing together these two very different work forces may well be the most difficult problem faced during cable/telco mergers. I'm not sure what the fix is, but the leadership of the two industries will have to take a long, hard look at this problem.

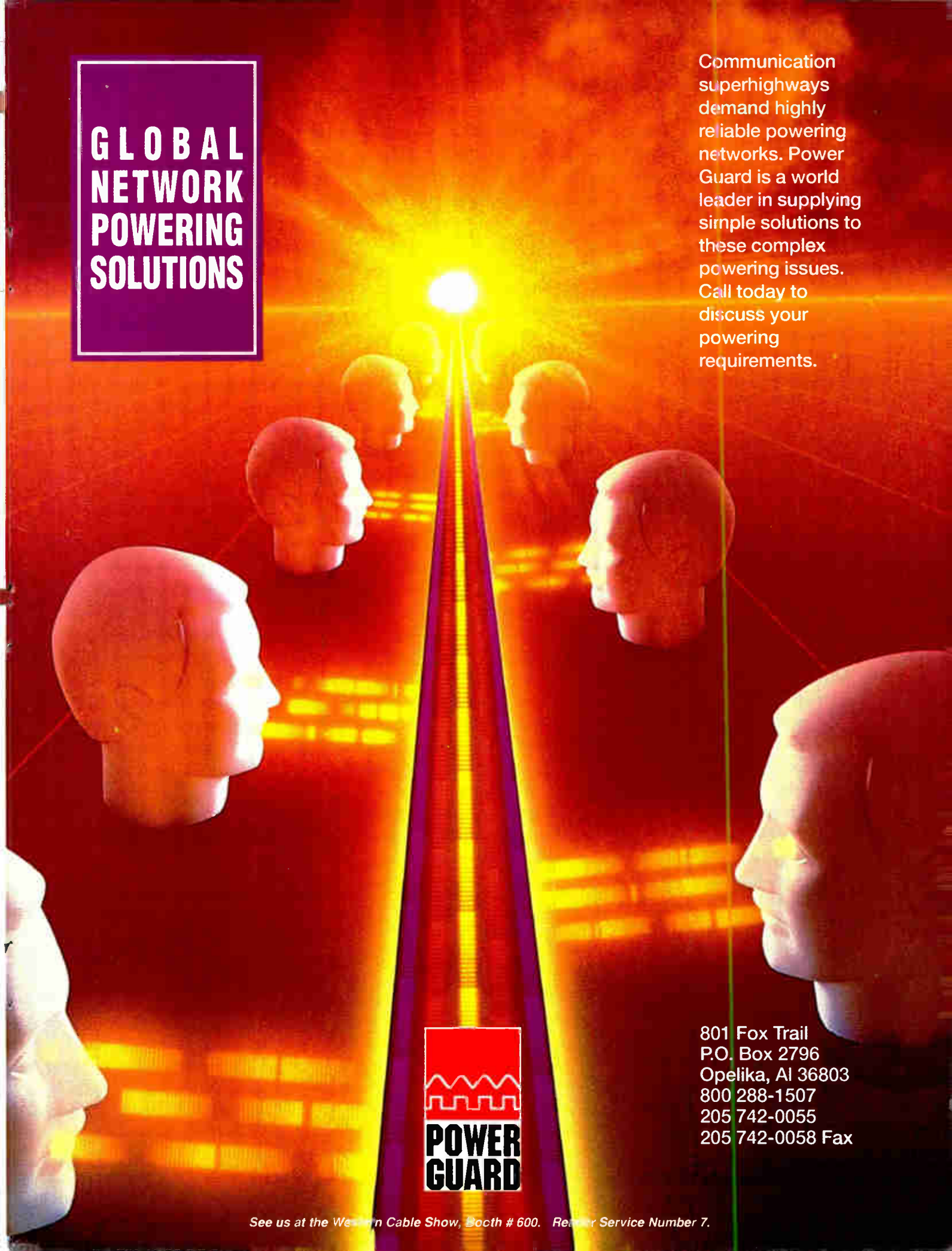
The second possible train wreck is in our own digital future. The cable industry is spending billions to upgrade its hardline infrastructure, deploying sophisticated architectures that use fiber optics and other technology. The goal is to initially improve quality and reliability, then prepare for digital video compression and advanced services such as personal communication service (PCS).

While we definitely need to upgrade our hardline plant, we also need to upgrade our subscriber drops. Already I'm hearing about operating problems with the new digital audio services, and most of the problems are in the drop. Nothing new here: poor craftsmanship, loose or corroded connectors, etc. The impact on digital audio is pops, clicks and occasional dropouts. Think what this might do to digital video!

Granted, providers of digital compression technology are including forward error correction and adaptive equalization to make their signals more robust. But how well will they actually hold up in the real world of cable TV subscriber drop problems?

I do know what the fix is here: upgrade our drop network at the same time we upgrade our hardline plant. Unfortunately, this also will cost several billion dollars, but it will have to be done. If not, the result might well be a big embarrassment as we demonstrate that bandwidth alone doesn't guarantee a successful role in the digital superhighway. Sadly, our digital future could be derailed by something we should have been paying more attention to all along.

Ronald J. Hranac
Senior Technical Editor



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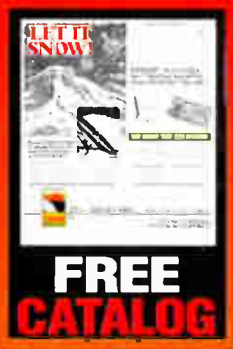

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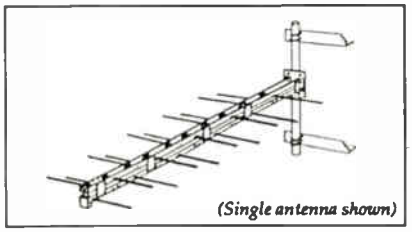
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Interested in the infohighway?

San Jose, CA — On Oct. 29, a telebriefing was held on CableNET '93, the first interactive multimedia digital network model, previewing its exhibition at the Western Cable Show to be held in Anaheim, CA, Dec. 1-3. The overview was presented by CableLabs, the California Cable Television Association (CCTA) and executives from EDS, Hewlett-Packard, Northern Telecom, TCI and Unisys.

The Western Cable Show is showcasing CableNET '93, aimed to show how industry participants can work together to build an information highway. Approximately 25 companies will participate in the network, bringing experience gleamed from computers, communications and every intersection between the two.

CableLabs is hoping the network will show attendees that the building blocks of the superhighway are here today. Although the cable industry can play an important role providing the on- and offramps into the highway, computer, telephone and cable equipment companies all have roles to play toward making it happen.

New content will be required to attract consumers to the highway. Software engines to run the vehicles needs to be written. Computer chips for compressing, processing, decompressing and presenting this information need to be designed. User-friendly consumer interfaces are required to provide techno-handicapped access (which unlike the real world will prove to be the majority of people).

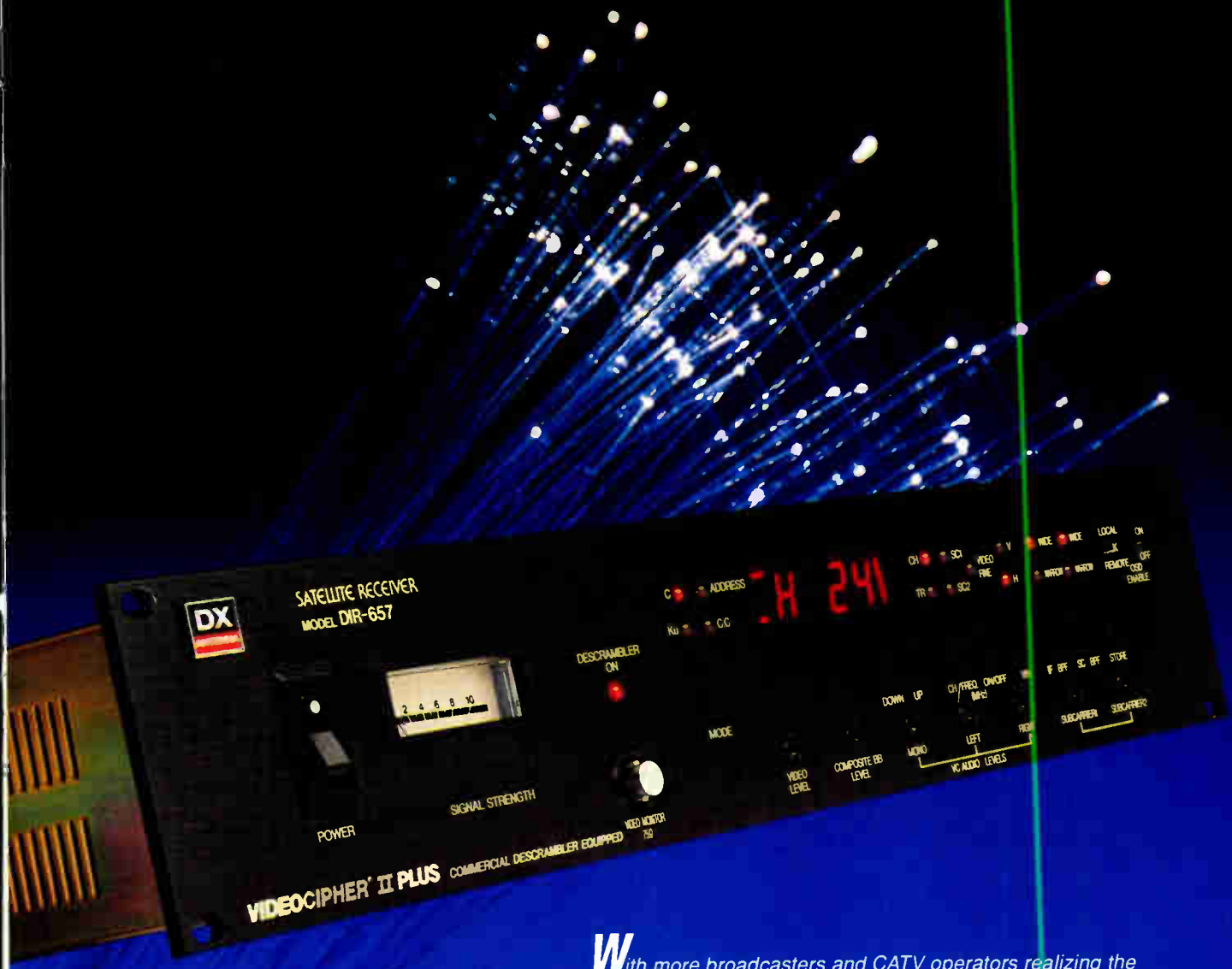
At the heart of the network will be key technologies for moving and parking information in this highway. Northern Telecom, Digital Equipment Corp., NEC and Synoptics promise to show how their ATM equipment can be used to carry voice, video and data across thoroughfares on the highway. Zenith and Digital Equipment Corp. will show how Ethernet can provide offramps for data into the home. IBM, Hewlett-Packard and TRW will demonstrate how their video servers will create the shopping malls and theaters required to get people to cruise the info-turf.

Dale Bennet, vice president and general manager of TCI in California, said, "The message we want to leave you with is that there is still plenty of room for players in this industry. We think the Western Show is the place to come and find out how you can fit into the new information age."

Bennet believes the network can go beyond just taking revenues from existing businesses like video stores and shopping malls. "It is not necessarily a zero sum game in which all the money has to come from someone else."

Kaiser-Permanente, for example, has been discussing the possibility for distributing information about common illnesses over the network. It turns out that over half of their patient visits are not required. But uncertain patients lacking knowledge come in just in case. "If they had some reliable way to

Light up your fiber with the best broadcast quality video possible.



With more broadcasters and CATV operators realizing the benefits and switching to fiber optic networks, the demand for "signal purity" and higher signal quality transmission has increased.

DX sheds a new light on high performance for today's cable operators with the new DIR-657 integrated receiver/ descambler. With a long list of features, including RS-250B broadcast quality performance and optional RS-232C interface for remote operation, the new DIR-657 outshines all other satellite receivers in delivering the sharpest video and soundest audio signals possible.

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send video-on-demand chats asking about specific illness in order to understand their symptoms, that saves the entire system a tremendous amount of money," Bennet explained.

CableNET '93 is not just for cable companies. It also is for companies like Kaiser who will see how they can fit into this superhighway and bring value to their customers. — *George Lawton*

☛ General Instrument and Scientific-Atlanta announced their outstanding patent litigation over scrambling and impulse pay-per-view technology has been settled. The lawsuits have been dismissed and cross-licensing of the patents agreed upon.

In other news, S-A announced it has been selected by Digital Equipment Corp. to supply MPEG-based digital compression equipment for an enhanced version of the Digital SPOT System, a video and audio storage and retrieval system that replaces traditional analog videotape players with computer-based technology in which digital video and audio are used for ad insertion. According to Digital, S-A's digital storage and retrieval products will be used to upgrade JPEG-based Digital SPOT systems currently testing in five cable systems, and will be used in future digital ad insertion installations.

Also, Jerrold/GI won a contract to supply addressable converters to TeleWest Communications Group Ltd., a cable TV system operator in the U.K. The converters will be used in TeleWest's new-build franchises operated by United Artists in North Thames Estuary, South Thames Estuary, Cotswolds and North East (Newcastle/Gateshead/Tyneside), which together represent about 859,000 homes.

☛ Compression Labs Inc. announced that Thomson Consumer Electronics has awarded the company a $10.8 million contract amendment to purchase additional compressed digital video (CDV) encoding systems for North America's first high-power direct broadcast satellite system.

In April 1992 Thomson awarded CLI and initial contract for up to $5 million to furnish CDV encoding systems for DirecTv, a unit of GM Hughes Electronics, and Hubbard Broadcasting's United States Satellite Broadcasting's (USSB) subsidiary.

The additional encoding systems will be used to expand the direct broadcast satellite (DBS) system being built by Hughes to carry programming channels offered by the DirecTv programming service. The encoding systems are based on the MPEG-2 (a) standard, an emerging standard for broadcast video.

☛ Zenith Electronics Corp. reported a net loss of $14.5 million (44 cents per share) for the third quarter of 1993, an improvement over the $41.8 million loss ($1.42 per share) recorded for the third quarter of 1992. Last year's loss included restructuring and other special charges of $23 million and a $2 million tax credit.

The company's pretax operating loss before the special charges narrowed to $10 million in the third quarter of 1993 from $17 million in 1992.

☛ Southern New England Telephone (SNET) announced that the Federal Communications Commission has approved the company's application for a trial offering of video-on-demand services to 1,500 homes in West Hartford, CT. The company says it will be the first video-on-demand service in the state, bringing 110 television and video channels to an estimated 500 customers participating in the trial service.

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As a cable operator, you want to give your subscribers the best picture and programming. But you don't want to give anything away. That's why the Pioneer BA-9000 addressable converter provides line-by-line ***digital signal security*** coupled with Dynamic Picture Shift (DPS) encoding.

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the conference will be mailed to all active members in the near future. However, the following is a preliminary schedule of events for our 1994 Conference on Emerging Technologies.

12-1:45 p.m.: Lunch with Keynote Speaker
2-4 p.m.: Session D: "Who Are Those Guys?"

Also, see "President's Message" on

Preview: Cable-Tec Expo '94

The Cable-Tec Expo '94 Program Committee has voted to expand the exhibit hours of the Cable-Tec Expo 1994 to be held June 15-18 in St. Louis. This is indeed good news for both exhibitors and attendees alike, who have long been suggesting this improvement for an event that is already touted by many to be the "the best hardware show of the year." The '94 Expo, to be held at the Cervantes Convention Center in St. Louis, will offer 15 exclusive exhibit hours at the following times: Thursday, June 16, 12 to 6 p.m.; Friday, June 17, 12 to 6 p.m.; and Saturday, June 18, 9 a.m. to 12 p.m. As is customary at Expos, the technical workshops have been scheduled so as to not conflict with exhibit hours, allowing for maximum attendance and participation. The workshops will be held from 8 a.m. to 12:15 p.m. on June 16 and 17.

Along with these expanded hours will be the Society's Annual Engineering Conference, which is scheduled for Wednesday, June 15. Comprised of six hours of technical and management papers presented by many of the industry's engineering leaders, the conference will conclude with the annual membership meeting, affording attendees the opportunity to meet with their national board of directors. The ever-popular SCTE Cable-Tec Games, testing technical skill, speed and accuracy, also will be held on June 15, from 6 to 8 p.m.

BCT/E and Installer Certification exams will be offered at the convention, on Thursday, June 16, and Friday, June 17, from 10 a.m. to 2 p.m., and on Saturday, June 18, from 8:30 a.m. to 12 p.m.

This year's Expo Evening promises to be an extra special event, combining a "1904 World's Fair " theme with the Society's 25th anniversary party. The celebration will be held at the convention center directly following the close of the exhibit hall on Friday evening, June 17.

Obituary: Carol Allen

The SCTE regretfully announces the passing of Carol Allen, wife of Region 1 Director Steve Allen, on Oct. 17. A biking enthusiast, Mrs. Allen was on a nine-day bicycling outing at the time of her death. She had a 7-year-old son, and was a devoted wife and mother. She was generous in volunteering time to organizations such as Meals on Wheels and the Sierra Pre-School. Contributions may be made in her memory to: Sierra Pre-School, 13315 Luther Road, Auburn, CA 95603.

Members elevated to Senior status

The national board of directors of the Society voted at its September meeting in St. Louis to elevate three SCTE members into the ranks of Senior membership, the highest professional grade for which the Society will accept application. The recipients are: Gaylord Hart, ANTEC; Dan Nofs, Cablevision Industries; and Randy Midkiff, Continental Cablevision.

This level of membership recognizes an individual's professionalism, significant performance and technical competence within the industry. Applicants must send their credentials and references to the Senior Member Subcommittee for review, after which recommendations are made to the national board of directors. We congratulate these members and encourage those of you who feel you may qualify for Senior member status to apply.

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The 8000XG operates over the 850 to 1550 nm wavelength range, and functions at -50 dBm sensitivity levels for positive identification in long-haul systems. The unit also features a "no signal" indicator to identify unused fibers as well as signal direction indicators to help the user distinguish between traffic and tone fibers.

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Reader Service Number 17

Video servers

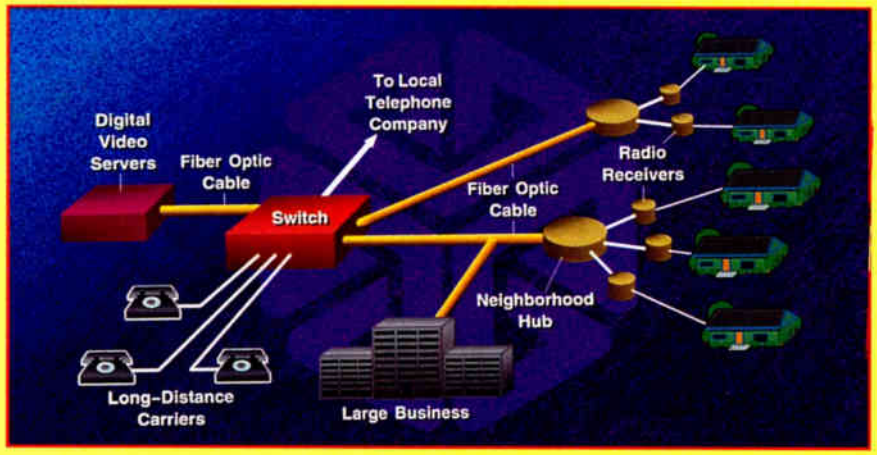
By Lawrence W. Lockwood
President, TeleResources
East Coast Correspondent

Digital video servers are going to be an essential component in building the "blue sky" systems of the future. They are absolutely necessary to provide true video-on-demand (VOD) services — e.g., movies in the home. The movie would be selected from a library, delivered when ordered, and the service will allow control of the movie as if it were in the home VCR, i.e., start, stop, pause, etc.

Two tests of systems with VOD are being developed. They are the Time Warner system in Orlando, FL, with the video server supplied by Silicon Graphics, and the Viacom system in Castro Valley, CA, with the video server supplied by AT&T. Features of the Orlando network are shown in Figure 1.

A couple of caveats regarding video servers must be noted. First, one cannot now — and probably never will be able to — buy a *single standard* video server. The servers will have to vary in capacity to reflect the different requirements of individual cable systems. Second, the tests will determine the marketability of various services and the results will probably be reflected in new video servers. However, there will be a basic generic video server capability and that will be addressed here.

Figure 1: The Orlando full service network



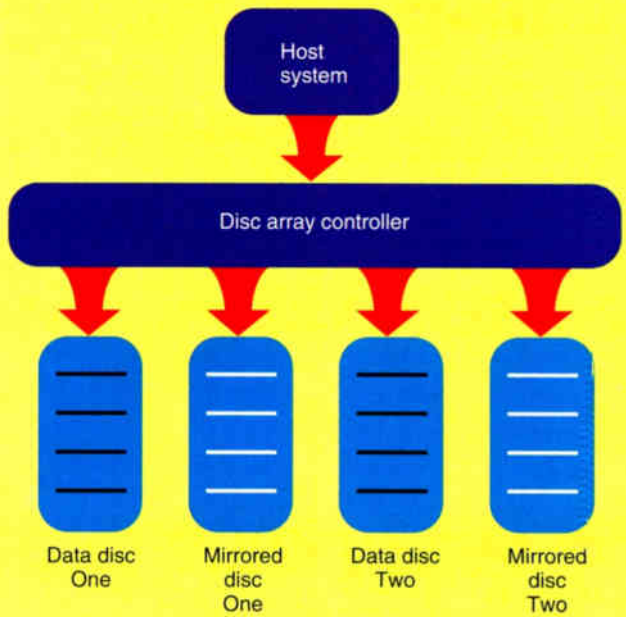
"One cannot now — and probably never will be able to — buy a 'single standard' video server."

Recent computer developments used in servers

RAID (redundant arrays of inexpensive discs) is used in most video servers. It was first described in a Berkeley paper written by Patterson, Gibson and Katz in 1987. High data availability is the primary purpose — and number one benefit — of disc arrays. The disc array achieves this high data availability through one of several possible configurations, each classified as a unique RAID level. There are six RAID (RAID 0 to 5) levels of varying complexity. RAID 1 (shown in Figure 2) is a simple configuration.[1]

RAID 1 mirrors individual disc drives, so that a duplicate copy of the data is stored on a second disc every time a disc write occurs. When a disc drive fails, the array controller automatically switches all system I/O (input/output) activity to the surviving drive. With a nonarrayed disc drive, a failure liter-

Figure 2: RAID Level 1 makes use of mirrored discs



ally will bring the system to a halt, even perhaps forcing a reload of the data. Most video servers use other RAID levels that have a more efficient use of disc space.

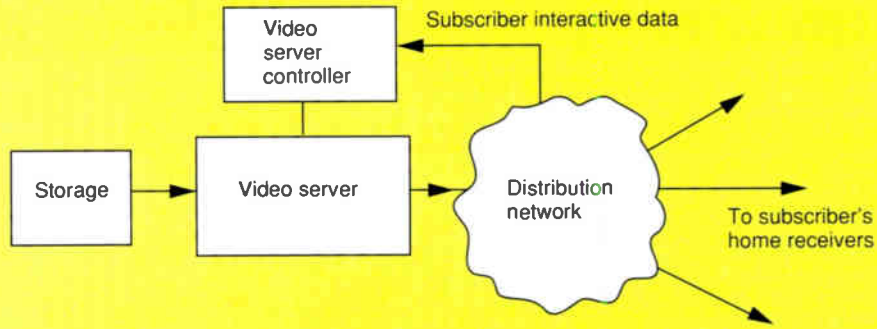
RISC (reduced instruction set computing) also is used in most video servers. The RISC approach to designing a microprocessor is fundamentally different from what is used in today's reigning line of desktop chips, made by Intel, Motorola Inc. and other companies. Their approach is generically called "complex instruction set computing" or CISC.

With CISC, every microprocessor has "hard-wired" into it a set instructions that it executes to solve computing problems. CISC chips, built to be versatile, handle a mammoth-sized set of instructions of often varying lengths.

RISC arose when designers found that in many cases 80% of a microprocessor's instructions are used only rarely. Better to throw them out, the RISC approach says, and focus on shortening the execution time of the 20% that are often used. This approach also entails executing several instructions at once. The RISC chips are generally smaller, cheaper to manufacture and draw less power — and thus have less heat dissipation problems. Motorola, codeveloper of the first Power-PC chip, claims it runs many applications 40% faster than Intel's new Pentium and runs cool as opposed to Pentium, which from the start has been plagued by overheating problems.

Getting specific technical information on video server design from either Silicon Graphics or IBM (which is supplying them to ICTV) proved very difficult. (Perhaps they are still operating in the classical computer marketing syndrome — the vendor will define performance and the buyer will buy what's offered — as opposed to the consumer marketing syndrome, where what the buyer buys determines what the vendor will supply.) No matter, the Hewlett-Packard Co. has produced an excellent and comprehensive technical study of video servers.[2] Even though this study was for internal use and not for publication, David Andersen, manager of research and development of the H-P Video Communications Division, kindly gave me permission to quote freely from it in addition to answering questions and supplying supplemental information.

Figure 3: A video server as part of a larger system



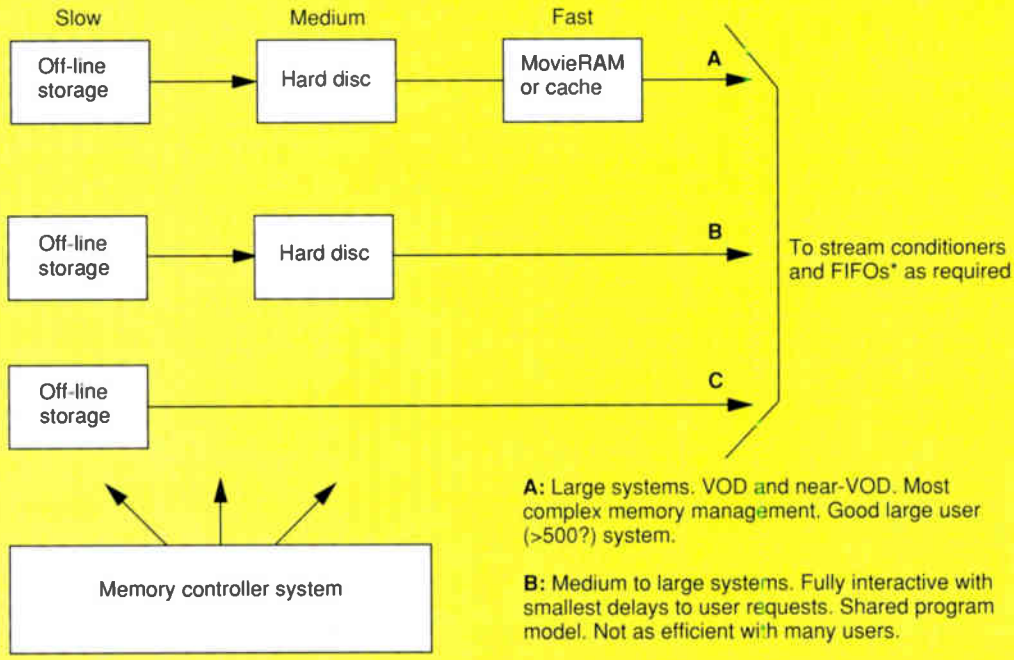
Note of caution: Video servers used in cable systems must of necessity deal with both memory and transmission considerations. Classically, memory has been specified in bytes (8 bits) and transmission in bits. So beware, throughout this piece specifications in upper case B are in bytes and those in lower case b are in bits.

Video server basic concepts

A video server delivers a stream of digitized video to a subscriber over the cable network. Figure 3 shows the position of a server in a distribution system. For any server, the subscriber's program material will come from a memory source at the server. The simplest source is a dedicated player that contains the video in a compressed form (probably MPEG-2). (See Figure 4 for an example.)

In Figure 4, three different hierarchies are shown. The one labeled C is the simplest. The player may be a VCR or a laser disc player for example. Only one subscriber may view this program material unless others agree to view it at the same time. This method offers little or no interactivity. The method labeled B in the figure allows for more

Figure 4: Memory hierarchy systems



A: Large systems. VOD and near-VOD. Most complex memory management. Good large user (>500?) system.

B: Medium to large systems. Fully interactive with smallest delays to user requests. Shared program model. Not as efficient with many users.

C: Small systems. PPV, hotel installations. Some ad insert application. Simple, commercial systems exist today. Dedicated program player concept.

* FIFO (first in, first out) is a buffering scheme in which the first byte of data that enters the buffer is also the first data out of the buffer.

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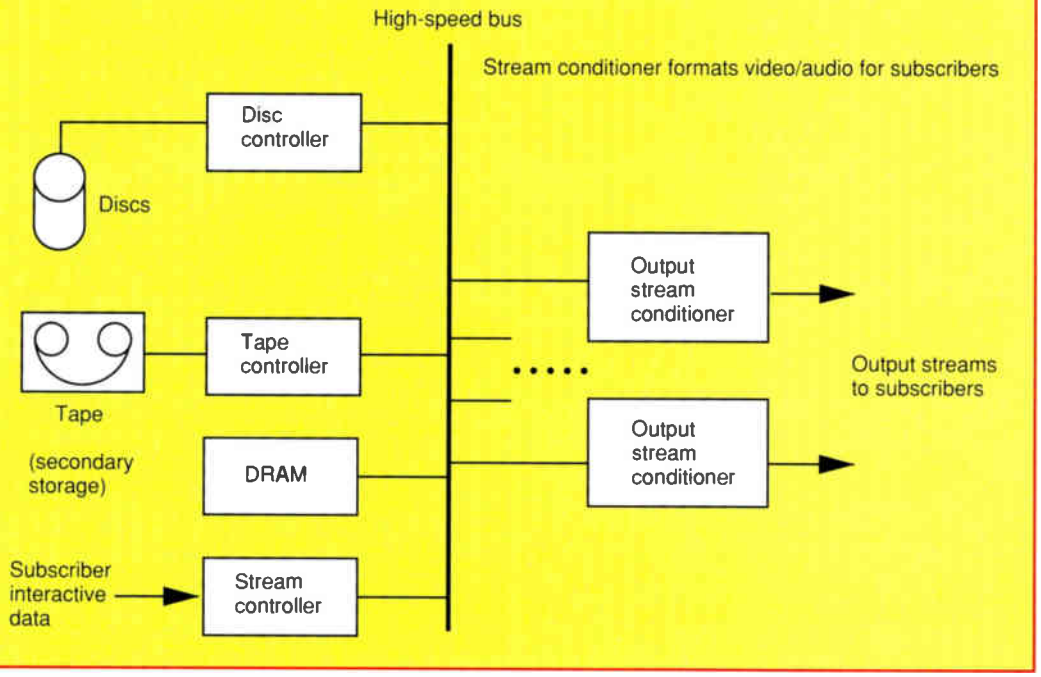
Figure 5: Generic diagram of a video server



interactivity. Programs to be viewed are first loaded from the off-line storage to the magnetic discs. The memory controller is responsible for managing the use of the disc resource. It's possible to share one program among many subscribers if this disc is managed properly. So option B is more efficient than C in terms of memory usage and interactivity.

Finally, option A. For this choice a fast DRAM (dynamic random access memory) based memory is inserted into the chain. This memory may be used for a variety of purposes. First it may be used as storage for a complete movie. This is only effective if many subscribers are viewing the same "hot movie." It may be cost-effective if a large (>400) number of viewers are attached to the same program. Another application of the DRAM is as a cache. Depending on the distribution of the program material, a cache may offer savings in disc hardware when many subscribers watch the same program. Cache memory management may prove to be a key to a cost-effective server. So, what memory configuration is best? Answer: It depends on the system's requirements.

A video server architecture

A generic architecture is shown in Figure 5. There are six main components to the design. It is likely that any server architecture will have these same six parts. The six components are:

- Off-line (or secondary) storage
- Hard disc storage
- Stream controller
- High-speed bus
- MovieRam/cache (DRAM)
- Output stream conditioner/FIFOs

Secondary storage

Off-line (or secondary) storage is usually archival in nature and may be: CD ROM, VCRs, laser disc players, etc. In general the off-line storage will use inexpensive media. CD ROM costs are currently about $5/GB. In general off-line storage will have slow access (200 kB/s to 2 MB/s typical) but with huge amounts of storage (terabytes typically). By the way, the prefix tera corresponds to 10^{12} units, peta is 10^{15} and exa is 10^{18}. The movie *Jurassic Park* has about 1.44 terabits of data in *uncompressed* video component format. Storage for 700 uncompressed movies needs 1 petabit! →

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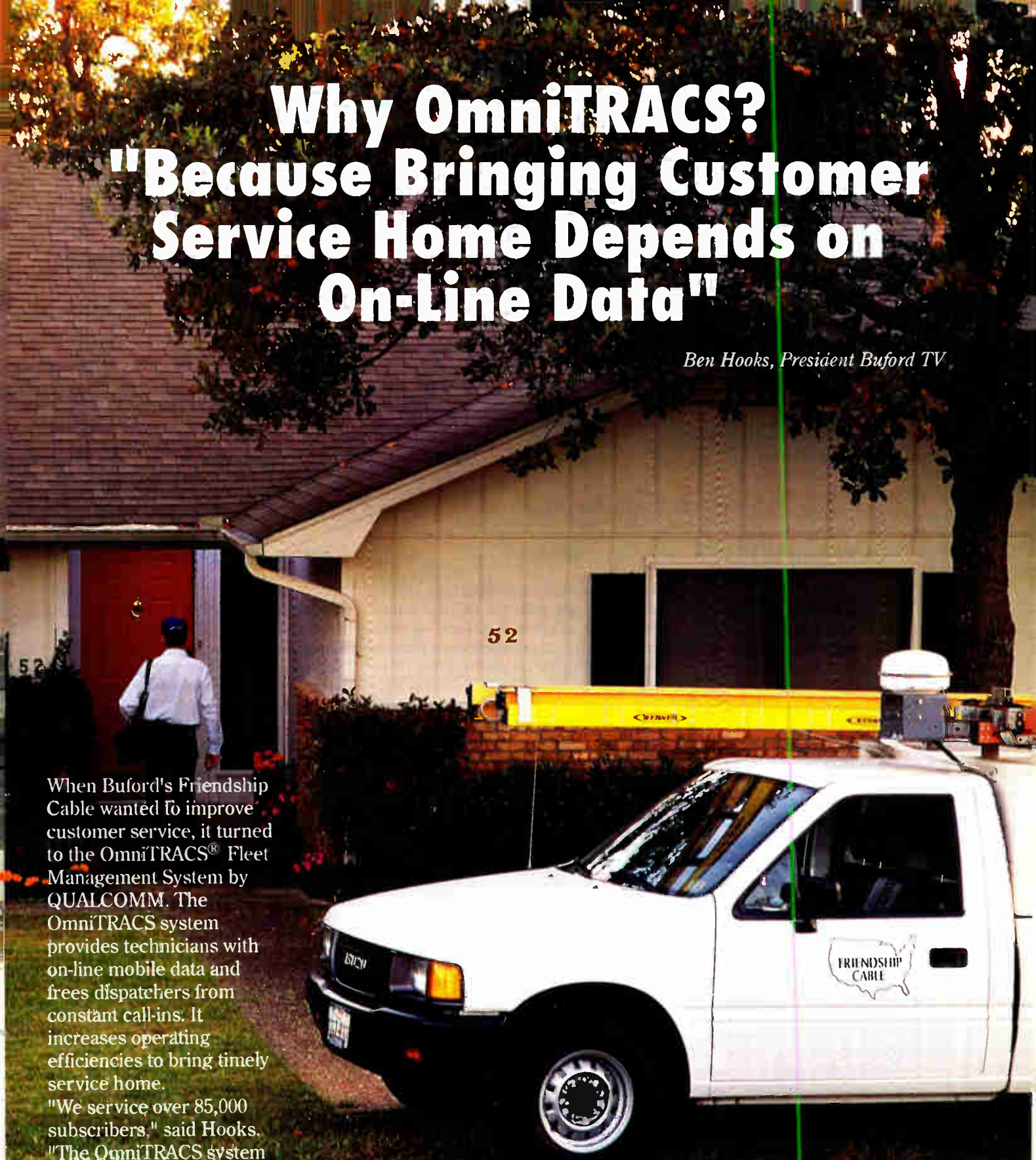
Ben Hooks, President Buford TV



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BLONDER'S VIEW

What's the dollars and sense behind the report on the proposed HDTV standard?

Isaac S. Blonder
President, Blonder Broadcasting Corp.

The "Grand Alliance" of the high definition TV (HDTV) proponents desires to merge all the technologies into a single format from which the viewer may extract the quality level he can afford. The format chosen is surely to be based upon the submissions on record with the Advanced Television Testing Committee.

The *IEEE Transactions on Broadcasting* (March 1993), included a special report on the Federal Communications Commission Advanced Television System Recommendation by the FCC Advisory Committee on Advanced Television Service. As well, the deliberations of the ATTC were codified and exposed to public view.

The main flaw

In my opinion, this report is seriously flawed and cannot serve as the basis for the FCC to formulate standards for an advanced TV service. There are two main defects. They are the fact that the field of audience research is totally absent, and the critically important knowledge about terrestrial coverage is both delayed and obsolete.

The report revealed that finances could not be secured for PS/WP7 (Working Party on Audience Research). The title of this group also could have been designated as "Psychophysics." What was suggested for the research topics included the audiences' willingness to pay a premium for advanced TV (ATV) services, types of displays to be used, reaction to a letterbox display, and other consumer interactions to the ATV scene. How can engineers proceed with the design of a new TV system without heeding the willingness of the public to pay for the new gadgets?

On C-SPAN, the Grand Alliance stated confidently that progressive scan and square pixels are needed to include computer functions and that the customer would pay for the added features. But the audience research on this topic is absent from the ATTC report! My own experience in 40 years of manufacturing demonstrated that price is the all-important factor in the salability of a product. Fair and honest studies by PS/WP7 are indispensable.

Elsewhere in the ATTC report, the price for a 34-inch ATV receiver was set at $2,500! What would happen if any potential viewers were informed that their new ATV set would cost five times as much as a 27-inch NTSC model and the height of the picture would be the same

16 inches in both cases? What about the fact that at a viewing distance of 8 feet, human vision could not tell HDTV from NTSC (on these sized TV sets)? A side-by-side comparison of the 16:9 ratio PAL screen with the 4:3 screen (as I saw in a demo in Europe) could kill the market for the higher priced 16:9 set. None of the American published studies comparing 16:9 to 4:3 looked impartial or credible to me. PS/WP7 must present the real world of price vs. features to real-world viewers before a system is selected. One of the studies that did make the light of day was a psychophysics-based poll affirming the superiority of 16:9 by a company

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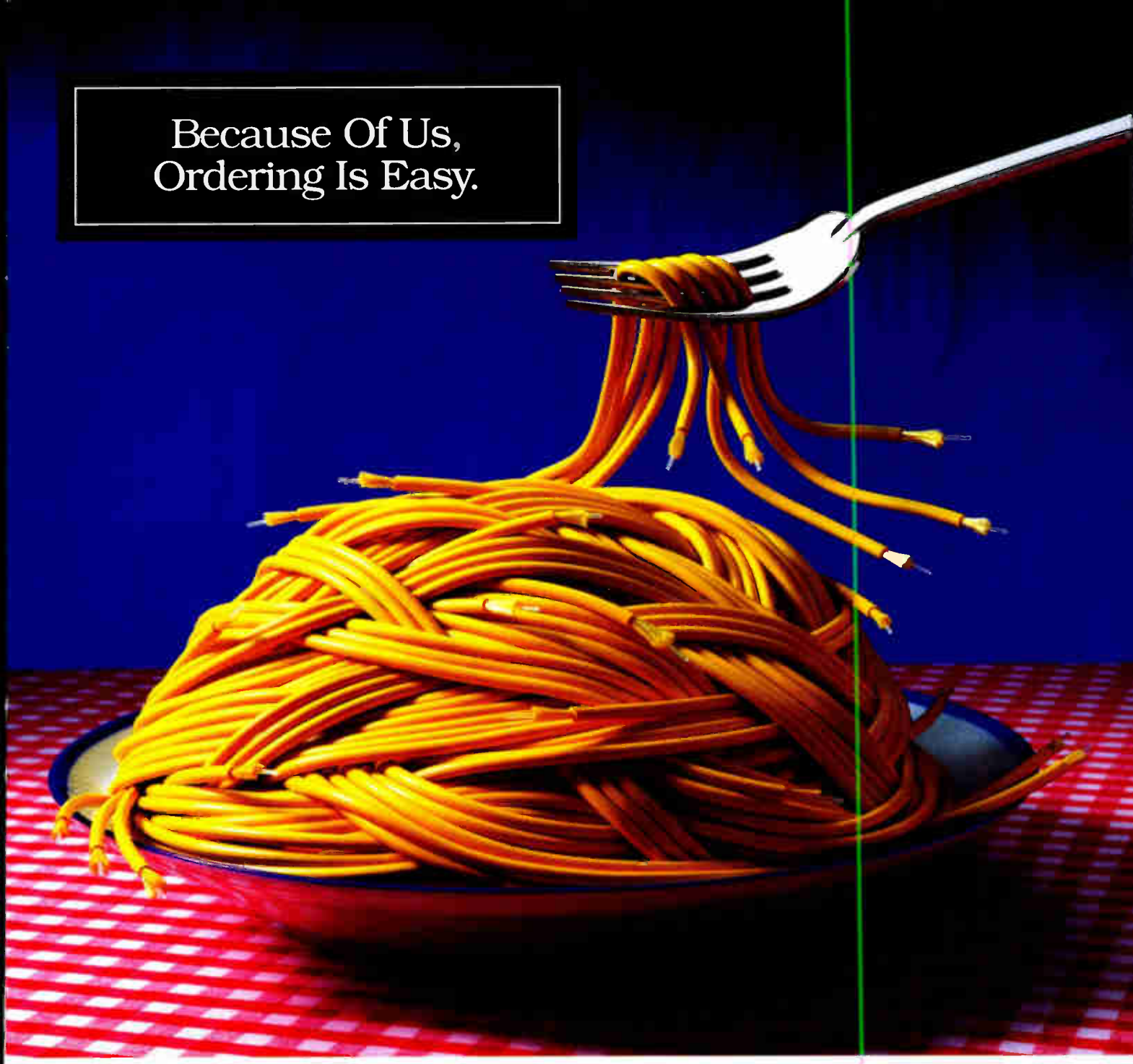

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proposing a HDTV system with the members of the study recruited from the employees of said company! Biased questions and presentations will give any answer the poll taker wants as we see in the papers every day.

Let's look at some facts. Human vision is limited to 250,000 pixels on a 27-inch TV set at a viewing distance of 8 feet. The HDTV picture with four times the number of pixels is wasted in the home environment. Generally, the cost of the screen is exponentially proportional to the diagonal measurement. To obtain the same vertical height of 16 inches, as is the case in the 27-inch tube, requires 34 diagonal inches. In the current TV set cost basis where prices have stabilized, a 34-inch NTSC tube would be double that of the 27-inch one. The new HDTV tube is now much more expensive than the NTSC ones and likely to stay higher forever. Even when volume brings down the prices, the electronics are many times more complex, and the HDTV receiver will probably never drop below double that of the 4:3 NTSC beauty.

Now to a little bit more of the psychophysics area. Human vision is about 140° horizontal. The subtended angle to the eye has to be over 20° before one gets the sensation of being in the action. In the average home, this would require a wall-sized screen. Of course, a much higher resolution is needed for this presentation, but how deep is the public's pocket?

Similarly, large-sized NTSC pictures are available to the home today and the sales are low indeed. Is it because the scanning lines are visible and the resolution poor? I believe that the viewer, who enjoys the one-third lower picture quality of VHS is not rejecting the large screen because of picture quality, but because of the dual deterrence of wall space and cost.

Next, let us consider the factors in the entertainment that may impinge on the value of 16:9 compared to 4:3. The typical scene in the typical drama is of two individuals relating to each other. Fill up the screen with their images and you will see that the extra horizontal space contributes nothing to the story. Maybe a horse race or some athletic events benefit from 16:9 but at what cost?

Comes the inevitable comparison by the home viewer of the two formats. At the same price, the HDTV screen is miniaturized to less than one half the area of NTSC. If he wishes to keep up with the Joneses and buy the new HDTV wonder, his wallet will shrink by 80%.

I am sure you will agree with me that the engineers and visionaries should put psychophysics ahead of inappropriate research. HDTV, at the quality level of film, is desirable only for the commercial marketplace where the price is secondly to the function. Research, to lower the price of home TV set, as is coming with digital compression of NTSC, and the addition of computer goodies at affordable figures makes sense.

If the ATTC report is unchanged and a final system is selected that requires a $2,500 TV receiver, and if by 2008 all free broadcast stations are required to present HDTV only, the home viewer can still watch NTSC on cable or satellite TV. It is probable that no more than 5% of the audience that now has large screen TV sets, will buy the $2,500 HDTV set. Without viewers, ATV stations are sure to go bankrupt and that will spell the end for "free" broadcast TV.

Another serious problem

The other major flaw in FCC Docket 87-268 is the delay in field testing the winner of the laboratory contest. As an experienced chief engineer, I went through many a painful period when a new product encountered field problems not anticipated by the laboratory engineers and required expensive redesign. In my opinion, field testing is as important as any other feature of the new service.

Apparently, ATTC closed the door to new contestants. As is the case in any technology, new technology is rearing its spoiler's head! Professor Schreiber of MIT has mentioned a few topics needing urgent studies — soft thresholds, spread spectrum, single frequency networks and orthogonal frequency division multiplex. Substantial improvement in coverage and echo protection are projected by the sponsors.

To repeat the theme of my previous articles on the subject of HDTV, I believe that HDTV should be left to the private entrepreneurs who need large screens for their showplaces.

The FCC should concentrate on setting a standard for multiple NTSC programs on a single 6 MHz carrier to serve the "free" broadcasters with the most economical TV service for the entertainment and educational needs of the public.

The multimedia (computer) industry could always marry their ever-changing products with a standard TV capability without the blessing of an FCC mandate.

Let the marketplace be the judge! **CT**

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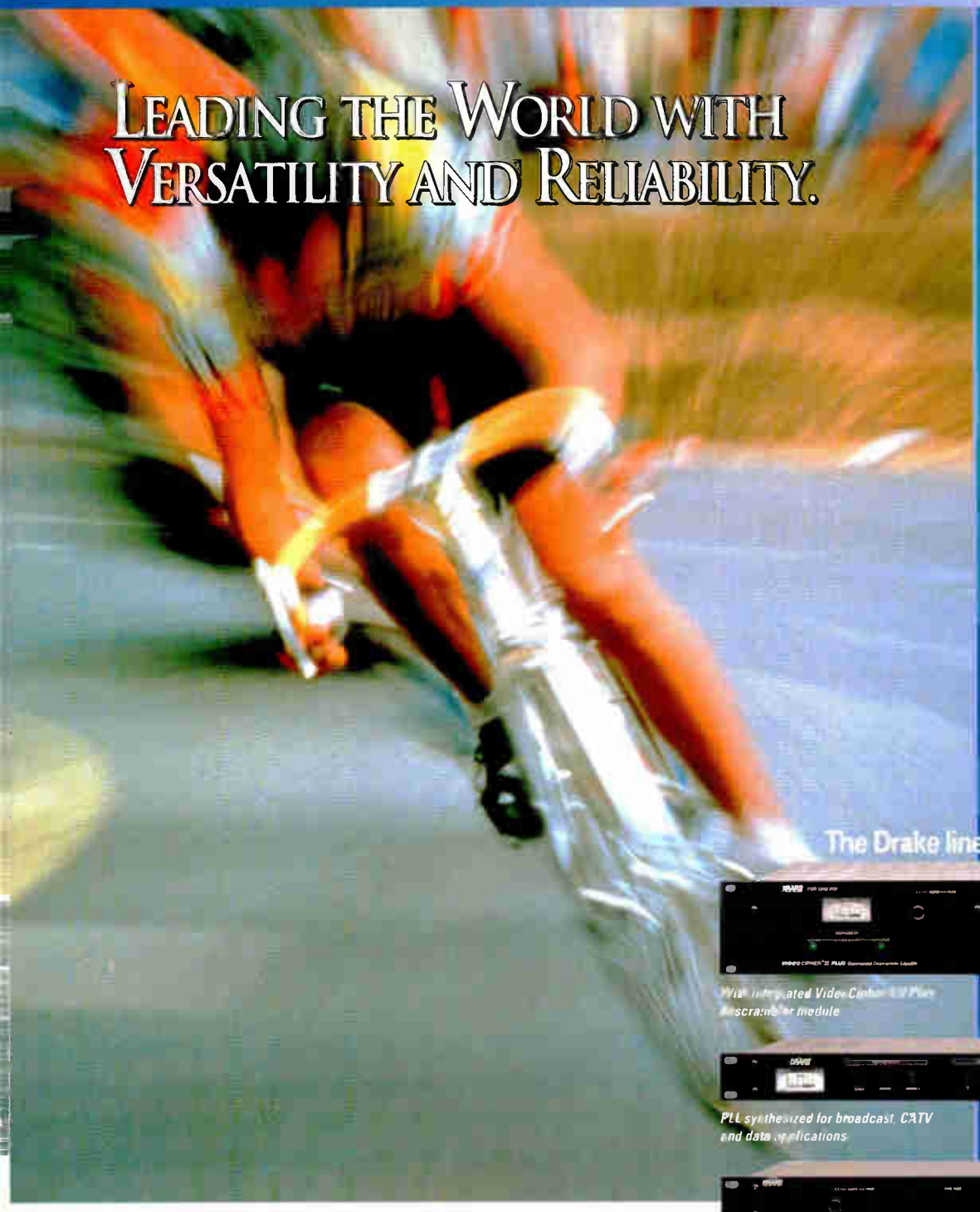

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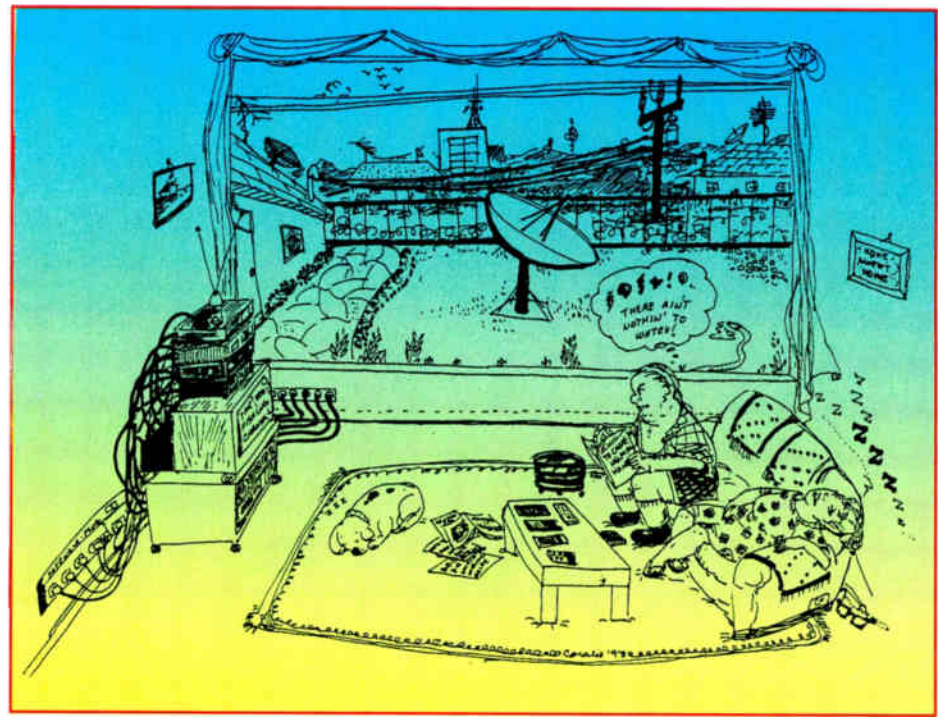
My opinion of telephony entry into cable TV

By Fred J. Rogers
President, Quality RF Services Inc.



In many political elections, the incumbent has the advantage of winning. Just as in politics, the incumbent supplier of any telecommunications service must be considered the favorite to dominate that service. The incumbent's position can be undermined by vigilante actions when customers' needs are neglected. A combination of excellent customer service, channel selection, reliability, community awareness and government-imposed low prices ensures a firm long-term subscriber base.

Many observers in the struggle for dominance of video delivery discount the value of being the incumbent supplier. Many believe that a savings of a few dollars a month or a pay-per-view (PPV) service will inspire cable customers to switch video suppliers and these believers have telephone "polls" to back their positions. Customers satisfied with their cable service will require a substantial incentive to switch and many will never change video suppliers. The difference between answering "Yes, I will switch" on a telephone poll and making an appointment to "rewire" may be as different as night and day.

Advantages, disadvantages

The main advantage a telephone company has in being a video supplier is having the house "wired." I must admit that not digging up the customer's yard to install a new drop is a major telco advantage, but what about the wiring in the house? Is there any chance the telephone outlet will be next to the family TV set? Will telephone connections be near the other TV sets in the household? Not likely!

The telephone company will still need to do some in-home wiring to be in the video business even with the twisted-pair now in place. The requirement for an appointment to install in-house wiring drastically reduces the threat of immediate telephone video service. Also, how will the customers react to another "box" on each and every TV set for PPV? Next, how much threat can one to three channels of instantaneous PPV be to cable TV? Correct me if I am wrong, but video stores seem to have more to fear from the telco threat than cable TV operators. Also, once the telephone company has this service, why not put the very same service on the regular cable? This could be just the service to make PPV additional revenues for both large and small cable operators.

There are other video suppliers in addition to the telephone industry, one being the "wireless cable" industry — multichannel multipoint distribution services (MMDS). For the wireless industry to be a major video provider, signal compression must become a cost-effective reality. At the point compression increases the number of channels for cable's competitors, the same technology can be used to strengthen cable's incumbent position. As wireless cable continues new startups, many future potential cable subscribers in areas not yet cabled may be lost for good; the incumbent rule will work in the wireless cable operator's favor too.

Another cable TV competitor, direct broadcast satellite (DBS, also called DTH or direct-to-home), has several major hurtles when competing with cable TV. Most homes have more than one TV set. In fact, the average TV set operates 13+ years and often the family TV set moves to the master bedroom when a new one is purchased. Meanwhile, the kid's room inherits the old bedroom "boob tube" and so on.

Will a cable customer settle for DBS on just one TV set? Does this mean internal wiring and "boxes" on each TV set? Who pays for all that electronics? The lack of major broadcast networks on DBS will require internal home wiring and outside antennas for typical ex-cable subscribers. Many satellite dish customers still have a large "bird bath" in the back yard and may be reluctant to buy another satellite dish even if it's small.

Government regulation of cable TV rates may become a major problem for would-be competitors. Artificially depressed cable rates may discourage competition. With the Cable Act, competitors usually pointed to rising cable bills as a reason to switch to a new video provider. Now cable competitors need to find a new cause, other than rates, to get a foot in the door. Score another point for the incumbent cable TV video supplier and government regulation. **CT**

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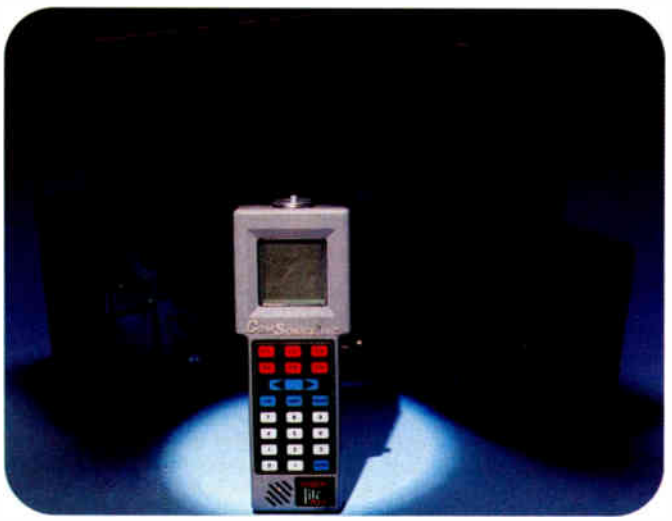

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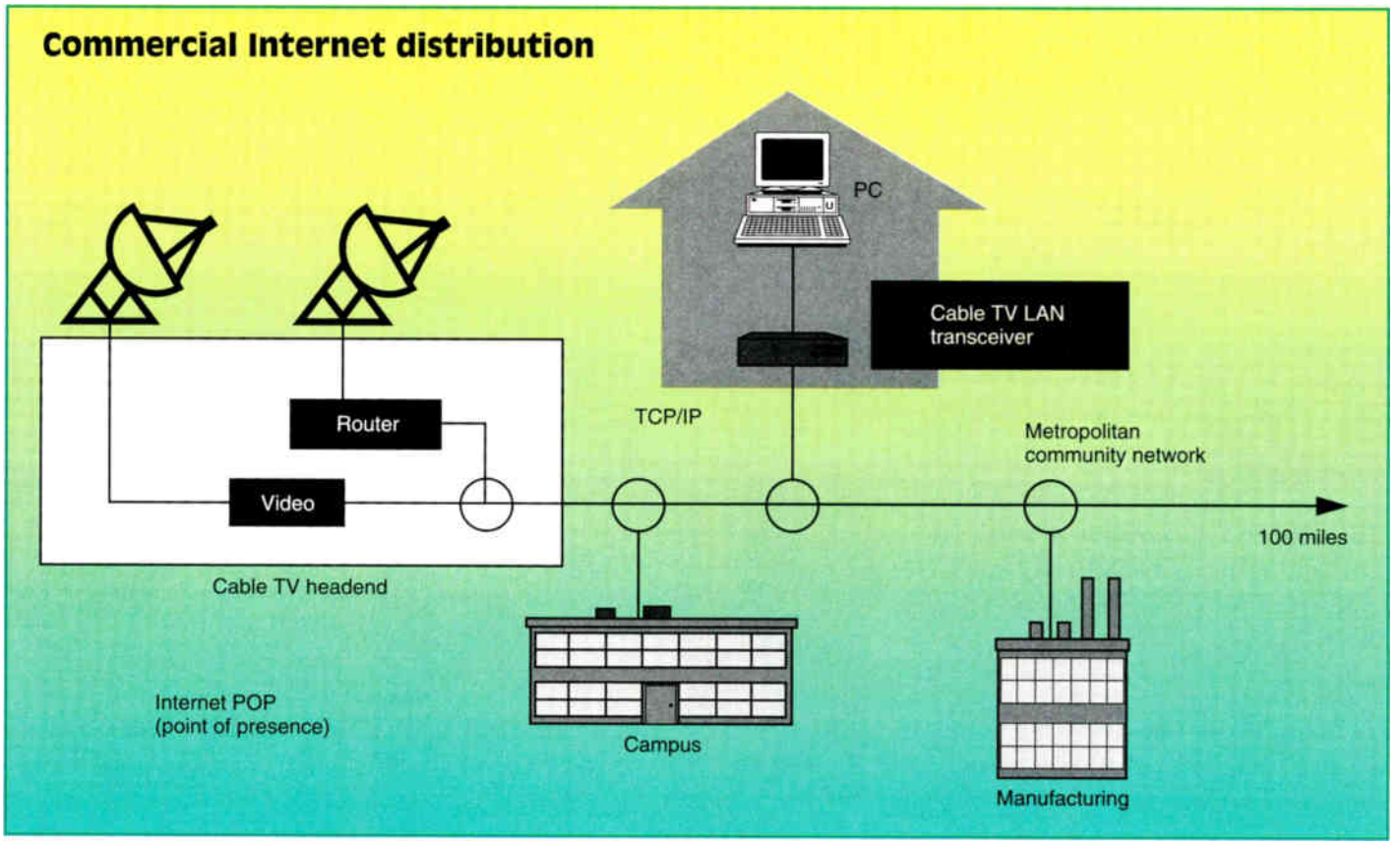

New revenue sources: Nonentertainment services

By Edward J. Zylka
Director of Marketing
Zenith Communication Products

As we all are hearing a lot about, the acceleration of digital technologies for cable TV is creating new opportunities for cable operators beyond the realm of traditional video entertainment services. In addition, the new Cable Act, fiber deployment and telco entry into cable will facilitate the move by the cable industry into nonentertainment services. The high bandwidth conduit offered by cable presents a fully interactive "last mile" connection that can support not only traditional entertainment (video) but also nontraditional services including data (local area networks — LANs) and telecommunications (personal communications networks — PCNs). The seldom-appreciated upstream or reverse channels are of great value to the cable operator. Interactive applications that utilize the two-way cable plant will provide cable operators with a new source of revenue.

Link Resources (IDG) reported that $25 billion was spent on personal computer-based communication systems for the home in 1992. It is estimated that more than 50 million U.S. homes have a cable TV connection and a 25% penetration of homes have personal computers. The opportunity exists for the cable TV operator to support data connections using the wideband connection of coaxial cable to over 12 million homes.

Municipal market segments that are already reached by cable TV include businesses, health services (hospitals, doctors' offices, clinics), legal offices, financial institutions, educational institutions, community facilities, and, of course, homes and apartments. Computer-based distance learning can be accomplished for K-12 (kindergarten through 12th grade), and colleges and universities with links to homes, dormitories and campus resources (libraries, mainframes, file servers, etc.). Consumer services can be offered to home users such as work-at-home (cable-commuting) and electronic resource access.

What are we waiting for? — ATM?

The future advancement of asynchronous transfer mode (ATM) from money machines to money-making machines does not restrict cable TV operators from developing strategies today to create incremental revenue using currently available hardware and software technologies. The need for a "virtual" point-to-point connection, as provided with ATM, is necessitated by services such as video and voice, which require the guaranteed delivery of digitized data. LANs use media access control protocols to enable multiple stations to transmit and receive data on the same cable and, in general, were not designed to provide prioritized delivery. Delays generated by traffic congestion and access negotiation on these networks is easily accepted by data users — access may be hundreds of milliseconds and appear similar to retrieval times for a floppy disk drive. LAN-based systems for

(Continued on page 63)

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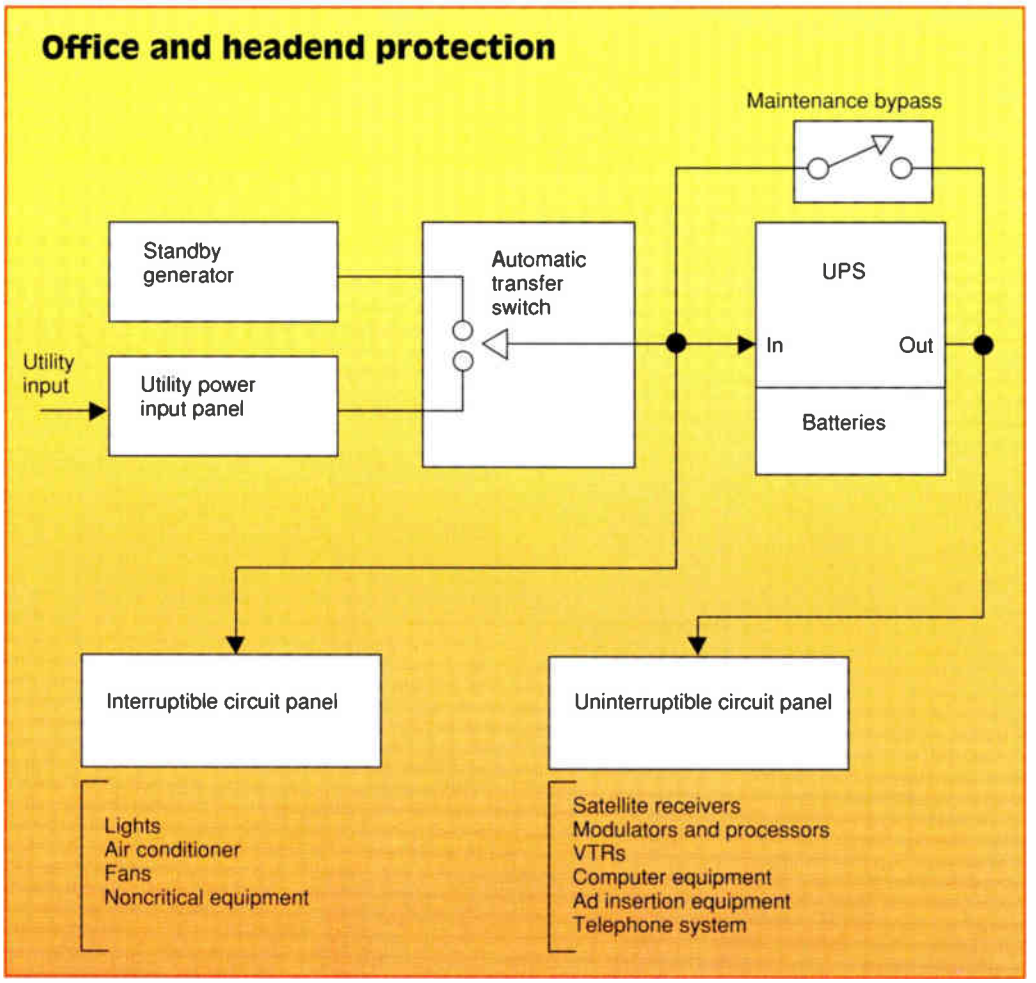
light of the move into delivery of telephony services is access to existing telco facilities. Is there proximity or access to the long distance carrier's "point of presence" or main trunk? Access to the local telephone central office facility may be necessary not only in terms of collocation of interface equipment within their facility but access and interface to hub sites and trunking. Will there be convenient access to the local cellular telephone carriers? Some cable systems are aggressively pursuing partnerships with cellular providers to provide fiber interconnection of cell sites. If a personal communications network (PCN) is implemented in some areas, this will become even more of an issue. Is the proposed headend location conducive to implementation of interconnects with other signal carriers, alternate access or other potential new business opportunities?



Our industry is rapidly coming to the realization that we are no longer an isolated video distribution system but the backbone of the delivery of many other services that are now facilitated by fiber optics and digital transmission. The headend of the new digital network is becoming one big computer facility with multiple signal processing systems. Interconnections with other cable systems, telephony providers, government entities and others will be the key requirement for success. Interconnectivity is very important and the headend must be located, designed and operated in such a way as to optimize this goal.

Headend design objectives

When designing a new facility or remodeling an existing location, there are several very specific design objectives to consider. There is no "right" or "wrong" design, but each operator must take into account unique local conditions and characteristics as well as anticipate future growth requirements. All this must of course be kept in the proper financial perspective. The cost of these new facilities can be significant and they must be designed and constructed in such a way as to minimize waste and unnecessary cost and maximize utility and longevity.

Powering

The fundamental base to build from is the power reliability of the facility. In older locations, this can be a real problem. Additions to the building and headend rack space have been "tacked-on" over the years. There may be several additions and expansions that have exceeded the initial electrical capacity of the facility. Subpanels and extra feeders may be distributed throughout the building with poor grounding integrity and improper load balance. When the operator has the opportunity to start from scratch and design a new facility, there are several tips that really don't increase the overall cost and can greatly increase the reliability.

Most new facilities are designed with a "dual power bus" system, which is a division of electrical distribution into two categories: "interruptible" and "uninterruptible." (See accompanying figure.) The electrical panels are designed in such a way as to permit load shedding of nonessential equipment in the event of a power outage until a standby generator is started and comes on-line in about 30 to 60 seconds. This power circuit is called the interruptible bus because it is allowed to go down for a brief period of time during an outage. Examples of interruptible loads are lighting, air-conditioning, heating, fans and noncritical electrical equipment. Keep in mind that these loads only go off for the amount of time that it takes the generator to start up and transfer into service.

The uninterruptible bus is powered by a UPS (uninterruptible power supply) and is designed to power the critical loads in the headend such as the receivers, modulators, processors, amplifiers, fiber-optic transmitters and receivers, microwave equipment, telephones and telephony equipment, etc.

Really any electrical device that directly or indirectly affects the reliable transmission of signal in or out of the headend should be powered by the uninterruptible bus. The ferroresonant transformer-based UPS design provides line conditioning and protection from voltage transients during normal utility operation. When there is a

(Continued on page 64)

Keep Your Revenue Flowing

Pay-per-view, PCS, movies-on-demand, interactive services . . . the list of additional revenue streams grows each day. And, as these services increase, system reliability becomes more critical.

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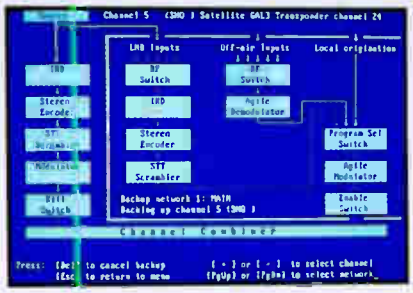

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Telephony over cable: CISN and CLC-500

By Richard Lyford
Product Manager, ANTEC Network Systems
And Thomas Tighe
Product Manager, AT&T Network Systems

Because the United Kingdom vigorously encourages competition in its local telephone market, regulators have embraced cable systems' capability to provide both entertainment and telephony services via one hybrid fiber-optic/coaxial system. TeleWest International — the joint venture between Tele-Communications Inc. and US West — is taking full advantage of this favorable regulatory climate by adopting a highly flexible evolutionary path for its developing cable networks.

The company's strategy is to provide both entertainment and telephony services over a "single pipeline" to the home. This approach would eliminate the need for two separate cable and telephone networks by offering both services over one infrastructure.

"Obviously, it's less expensive building one network rather than two," explains TeleWest Senior Vice President of Engineering Chuck Carroll. "Since broadband cable TV systems are very good candidates for delivering both traditional entertainment video and telephone services, there's a huge potential for those just starting out to build networks that will provide both. In this way, CATV (operators) can position themselves to take full advantage of new service offerings — like telephony — that the cable TV network can provide."

Network evolution

Over the past 20 years, cable companies have invested heavily in coaxial cable to deliver their services to households. Today, this investment not only pays off in cable revenues, but turns out to be the most cost-effective way to link the broadband network to the home. The last few years

(Continued on page 70)

Figure 1: Spectrum allocation

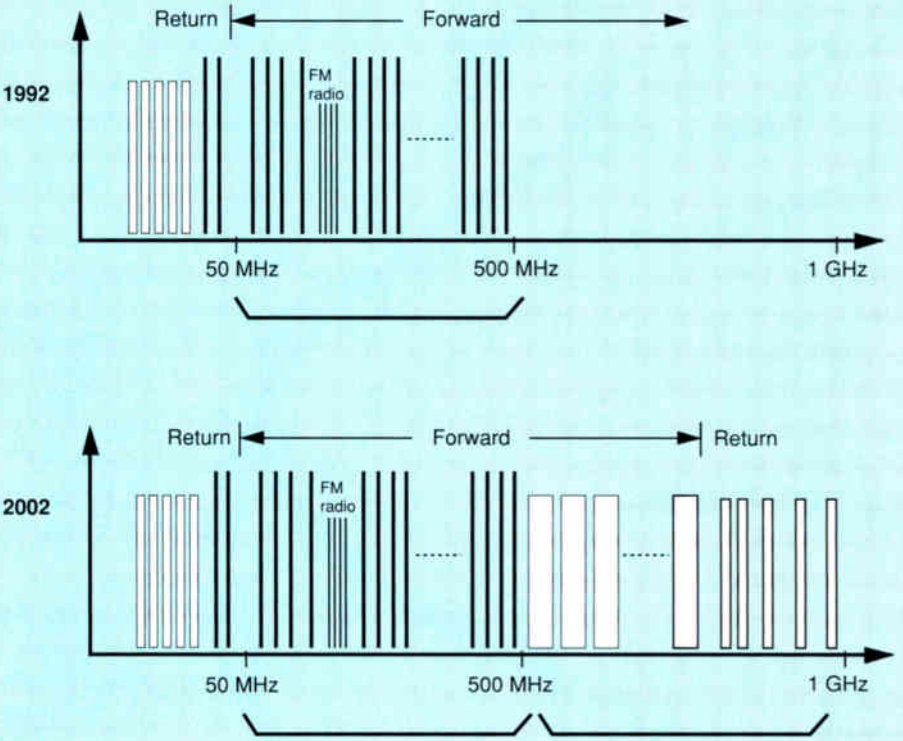
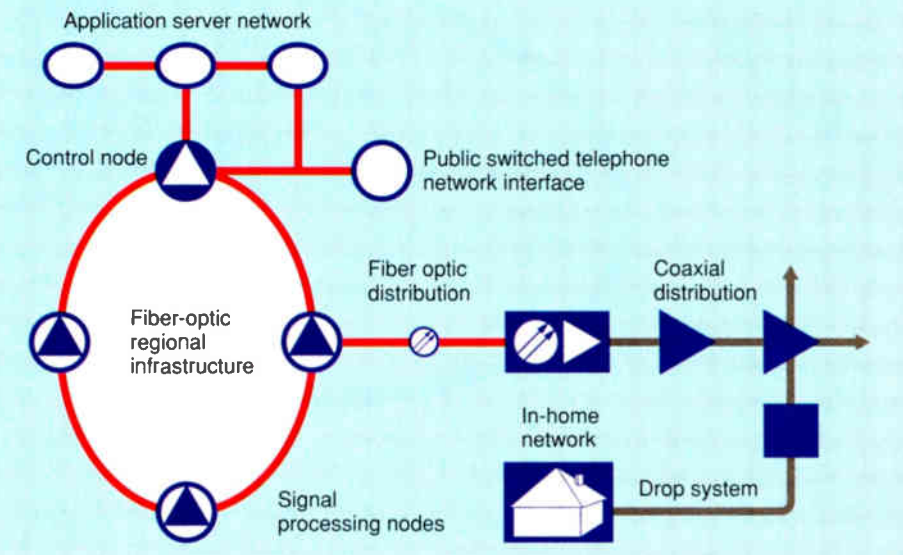


Figure 2: CISN framework



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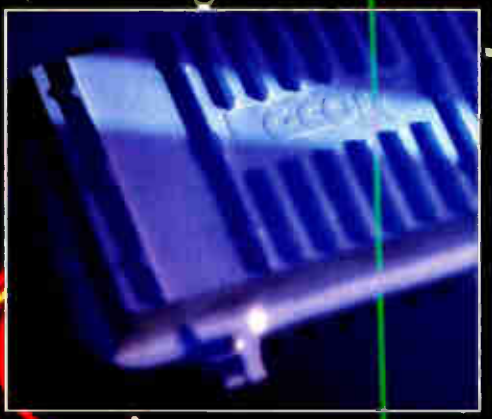

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ATM's role in CATV/telephony/multimedia

By Robert E. Baker
Plant Manager, TCA Cable TV

With all the talk today of superhighways, multimedia, interactive video, video-on-demand (VOD) and the such, its hard to pick up a trade magazine nowadays and not see technical jargon that was not seen a year ago. For the most part, we don't know the meanings nor how they will affect us in our industry. Just exactly how will our CATV outside plants and our headends get into this superhighway anyway? Enter ATM (asynchronous transfer mode), one of those bits of jargon.

A simple explanation

In the Society of Cable Television Engineers Broadband Communications Technician/Engineer (BCT/E) Category V training, you can learn about different data networking and architectures and find out that a CATV system is really a broadband communications network capable of handling data and voice transmissions as well as video information. Because of the medium CATV uses (mostly coaxial cable) we have a definite bandwidth advantage over the miles of mostly twisted-pair copper wire the telcos have in place. (Twisted-pair bandwidth decreases with length.) While cable and the telcos are both moving toward deployment of fiber, the telcos still have all that copper wire to deal with. It will be some time before the telcos can deliver the bandwidth and quality to the home, which we are capable of now.

When we get into multimedia, interactive video, VOD, personal communications services (PCS — another piece of jargon for mobile phones), alternate access, and the like, our cable systems will be handling voice and data in addition to video information. Our baseband of signals will be of different formats and speeds and multidirectional. To be fully functional we must interface with terminals outside of our system. Just how will we do that with all of the different signal sources? And for a large volume of users and possible high-speed data traffic, how will we ensure everything gets from us or to us intact and efficiently?

"ATM is capable of data rates into Gb/s and can switch and transmit unrelated and diverse services."

Picture if you will, a simple local area network (LAN), consisting of a user at both ends, two modems and coax in between. User Number One sends information (any kind) to User Number Two. That information goes into a modem that converts and conditions the information for transfer via the coaxial cable. At the distant end, another modem simply reconverts and reconditions the information back into the form it was at the sender, so it may be received. While I am oversimplifying, ATM will fulfill the "interface" requirement as did the modem, and the superhighway will replace the coaxial cable.

The superhighway will most probably be a hybrid system of fiber, coaxial cable and microwave, and will be provided by long-haul communications companies such as AT&T, MCI, Sprint, Internet and the like. This superhighway will provide a pathway between our CATV system and other CATV systems, and between us and other information sources such as phone companies, computer services (Compuserve, Dow Jones, etc.), information archives such as libraries around the country and the world, video game sources and movie suppliers, and on and on and on. The gate through which we must pass all of this to and from the superhighway will be the ATM switch and that will most probably be located within our headend.

A short overview

If you were to rent lines from your local telco, and you were providing an interconnect for some business within your service area, and that business needed a DS-1 or T1 (1.544 Mbps) or a DS-3 or T3 (44.736 Mbps) service, the telco would charge you for that data rate regardless of whether the line was fully used or not. With ATM, you pay for the bandwidth that you actually use, when you use it. How's it work? Here's a brief overview.

Let's go back to SCTE BCT/E Category V training. As said before, this category teaches about many kinds of transmission methods. One of these was "asynchronous transmission," which simply put is a data transmission with overhead bits that contain transmission information such as speed and routing in the cell header. It has start and stop bits and timing is independent. In Category V, you also can learn about various protocols, which again, simply put are the rules for communications systems operation that must be followed. ATM is a series of powerful protocols that define a fast-packet switching technology capable of carrying voice, data and video (all at the same time and at gigabit rates).

ATM is capable of data rates into Gb/s and can switch and transmit unrelated and diverse services. It is a cell relay technology and consists of a fixed length 53-byte packet or cell. (Note: 1 byte contains 8 bits and is sometimes referred to as an octet.) All these cells, which are constant in size, enter the ATM switch in an asynchronous manner. It can vary the bandwidth provided for a given service using the header information within the cells consisting of 5 bytes or octets (40 bits). This is where the cost savings is realized over typical DS-1 and DS-3 services, since with ATM you only pay for what you use.

Another advantage is that software is not required for ATM use. The ATM switch is hardware-based using RISC (reduced instruction set computing) in-

(Continued on page 73)

capital costs of building an all-glass network.

He believes the cost may come down when vendors begin designing their networks with FTTH in mind. For example, between 35% and 50% of the cost of the optical network units in typical FTTC networks is for fairly low tech components that could be optimized if placed in the customer's premises. "If manufacturers get the right signal, they can focus on that a lot sooner than people believe. That will let us build far cheaper passive optical networks in the outside plant," he says.

If the current generation of FTTH customer boxes cost $1,500 to $2,000, these may tumble like the cost of the VCR, points out Gaspare, who also believes that ambitious plans by large companies will play a key role in getting ambitious vendors to cut costs.

Here today?

It was this large market that inspired Optical Communication Corp. to develop its FTTH system. OCC plans to bring the cost of FTTH down to less than hybrid coaxial networks, while maintaining compatibility with existing telephone standards and providing video services capability.

OCC has developed a low-cost way for getting signals from an optical network unit to the home. Loughery Kuhn (CEO of OCC) maintains that the system enables homes to be attached to the optical network at distances well over 500 feet, but the exact distance is proprietary.

The capital cost savings result from the lower cost lasers used for transmission, as well as the increased number of homes accessible by fiber from the optical network unit. Kuhn says OCC is actively looking for communications companies to participate in future trials.

Although no one has yet installed fiber-to-the-home on a large scale, it may ultimately provide the lowest cost, lowest maintenance and highest bandwidth link to the home. Even if companies have no plans to use fiber on the current rebuild, it might make sense to pull fiber along with the coax, so that when the technology is cheap enough, it will be easy to rebuild. But if OCC's claims are true, perhaps coax is past its prime, and FTTH has become the lowest cost architecture for bringing the information highway home. **CT**

If you're like many cable systems, you're paying way too much for cable. Too much in rebuilds because of moisture and corrosion damage. Too much in truck rolls because of cold weather conductor pullouts. Too much in upgrades because the bandwidth couldn't live up to the demand. Too bad. Because it doesn't cost any more to specify 1 GHz bandwidth, triple-bonded Times Fiber trunk and feeder cable up front. And then reap the rewards of superior cable technology all the way down the line. Call 1 (800) 677-CATV.

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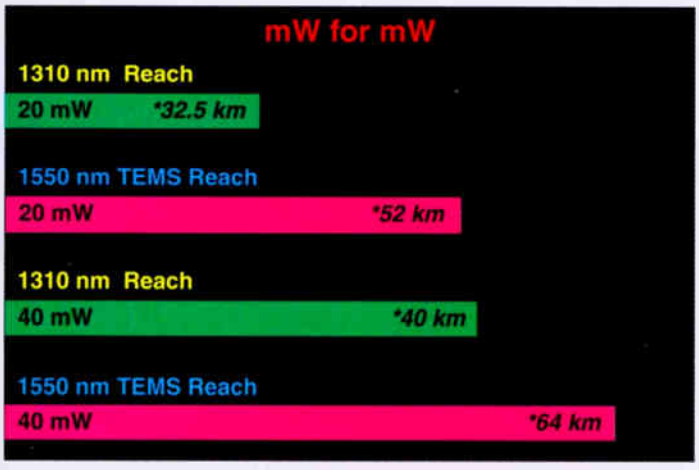
Texscan's new TEMS-1550 takes full advantage of the lower optical losses encountered when fiber optic cable transmission occurs at 1550 nm. Since the optical loss at 1550 nm is approximately 40% less than at 1310 nm, its reach is consequently 40% greater than 1310 nm lasers of equal power output. Additionally, the TEMS is capable of launching a full 40 mW (16 dBm) into a single fiber for even greater reach advantages.



CHIRPLESS TECHNOLOGY MEANS BETTER PERFORMANCE

The TEMS-1550's **chirpless** technology eliminates the need for dispersion shifted fiber. Its highly reliable 1550 nm light source, coupled with its internal erbium doped fiber amplification circuitry (that includes a highly reliable 980 nm pump laser) and its unique Mach Zehnder modulation circuitry, allow the unit to be optically, not electronically, optimized. Since there is no electronic restriction on bandwidth, performance to 750 MHz and 1 Gigahertz is easily attainable. With full channel loading capabilities on a single fiber, there is no need for multiple fibers. The TEMS-1550 eliminates added costs and wastefulness associated with multiband/multifiber approaches, and also eliminates the need for "re-lasing" and its associated performance degradation.

MORE VERSATILITY—EVEN MORE REACH

The TEMS 1550 is available in outputs up to 50 milliwatts (17dBm) allowing you to reach the farthest regions of a system, to connect a network of systems, or to supply sufficient optical power for true "fiber-to-the-curb" system architectures. Complementing the TEMS 1550 is Texscan's Erbium Doped Fiber Amplifier, model EDFA 1550. The EDFA 1550, in conjunction with the TEMS 1550, form a true distributed (not "re-lased") optical system. The TEMS 1550 allows you to take full advantage of the low fiber loss at 1550 nm and the EDFA 1550's high output power as a solution that, until now, required "re-lasing," FM or digital schemes.

MAXIMIZE YOUR FIBER INVESTMENT NOW

For years, cable operators have built RF systems using lower loss coaxial cable. The same should apply to fiber optic systems: It wouldn't make sense to build an RF system using "high loss" .412-type coaxial cables, and it certainly doesn't make sense to build a fiber system using "high loss" 1310 nm transmission wavelengths when a lower loss path is available. It does, however, makes sense to get the most for your fiber dollars now with Texscan's lower loss, greater reach TEMS 1550 External Modulation and Distributed Lightwave Systems.

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Optical loss @1310 nm is .4 dB/km; @1550 nm is .25 dB/km

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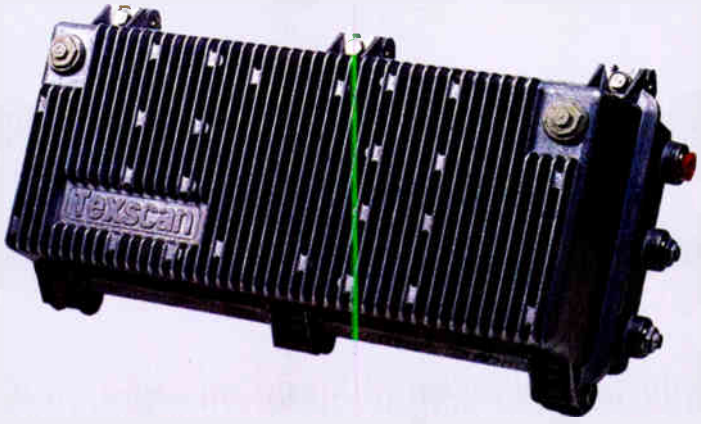

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- No bandwidth limitation
- Full 750 MHz plus+++ (1 Gigahertz late '93)
- Eliminates the need for "re-lasing" and its associated performance degradation
- Eliminates added costs and wastefulness of multiband/multifiber approaches
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Nonentertainment services

(Continued from page 40)

cable TV remove the expense associated with the central office switch of the telephone world, which is emulated by ATM.

The emergence of the Internet as a viable "channel" for the cable operators is creating a new revenue opportunity. (See accompanying figure on page 40.) CableLabs is supporting a move by cable operators to provide Internet (a global electronic network previously used and marketed to scientists, universities and businesses) access over cable TV by early 1994. The Internet "web" permits connection to an immense array of electronic information and user groups with discussions and topics ranging from genealogy to meteorology. Electronic connections can be made to the National Archives, the CIA, the White House, the Library of Congress and thousands of other facilities worldwide, offering vast resources for researchers, students and business professionals.

Educational opportunities for cable

The Village of Glenview, IL, in cooperation with Tele-Communications Inc. (TCI-Illinois), is utilizing the institutional cable TV plant to network seven schools within the district. The district's computer system uses Unix-based server equipment and Apple Macintosh personal computers at each school site, which are then connected to the broadband cable TV LAN backbone. This community computer network supports both instructional and academic applications and enables network access for 3,000 students and 400 administrators. An Internet connection to Northwestern University is linked into the school network, distributed to the school facilities and can be shared by all users.

A distance learning pilot program is being conducted in Provo, UT, as a trial under the Utah Valley Business/Education partnership. Its purpose is to provide home computing resources, including Internet access, distance learning, municipal government access and other services. Using a new cable-LAN modem product called HomeWorks installed in standard IBM-compatible PCs, students had access to a complete LAN-based K-12 educational learning system at the cable headend. Depending on the grade level of the students, a specific curriculum could be downloaded to the home with courseware, which included math, English and science.

In the field trial, PCs were located at various locations within Provo, varying from five to 10 miles from the headend. The trial proved that two-way cable TV technology can be practically applied to a residential cable TV plant for the delivery of high-speed local area networks. A cost-effective product will allow cable TV operators to compete favorably with phone-based modems and ISDN, and a computer-based educational learning system will permit the extension of a school curriculum to students at home.

The virtual office

Currently available data communications options to the home are limited to "low-speed" telephone modems, from 1,200 bits per second to 14.4 kilobits per second. The only other telco option available is ISDN at speeds of 56 kilobits per second. A typical installation cost for an ISDN line and PC equipment is approximately $2,200 per user. Because of the low speed of phone modems, computer applications are limited to point-to-point connections and simple file transfers.

New LAN-based digital cable TV technology will now provide operators with options to provide high-speed data services to home subscribers. The performance offered by cable TV LAN products such as HomeWorks offers performance up to 50 times faster than 9,600 bits per second telephone modems per user connection and will permit operators to favorably compete against phone modems and ISDN.

"The combination of value-added services, such as Internet and high-speed LAN-based products for the cable industry, presents an excellent new market opportunity — a new revenue source, which takes on special importance in the era of cable reregulation."

The beginning

The combination of value-added services, such as Internet and high-speed LAN-based products for the cable industry, presents an excellent new market opportunity — a new revenue source, which takes on special importance in the era of cable reregulation. Now is the time for the cable industry to embrace the future and take full advantage of the significant opportunities available to them through new cable-LAN technologies. **CT**

investment only where incremental revenues exist using today's fiber/coax plant as a foundation.

CISN was developed to support all of the possible business opportunities with a spectrum utilization plan that recommends using the upper bandwidth (550 MHz to 1 GHz) for digital transmission. A significant portion of this bandwidth is allocated for a return path as shown in Figure 1 (page 46). This return path would be in addition to the 5 to 30 MHz cable systems normally allocate. Remaining spectrum would be used for traditional CATV services.

For interactive applications, CISN accommodates transmission of voice, video, data or all three. Ultimately, signals could travel through digital rings of a regional interconnect and into the public switched network, using synchronous optical network (SONET) and asynchronous transfer mode (ATM) technologies. Profit opportunities will drive the evolution to each of these digital components, providing CATV networks with the means to be the broadband network of the future. (Refer to Figure 2 on page 46.)

For TeleWest, the driving force behind this type of network evolution is its opportunity to generate additional revenues now through residential telephony services in addition to traditional CATV.

How the network works

The Cable Loop Carrier 500 (CLC-500), a product jointly developed by ANTEC and AT&T, is one of the first "interactive" applications to expand the role of cable networks as envisioned by the CISN plan. As shown in Figure 3 (page 70), the CLC-500 combines the network design needed to provide telephony over cable and accommodates the associated equipment needed to interface between standard telephones and the public switched telephone network. This architecture offers CATV operators the opportunity to provide voice applications via the cable TV infrastructure.

A headend terminal presents 16 E-1 lines to the public switched telephone network. Up to 30 subscribers can be served by each of the 16 line cards, making each headend terminal capable of serving a total of 480 subscribers. Multiple units can be added at the headend to satisfy demand. The headend unit's system controller provisions subscriber terminals and acts as the network manager to monitor

"Profit opportunities will drive the evolution to ... digital components, providing CATV networks with the means to be the broadband network of the future."

and report on major and minor audible and visual alarms.

Incoming digital telephony signals from the public switched network pass through the headend terminal where they are assigned a specific frequency and time slot based on the address of the telephone call. Then, these signals are transmitted via fiber-optic cable through a Laser Link II telephony transmitter. Entertainment signals are transmitted via a Laser Link II through a separate fiber. At an intermediate point, called the hub divider, telephony and video signals are integrated. The hub divider converts the optical signals to RF, combines the RF telephony signals with the entertainment services that are received from the headend via the separate fiber-optic system, and transmits both signals over coaxial cable to the subscriber service area. Forward path telephony signals require a 25 MHz block of spectrum in the 500 to 750 MHz range. (TeleWest has chosen 625 to 650 MHz.) Return path remains in the traditional 5 to 30 MHz spectrum. TeleWest has devoted the 50 to 500 MHz spectrum for traditional CATV services.

Once entertainment/telephony signals arrive at the home, a directional coupler/splitter sends the signals to both the set-top converter and the CLC-500 subscriber terminal. The CLC-500 unit, which operates like a modem, converts the downstream digital telephony signal derived from the coaxial cable input into an analog signal that can be recognized by a standard telephone set. Upstream, the subscriber terminal converts the analog telephony signal back to RF and transmits it back to the hub divider.

Establishing the network

TeleWest designed its network to be enhanced incrementally, with the initial design serving 2,000-home

areas. With an assumed buy rate for telephony services of 20%, this network design will accommodate anticipated demand. However, should demand increase in a particular service area, TeleWest has planned for the placement of a secondary hub divider that can further subdivide the service area and reuse the same 25 MHz block of spectrum for additional subscribers.

Since entertainment signals continue to be available from the primary hub divider, the secondary hub divider does not need an optical receiver. Rather, the secondary hub divider simply passes the entertainment signals on to the smaller node (typically 500 households) through the coax input from the primary unit. New fiber links are established from the headend to the secondary hub divider to provide for telephony services to the smaller service area. (Dark fibers should be installed during the initial construction.) A filter at the secondary hub divider eliminates telephony data traveling from the primary hub divider to the secondary hub divider, and telephony signals are received and returned to the headend via the new fiber-optic links.

This type of network evolution is consistent with the CISN vision. It promises to provide cable operators with the means to build a combined network capable of integrating telecommunication services and entertainment video, without the need to dig up or redesign the network each time a new business opportunity presents itself. Subscriber service areas should be designed today to serve existing needs. However, those areas must be positioned to be further subdivided as demand for other interactive services increases, as TeleWest has done.

In the future, as more digital technologies come into play, this type of network will offer significant technical advantages in capacity and signal quality. And in the view of many in CATV, this evolution of cable TV networks will be critical to the success of the industry. For TeleWest and others, telephony represents a new revenue potential today. However, telephony will be just one of the many interactive services the digital world will bring to the industry and to the consumers CATV serves. **CT**

ATM's role

(Continued from page 48)

telligence. Data cells can travel from source to destination using the switching information located in the cell header. It's these features that give ATM the high switching rates through the switch (Gb/s). To save overhead, error checking takes place in the header only, assuming that if the header is correct, then the remaining data also is correct

Since ATM is a relatively new technology, there are no off-the-shelf switches available for sale at this time. Companies such as AT&T and TRW in the United States and Fujitsu Corp. in Japan are currently working with prototypes in the field. One that made waves in the media recently was the prototype being tested in the Time Warner system in Orlando, FL, by AT&T. This ATM switch is being tested with interactive VOD. Others are being used for transmission of high definition medical images via supercomputers. AT&T expects to have production versions in the field by the end of this year or early 1994. **CT**

HDTV update

(Continued from page 50)

"The Grand Alliance technical proposal does not at this time include this format," McKinney said in a letter to the Alliance and Technical Subgroup Chairs Joseph Flaherty and Irwin Dorros. "These values should be added to the Grand Alliance technical proposal at the earliest practical date."

Also promoting the 1,080 by 1,920 standard was NHK's Keiichi Kubota, who said the Japanese broadcaster will endorse a shift to the 1,080 active line standard if it is adopted in the United States. Japan's 1,125 line high definition system currently includes 1,035 active lines.

Should the Society of Motion Picture and Television Engineers adopt the standard, Kubota said, NHK will begin replacing its equipment with 1,080 line hardware when cameras become available. Such cameras might be available in about three years, Sony's Larry Thorpe said.

Though they voiced willingness to discuss the issue, Alliance participants initially voiced a preference for the 960 line approach, noting they had considered and rejected the 1,080 line idea before forming their group. Zenith Electronics Corp.'s Wayne Luplow said the 1,080 line system would create a need for more memory in receivers and also would lead to slightly more expensive displays.

The issue remained unsettled during a Technical Subgroup meeting in August, when the Alliance told the Advisory Committee panel it was still considering the choice between the two formats. Advisory Committee representatives, though, remained committed to the 1,080 format. "The Scanning Format/Compression Expert Group has found no reason for the Technical Subgroup to change its position," the Expert Group reviewing the issue told the meeting.

The group conceded the 960 approach presents less of a compression challenge, but maintained its recommendation of the 1,080 line option. AT&T's Bob Keeler, noting the Alliance still was "actively considering" the question, offered a defense of the 960 line approach, citing compression and receiver cost issues.

As the deadline for settling the issue passed, however, Alliance participants elected to avoid a confrontation and adopt the 1,080 active line approach. General Instrument's Bob Rast, facilitator of the Grand Alliance Technical Oversight Group, said the Alliance participants arrived at their decision after a mid-October meeting at which all of the open issues were placed on the bargaining table.

The Alliance earlier had found itself unable to convince all seven participating companies to agree to the 1,080 line format. Rast noted, while the Alliance did not achieve unanimous agreement on each of the open issues during its meeting, all parties agreed to support the final recommendations to the Technical Subgroup. "We followed a professional process," Rast said. "We got here for the right reasons."

Despite the initial disagreement on the format question, the Technical Subgroup Expert Group did not object to the idea of two formats, stating it would not be appropriate to forbid either the progressive or interlace format.

Embracing MPEG-2

The Alliance participants also bowed to Technical Subgroup wishes in adopting a compression plan with no divergences from the Moving Pictures Expert Group (MPEG) standard. Compatibility with MPEG-2 had emerged with a high premium from an August Technical Subgroup meeting

"Chief among the Alliance decisions was an agreement to include the 1,080 active line format in its HDTV standard."

after participants insisted the Alliance would need to present a strong justification for any divergences from the standard. The Alliance compression plan then included AC Leak, an AT&T-developed technology aimed at improving the system's error resilience and speed in channel change.

Though the Alliance presented AC Leak to the MPEG committee during a July gathering in New York, the technology was left out of the MPEG standard. Despite the MPEG group's decision, the Alliance had kept the technology in its plan, maintaining MPEG compatibility should remain secondary to high-quality pictures.

But at the Technical Subgroup's October meeting, the group decided alternatives to AC Leak — such as progressive refreshing — could fill AC Leak's role in the system. The Alliance also decided not to employ multiple variable length code (VLC) tables, another element outside MPEG-2 that the Alliance earlier had considered. "We are now fully compliant to MPEG-2 syntax," GI's Woo Paik told the subgroup.

Other Alliance representatives said the group plans to conduct computer simulations in the weeks ahead to assess the adequacy of high definition pictures produced without any compression tools outside of MPEG-2. Should the simulations prove inadequate, participants said, the Alliance might later add additional tools back into the compression system and then present them to the MPEG group for adoption in the international standard.

"The goal is pure MPEG," Zenith's Luplow said. Rast speculated the MPEG group would need to conform to the Alliance standard if hardware testing proved the pure MPEG syntax is insufficient for providing high definition pictures.

The Alliance also said it plans to include B-frames in its system. Alliance members earlier had made a tentative decision against using the B-frames, citing problems with complexity and channel acquisition time. The addition of B-frames, though, brings the Alliance system closest in compatibility to the MPEG-2 "Main" profile.

Another MPEG profile — the "Simple" profile — did not include B-frames in its specifications for high definition video, though the HDTV level of that profile was removed at a Brussels MPEG meeting following the Alliance decision to include B-frames.

Choosing an audio system for ATV

While accepting the subgroup wishes on compression and scanning, the Alliance also conformed with Advisory Committee recommendations against additional audio testing and instead put the contentious issue to rest by selecting the Dolby AC-3 system as the Alliance audio system.

The decision ended a dispute that earlier had generated reports of cracks in the Alliance, with Philips Laboratories pushing for a retest of audio systems against the wishes of Dolby Laboratories Inc., which refused to participate in additional testing. During testing performed at Lucasfilm in July, the Philips Musicam system suffered during the playing of glockenspiel and tympani test material.

While the Technical Subgroup's Audio Expert Group rec-

ommended the adoption of Dolby AC-3 at 384 kilobits, Philips pushed for a retest of systems, citing an implementation error in its system. The proponent took its case to the Advisory Committee in early October and explained problems with its hardware to Technical Subgroup Co-Chair Joseph Flaherty and representatives of the Audio Expert Group.

While Advisory Committee representatives accepted Philips' explanation as plausible, they maintained the group should make its system selection in time for October's meeting rather than submitting the systems to additional testing. Prior to the meeting, the Technical Subgroup's Audio Expert Group had strongly opposed a repeat of the testing conducted in July.

"We feel that the (Expert Observation and Commentary) testing that was conducted at Skywalker Ranch in July was fair and valid, and that any retesting is of questionable value and impractical," Expert Group Chair Jim Gaspar said in a letter to the Alliance. "The FCC Audio Experts Group recommends that the Grand Alliance make a decision based upon the findings of the Audio Specialist Group, since we feel that another month of delay would be expected to contribute little, if any, further useful information."

Gaspar's group later recommended the Alliance adopt the Dolby AC-3 system at 384 kilobits. "We've come to the conclusion tests are done," Gaspar said.

Following the meeting with the Expert Group and the Advisory Committee, Philips' Carlo Basile, department head of Advanced Television Systems, said his firm was disappointed with the outcome of the dispute but remained onboard the Alliance program. "We're here," he said.

In a separate statement following October's meeting, Basile's company noted Musicam will serve as the system backup if the Dolby system exhibits problems. The company also cited the hardware "bug" in its statement and said it has been able to correct the problem.

Cranking up the transmission derby

While settling disputes with the Advisory Committee concerning MPEG compatibility, the scanning format and audio testing, participants in the venture also have been preparing for an internal competition to determine what transmission technique the ATV system will employ.

The decision involves a battle between two approaches — vestigial sideband (VSB) and quadrature amplitude modulation (QAM). While participants spent much of the summer compiling a paper analysis of the two technologies, most expected the Alliance will need to conduct a hardware bakeoff before it reaches a decision.

Earlier testing did not yield a clear winner. During a February review of transmission performance from the first round of testing, Advisory Committee Special Panel members awarded 16 "stars" to the Digital Spectrum Compatible (DSC) system while awarding 15 to the Channel Compatible DigiCipher system. The DSC system employed a VSB transmission approach while CCDC used QAM transmission. Some observers, though, said the VSB results indicated a slight advantage over QAM.

CableLabs, in a statement made prior to the Alliance announcement, voiced its preference for multilevel VSB transmission. A separate recommendation, from the Advanced Television Systems Committee Broadcasters Caucus did not

specify a preference for QAM or VSB transmission, but did state broadcasters "prefer the highest data rate mode of an ATV system (32 QAM or equivalent) unless subsequent tests show that data rate reduction is the only effective method to solve interference problems."

Though the Alliance earlier had planned on conducting the bakeoff internally, at the meeting in October said it instead will conduct the tests at the ATTC, combining the tests with transmission verification work.

While preparing for the transmission bakeoff, Alliance and Advisory Committee participants also have been examining the European coded orthogonal frequency division multiplexing (COFDM) transmission technology.

The Technical Subgroup's Transmission Expert Group had planned a visit to Europe to inspect COFDM hardware during September, but decided to postpone the trip in order to see the latest COFDM hardware.

Making strides: ATV transport and interoperability

Other ATV issues generated less controversy throughout the summer and fall. While audio, scanning format and transmission questions remained open as late as mid-October, the Alliance Transport Specialist Group by then largely had completed its work in defining the system transport layer. The group, which like the Audio Group had set Aug. 31 as a target date for resolving open issues, originally listed program guide implementation, the details for local program insertion and the relation of audio and video clocks among the open transport layer issues.

Participants have since decided to lock the audio and video clocks, establishing a specifically fixed relationship between the audio and video data. Transport Group Facilitator Terry Smith said the decision should improve the cost of sets, because it will allow receivers to be built with one system to handle the audio and video clocks.

The group also decided to include information in the transport layer that will tell the receiver which services will be mapped together to form a program. Smith noted such information will become important in allowing the receivers to decode and assemble multiplexed programming.

On the issue of local program insertion, Smith noted the group has taken some input from the header/descriptor work of SMPTE and added the participants believe "hooks are in place" to allow for program insertion and live edits.

The Advisory Committee also has made strides in addressing increasingly popular concerns about the "interoperability" of the ATV system. Participants in August created a "Joint Expert Group" to examine the issue.

The group, chaired by Robert Sanderson, manager of the Image Telecommunications Center at Eastman Kodak, held a meeting in September to study the Alliance system in terms of interoperability. Executives listened to the latest description of the system design from Alliance representatives. Participants, representing such industries as broadcasting, telecommunications, computers and productions, reviewed the Alliance ideas with an eye toward how they serve "stakeholders" in the nation's telecommunications and information infrastructure.

Sanderson said Alliance representatives presented their system in a layered approach, as they had with members of the Technical Subgroup. Representatives offered updates on the transport, transmission, format, compression

"While accepting the subgroup wishes on compression and scanning, the Alliance also conformed with Advisory Committee recommendations against additional audio testing ... by selecting the Dolby AC-3 system."

and audio subsystems. The interoperability experts principally met to prepare for a later two-day review of the system in October by executives from various industries.

Such a meeting initially was proposed by Apple Computer's Michael Liebhold during the August meeting of the Technical Subgroup. While Liebhold did not attend the presentation of the Interoperability Group's report to the Technical Subgroup in October, other participants in the group gave the Alliance high marks on its interoperability performance. The group concluded the Grand Alliance proposal demonstrates "significant commitment" to interoperability by incorporating the concepts of all-digital implementation, layered architecture, header/descriptors, packetized data structure and MPEG-2 based video compression.

The issue of interoperability generated much discussion among Washington policy makers following the announcement of the Alliance. After the announcement, House Telecommunications and Finance Subcommittee Chairman Rep. Edward Markey (D-MA) held a hearing on the plan at which he asked witnesses whether the Alliance participants had "pushed the edge of the envelope" on interoperability. Markey later submitted a series of questions on interoperability to acting FCC Chairman James Quello, noting witnesses at the May hearing cited interoperability as a "critical" issue in the creations of new jobs in TV manufacturing and other industries.

The House Technology, Environment and Aviation Subcommittee also held a June hearing on the issue at which Apple Computer's Liebhold criticized the Advisory Committee process as ill-equipped to assess the Alliance system's benefits to industries holding a stake in the U.S. information infrastructure.

Saving the testing labs

In addition to establishing the Interoperability Group, Alliance members and representatives from the ATV testing labs in August established a plan to keep the both the ATTC and the Advanced Television Evaluation Laboratory (ATEL) available for testing the system once it is completed.

The two pacts, which the Alliance negotiated separately with the Communications Research Center (CRC) in Canada and the Advanced Television Test Center in Alexandria, VA, provide financing to help the labs remain open while the Alliance builds its system during the next nine months. The agreement signatures, which followed several weeks of negotiation between the two sides, gave the Advisory Committee assurance it will have indepen-

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dent facilities to test the Alliance system once its construction is complete.

"I'm confident we'll be able to get through the testing period," said ATTC Chairman Warren Williamson, who noted the two sides still will need to convert the general agreement into a final contract. The Alliance pact with the CRC — a Canadian government institute that oversees the Advanced Television Evaluation Laboratory — also awaits approval in a final form, though participants in the talks said they expect few substantial changes.

"I think our letter of intent is pretty close to what will be a final contract," said Williamson. He added the lab has been anxious to complete an agreement to ensure its ability to remain open.

Such financial concerns were bearing down on the labs this spring as they approached what was to be a second round of proponent testing. Both labs had specified the proponents would need to pay the costs of maintaining the labs beyond the planned start date for testing in the case of a delay.

Those "standby" costs — covering the period between the May testing start date and the official Technical Subgroup decision in late June to abandon a second round of competitive testing — will be paid by the Alliance as part of the general agreement. Alliance participants also will pay testing fees to both labs once they complete a prototype next year.

As the labs approached a second testing round this spring, the ATTC and ATEL estimated testing costs at $18,000 per day and $7,000 per day, respectively. Executives representing both labs said negotiators used those figures as a starting point for calculating costs for testing the Alliance system next year but ended with slightly different estimates.

"The agreement is similar, but not identical," said one participant in the talks. ATTC's Williamson noted his lab will continue to divide testing costs between the six funding members of the ATTC and the Alliance. He added, while proponent contributions to maintain the lab since its opening have amounted to less that one-quarter of the approximately $20 million price tag, contributions from the system builders will increase under the new agreement.

"It's true that it's costing us more this time," added Philips Laboratories' Basile. Basile, who participated in the negotiations, noted the ATTC will enjoy less broadcaster support than it did during the first testing round. Williamson added the lab sought to keep testing fees down during the first testing round to avoid deterring smaller competitors from participating. With the Alliance now assembled, he said, that concern no longer exists.

A four-month delay

The various conflict resolutions sealed at October's Technical Subgroup meeting did not come without a price. GI's Rast told the subgroup the decision to change the interlace format, combined with an earlier decision to include B-frames in the compression system would add time to the Alliance hardware development.

"It's a four-and-a-half month hit," Rast told the subgroup, speculating the ATTC would be able to begin its testing in mid-October of next year. The previous Advisory Committee schedule called for testing to begin in June of next year. **CT**

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Figure 4: Reed Solomon (7,5) code interleaved to depth 3

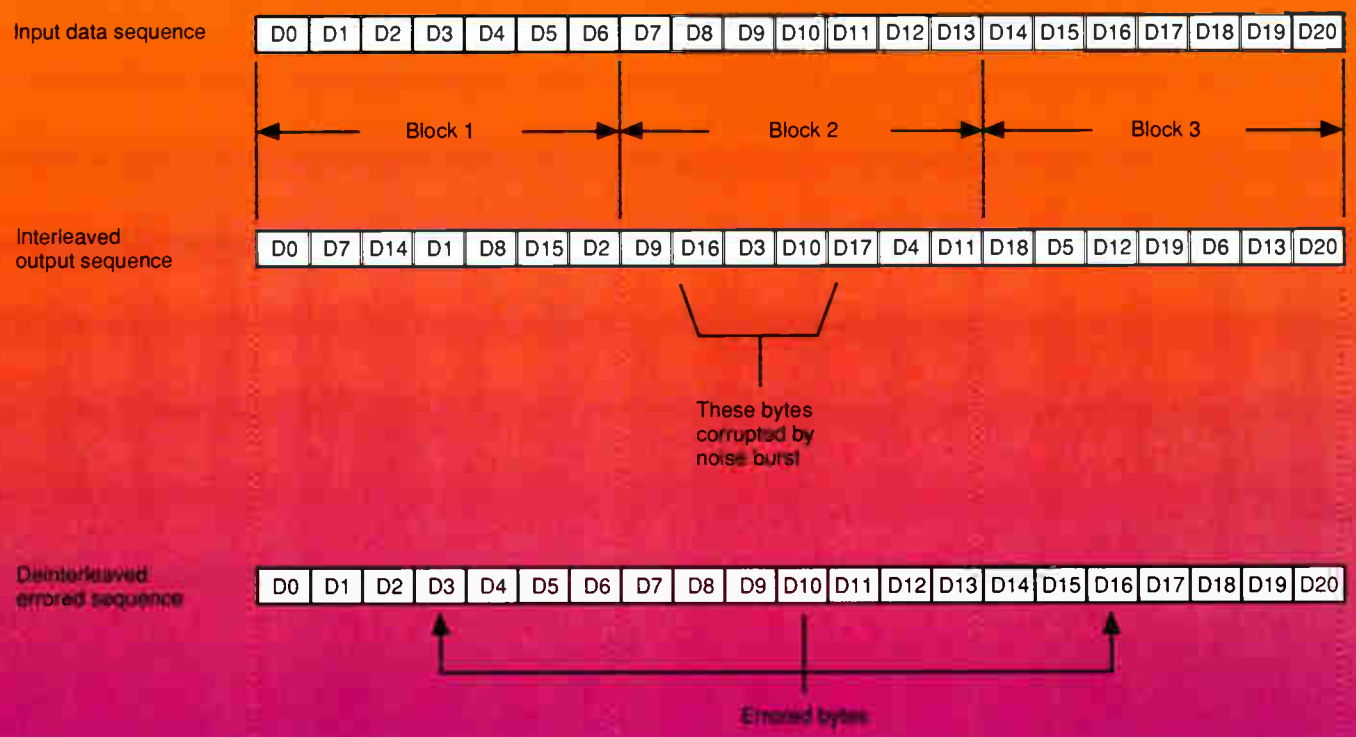
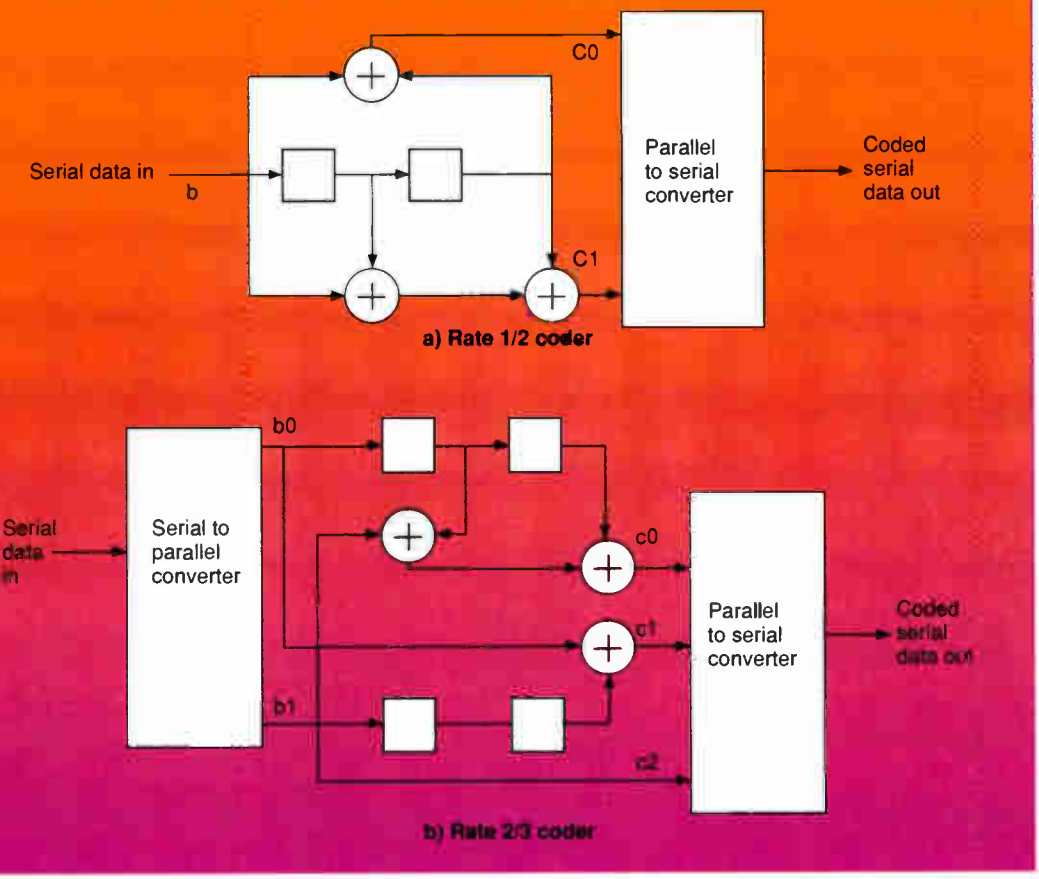


Figure 5: Examples of convolutional coders



Error correction

(Continued from page 53)

For example, the Reed Solomon (255, 223) code, which was used in the Voyager spacecraft, is capable of correcting up to 16 byte errors per block. Figure 2 (page 53) illustrates the formation of a Reed Solomon data block.

Errors in the Reed Solomon sequence are located by generating a set of bits known as a syndrome. The syndrome is obtained by re-encoding the received data bits in the receiver and using the re-encoded bits to generate a parity sequence. The regenerated parity sequence is then compared by exclusive-ORing it with the received sequence. If the result of the exclusive-OR operation is all zeroes, no errors are present. Otherwise, the nonzero syndrome bits point to those locations that are in error.

In order to provide extra protection against burst errors, the Reed Solomon data

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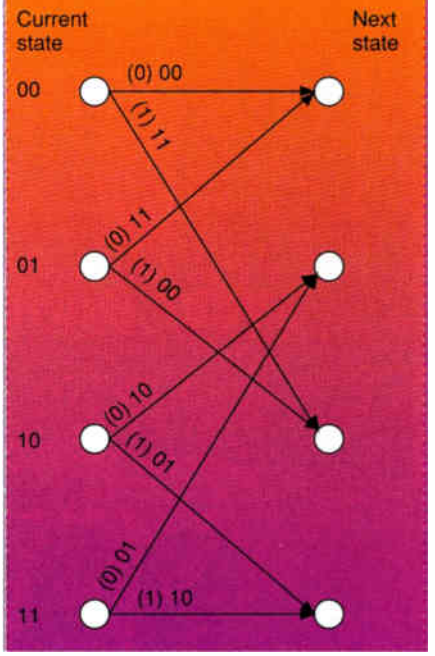
is often interleaved prior to transmission. Interleaving is performed by writing data into memory in sequence but reading it out in a different sequence such that bytes following each other in the transmitted data sequence are not from the same Reed Solomon block. If a burst error occurs, the corrupted data will be spread over several different Reed Solomon blocks, thereby facilitating error correction. The interleaving process is illustrated in Figure 3 on page 53 for the rather simple example of a (7,5) Reed Solomon code interleaved to a depth of 3 (Figure 4 on page 82).

Figure 6: Rate 1/2 coder input/output combinations

New input	Current state	Next state	Output C1	Output C0
0	0 0 X	0 0 0	0	0
1	0 0 X	1 0 0	1	1
0	0 1 X	0 0 1	1	1
1	0 1 X	1 0 1	0	0
0	1 0 X	0 1 0	1	0
1	1 0 X	1 1 0	0	1
0	1 1 X	0 1 1	0	1
1	1 1 X	1 1 1	1	0

Figure 7: Trellis diagram for rate 1/2 coder



Convolutional codes

Convolutional codes differ from block codes in that the convolutional code does not have a block structure. Instead, the n coded bits are based on k data bits plus the content of the encoder memory. Convolutional encoders are typically implemented by combinations of shift registers and exclusive-OR gates.

Two simple examples of convolutional encoding are shown in Figure 5 on page 82. The encoder in Figure 5a consists of a two-stage shift register and three exclusive-OR gates (denoted by a circled plus sign). For each bit shifted into the register, two output bits are produced. Therefore, this example is known as a rate 1/2 encoder. The example shown in Figure 5b is a rate 2/3 coder. That is, three coded bits are generated for every two information bit inputs. In general, the rate of any convolutional coder is given by the ratio of information bits to code bits. The data overhead of the convolutional coder is given by:

$$\% \text{ overhead} = 100(n/k - 1) \qquad (2)$$

Where:
k = number of information bits
n = the number of code bits

The number of memory cells in the coder is known as the constraint length. The constraint lengths of the coders in Figure 5a and 5b are two and four, respectively. A large variety of convolutional coders exist and are described in a number of texts.[3,4] In some QAM modulators that employ convolutional coding, only the lower order bits are coded and the higher order bits are transmitted as uncoded data.

Because a convolutional coder has a finite number of memory elements, only a finite number of input and output combinations are possible. The behavior of convolutional coders can be described in terms of either state or trellis diagrams. The state of an encoder is defined as the contents of the two leftmost bits of the shifted data sequence (including the input bit).

Figure 6 shows all the possible input and output combina-

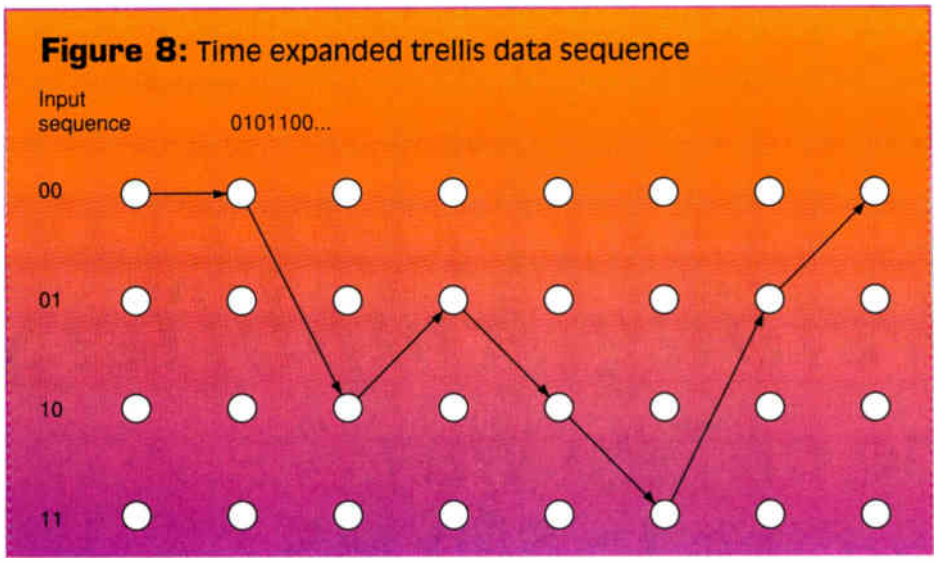


Figure 8: Time expanded trellis data sequence

tions for the rate 1/2 coder of Figure 5a. From an inspection of Figure 6, it is seen that transitions between certain states are not possible. For example, a transition from state 00 to state 11 cannot occur because shifting a 1 into state 00 causes the contents of the first shift register location to be 0 and not 1.

Figure 6 can be used to construct the so-called trellis diagram of Figure 7 (page 84), which shows all possible state transitions for both 0 and 1 inputs. In Figure 7, each state is represented by a circle and permissible transitions between states are shown by the arrows. The labels on each arrow in parentheses represent the inputs that produce the state change, and the labels without parentheses show the output resulting from a particular state change. The trellis diagram forms the basis for the Viterbi decoding algorithm.

Viterbi decoding

Viterbi decoding is best visualized in terms of a time expansion of the trellis as shown in the example in Figure 8 for the input sequence 0101100—. The Viterbi algorithm tries to find a path through the trellis that differs in the fewest bit positions from the received sequence. The algorithm does this by keeping a continually updated score, referred to as a branch metric, on each of the most likely paths through the trellis. The path having the lowest score is considered to be the correct path. Those information sequences that generate the most likely paths are known as survivor sequences. An excellent description of the Viterbi algorithm is given in Reference 5 at the end of this article.

In practice, trellis coding is generally concatenated with Reed Solomon coding because the combination of the two processes results in better coding gain.

Coding gain

Coding gain is defined as the reduction in the C/N required to achieve a particular bit error rate for coded vs. uncoded data.

The concept is illustrated in Figure 9 for a 64 QAM signal. In Figure 9, bit error rate is plotted vs. E_s/N_0. That is, energy per symbol divided by the noise power spectral density since this quantity is independent of the data rate. In the example shown, the coding gain is about 7.5 dB at a bit error rate of 10^{-9}. Coding gain must always be specified at a particular error rate. Another way of looking at the coding gain is in terms of the reduction in bit error rate that the code produces at a given C/N. For the example of Figure 9, at a C/N of 21 dB, the bit error rate will be about 2×10^{-3} for uncoded 64 QAM. This error rate will produce an unacceptable digital picture. Error correction reduces the bit error rate to 10^{-9}, which is quite acceptable since uncorrectable errors in this range can easily be handled by error concealment techniques.

Concatenation of Reed Solomon and convolutional coding provides quite good error correction since the two codes are complementary in many respects. Reed Solomon codes generally have lower coding gain than convolutional codes but are quite good for error detection and, with interleaving, are capable of correcting burst errors. Convolutional codes produce higher coding gain but perform rather poorly under burst error conditions. The use of soft decision demodulation[6] will provide additional coding gain for both single and concatenated codes.

This article has attempted to provide an overview of error correction techniques that are currently being used for digital video transmission. The reference material will provide a more rigorous mathematical treatment of the subject for those who are interested in studying it in more detail. **CT**

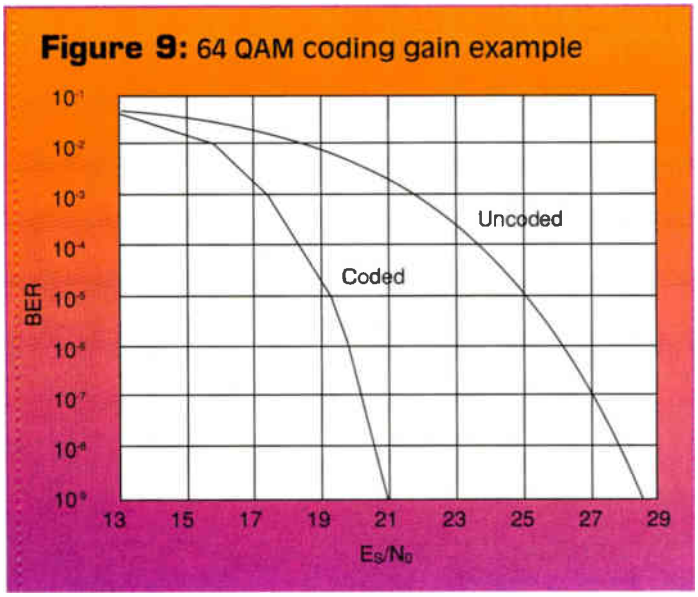


Figure 9: 64 QAM coding gain example

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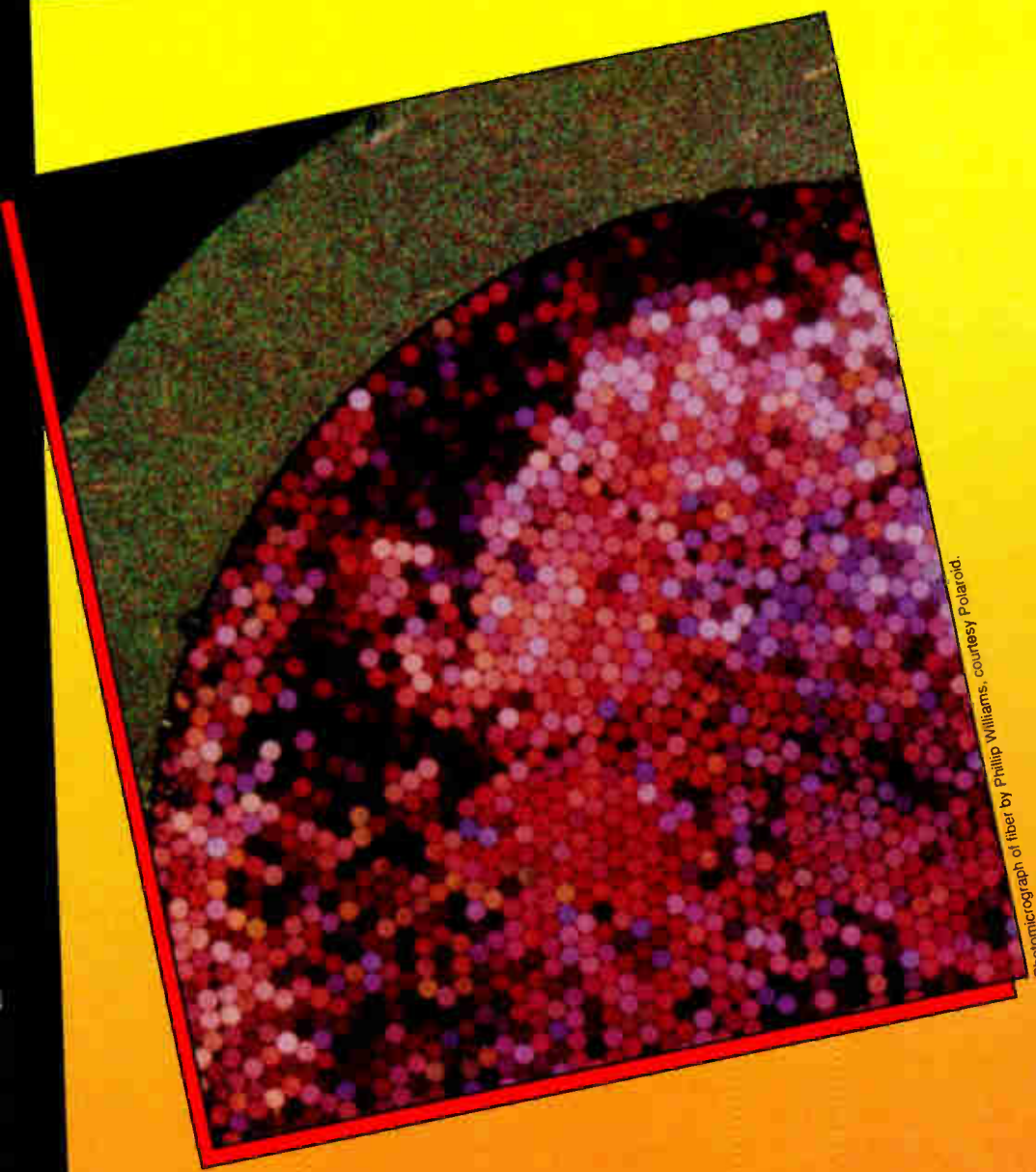

Photomicrograph of fiber by Phillip Williams, courtesy Polaroid.

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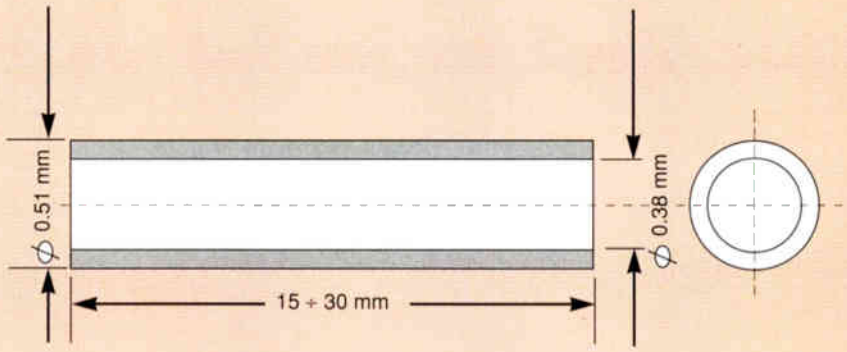
Optical fiber fusion splice protection for the trunk/feeder network

By Joyce Kilmer, Ph.D.
North American Agent
Optotec North American Agency

Figure 1: Single fiber splice protection sleeve



The decision to choose fusion splicing over mechanical splicing for the optical fiber portions of CATV networks was based primarily on the lower back reflections seen from fusion splices required for video transmission over fiber. Unlike fusion splicing where the glass fibers are actually welded together to form a continuous piece of glass, mechanical splicing relies on mechanical parts to hold the two fiber ends together in micron-dimensional alignment over the life of the splice.

The first generation of mechanical splices used glues to secure the two fibers in place. (Hence the term "glue splice.") Much development work was done to identify types of adhesives that could maintain stability after exposure to water, temperature and humidity cycling. However, with the advent of a new generation of mechanical splices that relied on mechanical parts that "gripped" the fibers to hold them in position, the glue splice fell out of favor.

Figure 2: Tool used to inject resin into protective sleeve

The "grip splice" became popular because it was easier to install in the outside plant environment. But the grip splice, like all mechanical splicing technology, requires some sort of index-matching material (e.g., a gel or a grease) to give acceptable optical loss and reflectance performance. There always has been an uncertainty about the stability of these index-matching materials over time. Consequently, fusion splicing was selected as the technology of choice for routine fiber installation and construction activities. Mechanical splicing is primarily used only for quick restoration of interrupted service. Then, at a more convenient time, the temporary mechanical splice can be removed and replaced by a permanent fusion splice.

Fusion splice protection

Fusion splicing always has been assumed to be more reliable than mechanical splicing, but that assumption is based on the fact that the fusion splice protector (or "protection sleeve") will stand up over time. Therefore, the fusion splice protectors need to be subjected to the same rigors and tested to the same degree as mechanical splices (e.g., water immersion, temperature humidity cycling, etc.). This is the rationale behind the recent issuance of a new Bellcore Generic Requirement

Figure 3: Splice loss change after recoat protection applied

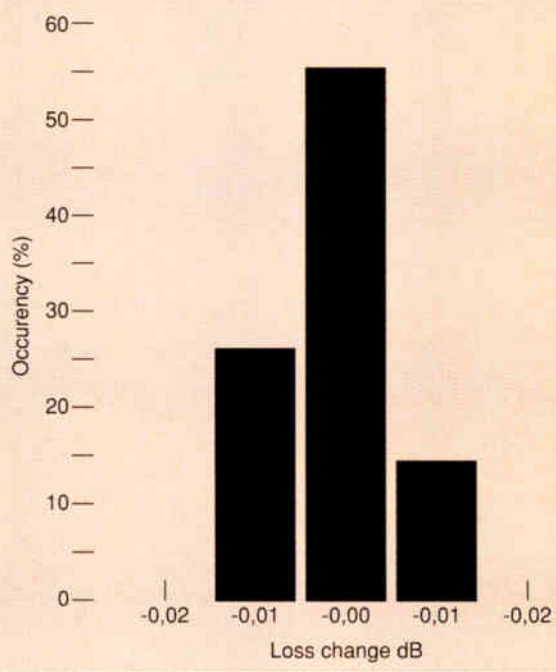


Figure 4: Weibull plots of tensile strength of single fiber

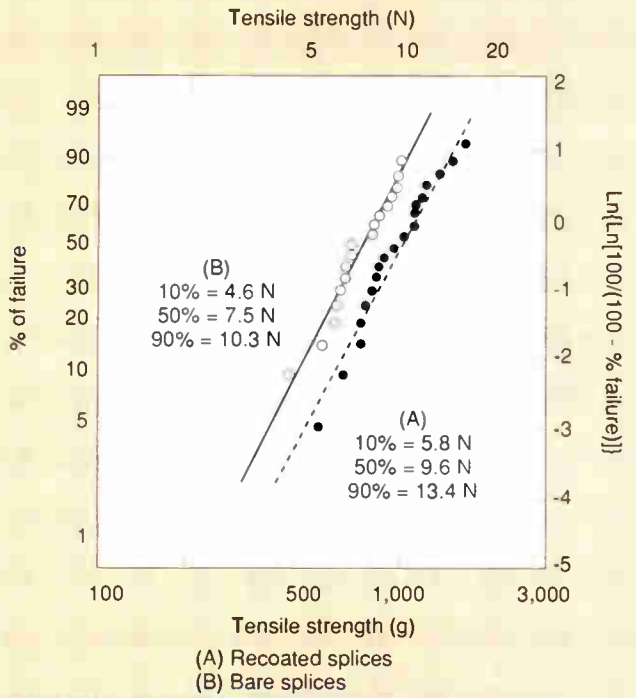
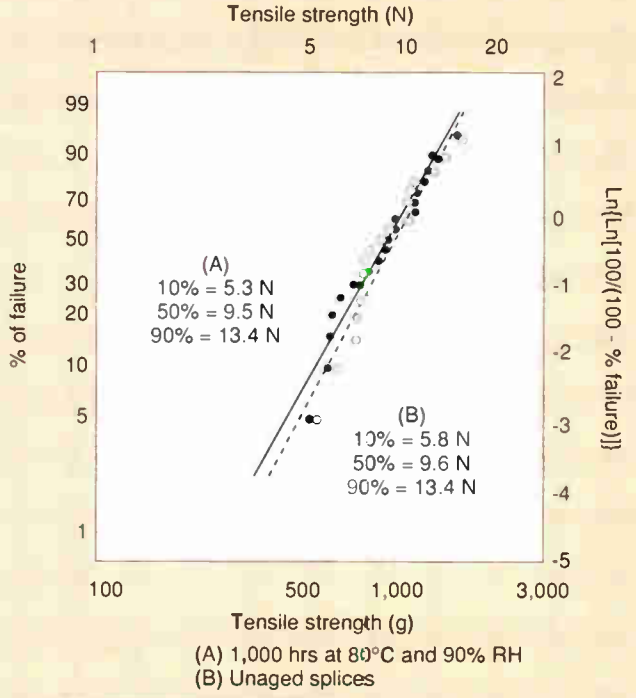


Figure 5: Effect of aging on tensile strength of single-fiber recoated fusion splices



Technical Advisory, TA-NWT-001380, Issue 1, September 1993, "Generic Requirements for Fusion Splice Protectors."

There are a number of different ways to provide protection around your fusion splice. One of the more popular employs a heat shrink plastic tube. However, quite a range of differences in the reliability of these products has been observed.[1,2]

A good way to quantify the reliability of a splice is to tensile test it. To do this, you grip both the fiber ends coming out of the splice and pull them until something happens. If you tensile test a mechanical splice, you effectively test how well the fibers are glued or gripped by the splice and a "pull-out" force is recorded. If you use this to test fusion splices you have to pull until the fiber breaks — which is typically five to 10 times more force than the mechanical splice's pull-out force. To gain information about reliability of a splice, you perform this test on splice samples that have been environmentally aged in water, in temperature/humidity cycling, or in the field.

For the case of the heat shrinkable splice protector, Hakan Yuce et al reported that some heat shrinkable splice protectors had their initial unaged median strength reduced by as much as 92% after exposure to one month in

Figure 6: Thermal cycling of single-fiber recoated fusion splices

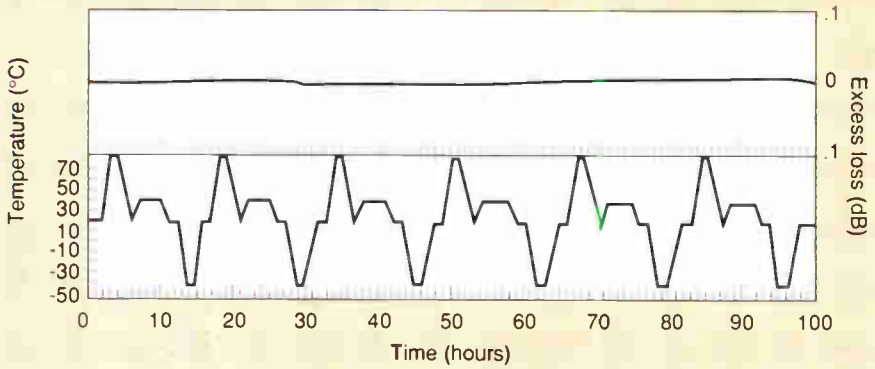
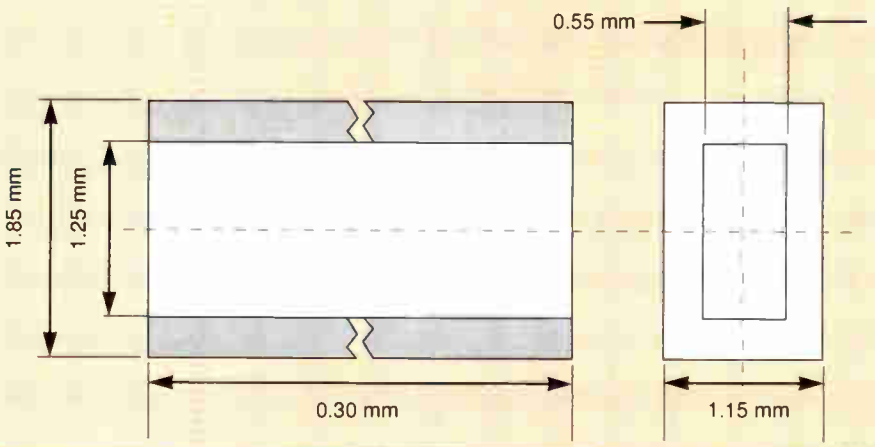


Figure 7: Multiple fiber splice protection sleeve



AEMS will identify and mark reflections that are echoes.

Another important feature of automated fiber analysis is the ability to identify multiple events too close to measure separately. On a long fiber with multiple events, some spaced close together, a single pulse width may not identify all events. Multiple pulse widths are needed. But selecting the appropriate pulse widths can be difficult, even for an experienced operator, and can leave some events undiscovered. Automatic multiple pulsewidth acquisition solves these problems by selecting the proper pulse widths (balancing dynamic range with resolution) needed to properly characterize the fiber link.

The mini-OTDR's low cost is designed to spur more widespread use throughout a system. That means the tool should find broader application in the field. And field use requires a tool that is easier and safer to transport, as well as more reliable under variable and often harsh field conditions.

Mini-OTDRs meet this challenge. They're exceptionally small and light — hand-held units, not bulky bench sets. For example, some models weigh only eight pounds, not the 25 to 45 pounds of traditional OTDRs.

Like the best notebook computers, the best mini-OTDRs feature backlit LCDs with high-quality graphics that are easy to read in the dim light of a cabinet or underground chamber, or in no light at all. Internal batteries that hold up to eight hours of power free users from the need for an AC power source. Mini-OTDRs also need to be rugged, with dust-, water- and shock-resistant cases. They should be able to withstand field temperatures from -15°C to 45°C — and accidental drops of up to 30 inches.

Because mini-OTDRs are less expensive than OTDRs, users get a higher level of price/performance benefits. They can deploy more units throughout their systems for more thorough testing, detecting more problems before they can cause costly downtime. And they can do so with lower investment in worker training and test budget.

Mini-OTDR checklist

CATV operators can gain better maintenance and system service, and do so for lower cost, by making mini-OTDRs an important part of their equipment mix. To gain these benefits, operators should consider the following mini-OTDR checklist:

- Accurate, repeatable, automated function: Does the mini-OTDR use technologies such as automated event marking software and multiple pulse width acquisition to ensure reliable, repeatable measurements from any point along the fiber?
- Clear, readable display: Does the mini-OTDR facilitate fast, accurate measurements with an easy-to-understand display? Is that display designed for use under actual field conditions?
- Ability to document and store data: For maximum productivity, your field workers will need to quickly document and store maintenance data. Will your mini-OTDR support electronic storage on floppy disks or similar media?
- Rugged: Is the tool resistant to moisture, dust, dirt and shocks?
- Extended dynamic/measurement range: Does the mini-OTDR have enough measurement range to accurately measure your longest fiber links?
- Ease of use: Powerful features won't be used if they're not easy to use. Make sure the features on your mini-OTDR pass this test. **BTB**

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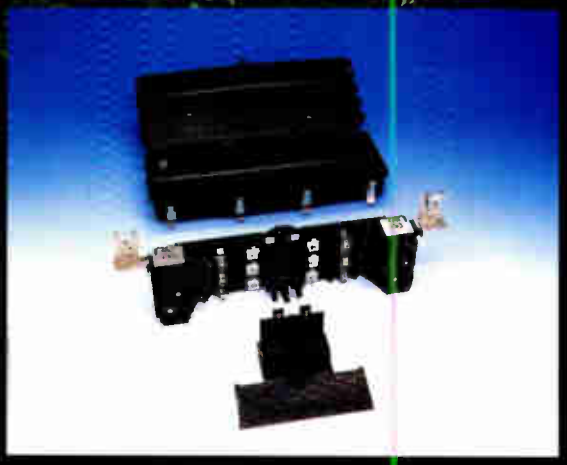

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Reader Service Number 72

It's been one of those days ...

By David Sutton
Chief Technician
TCI Cablevision of Galesburg/Monmouth

When the dispatcher came into my office and told me that one of our service technicians needed to talk to me on the radio, I knew it would be bad news. He's been a service technician for seven of his 10 years with the company, and if he couldn't figure something out it was bound to be interesting.

"Base to Unit 10."

"Dave, I need you to come to my Job Number 2. I've had a little accident."

"OK, do I need to call the police or an ambulance?"

"No, but I need the power company."

The incredible falling wrench

That's a new one, even for him. I asked the dispatcher to make the call and headed toward the job. Seems the day before he had made a temporary repair to a cut drop to a four-unit apartment building and was there to replace the drop and clean up the wiring. After tightening a fitting on the splitter, he sat the wrench on top of the power meter.

At one time the power service was overhead and had since been changed to an underground service. The electrician had temporarily covered the opening for the power riser with friction tape. Now, several years later, the tape gave way when the wrench came along.

The tech tried to make a grab for the wrench as it fell into the box. Fortunately he missed. Had he caught the wrench as it made contact with a live conductor, the results could have been disastrous.

The customer in the first apartment complained in loud, profane language about our incompetence and the fact that we had inconvenienced her.

"I don't think she likes me," the technician observed. "Maybe I should have just died in her backyard."

"I don't think that would be enough. She'd probably call the office and ask to have the next victim sent over."

We recovered the wrench, with the help of a power company service man. It is kept as a reminder that a slight misstep can lead to injury or worse.

The incompetent electrician

On my way to the headend one morning, one of our installers called me on the radio.

"I'm at my first job. I get a spark when I touch the connector to the grounding block or the trailer," she explained.

What's the big deal? This is a common problem in mobile home installs. She ought to know how to handle this.

When I pulled up, she was standing in the yard trying to keep the neighbor kids away from the house. She explained that she got a spark when she ran the drop under the fence. She had cut a connector on the end of the cable and I casually tapped it against the fence. The flash of blue light and the smell of ozone was enough to convince even me that there was a problem here. The voltage measured 108 volts between the fence and the cable sheath. I put out the fire in my eyebrows and went to talk to the customer. She obviously thought we didn't know what we were talking about, so I had to press the issue.

"You've got a big problem here. Anyone touching the trailer or fence could be electrocuted. We have to call the power company," I said. "We will be back out to hook up your cable service when your problem is fixed."

"My daughter said she got shocked but we didn't believe her," she finally admitted.

After talking to them, I discovered that a brother had just hooked up an outlet for a new dryer. He obviously got the wrong conductor hooked to ground.

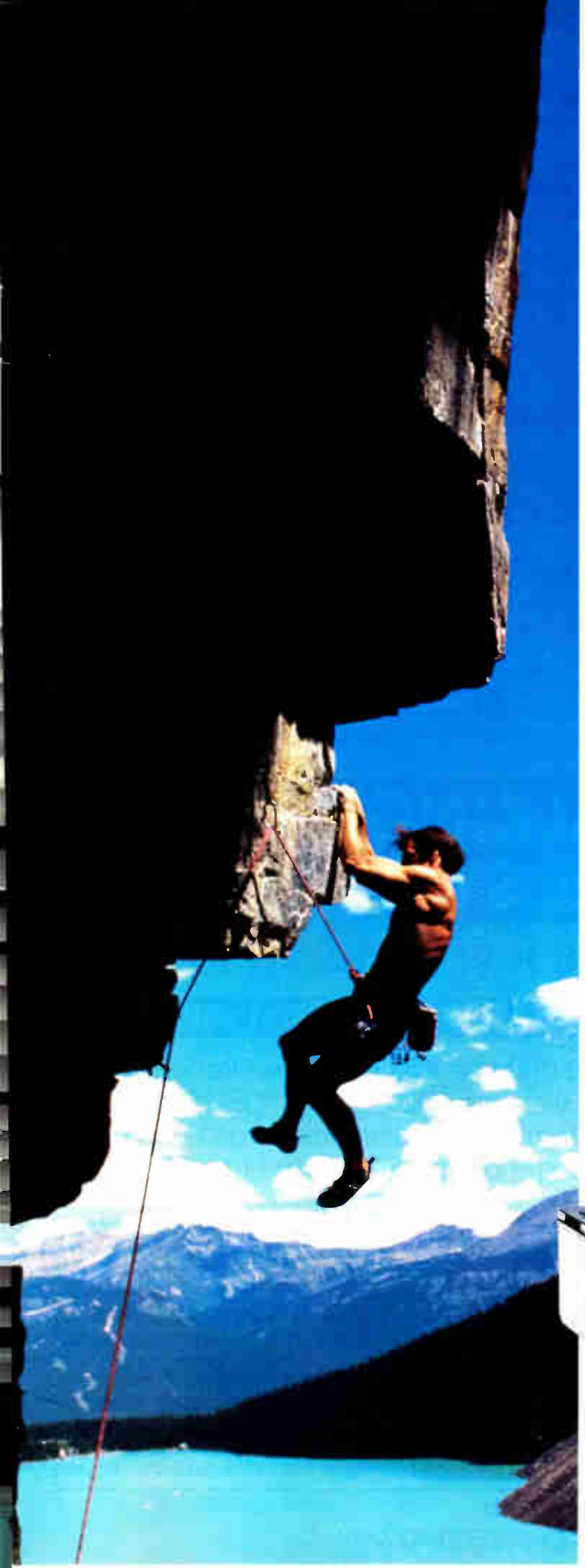
"He used to work for Acme Electric. He knows what he's doing."

Take a minute

What's the point? The things that kill or injure can come unexpectedly. Everyone knows better than to stick a wrench into an electrical cabinet that is still live, but wouldn't think twice about loosening a fitting on a grounding block that has a ground wire attached to it. Just because something is supposed to be grounded does not mean it is safe.

Take a minute to look things over. Are the grounding block, ground wire or connectors discolored as if they had been overheated? The jacket on the drop wire may show signs of melting or burning, particularly at the fittings. Look at any vegetation that touches the mobile home/metal siding. Burned leaves or branches are a good indication of trouble. If you're running a new drop, check for voltage between the sheath of the new drop and the grounding block.

I'm convinced the things that you're scared of are less likely to hurt you than the things you don't expect. **BTB**



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Reader Service Number 74

During the Annual Membership Meeting held at Cable-Tec Expo '92 in San Antonio, the national board and staff learned the importance of the development of new training programs to the membership. As a result, SCTE enlisted the services of William Grant, author of the widely recognized textbook, "Cable Television," to conduct a series of seminars to be professionally produced as video programs and made available on videotape to the members. These programs follow the textbook, and build upon it. Together with the textbook, the videotapes provide a comprehensive treatment of the basics of CATV design and operation. The tapes are available by mail order through the SCTE. The price listed is for SCTE members only. Non-members must add 20% when ordering.

☛ *Techniques of System Layout, Urban System Design and Rural System Design* — This video seminar discusses and builds upon Chapters 13, 14 and 15 in the textbook. It begins to apply much of what has been learned so far in this series, including application of splitters, directional couplers, selecting tap values and the close spacing of amplifiers. Trunk and feeder philosophy and applications are fully discussed, as well as rural single cable design and the possible integration of both techniques. (1 hr.) Order #T-1128, $45. **B-IV**

Note: The videotape is in color and available in the 1/2-inch NTSC VHS format only. It is available in stock and will be delivered approximately three weeks after receipt of order with full payment. The appearance of the symbol **B-** indicates a videotape relating to a certain category (noted by a Roman numeral I-VII) of the BCT/E Certification Program.

Shipping: Videotapes are shipped UPS. No P.O. boxes, please. SCTE pays surface shipping charges within the continental U.S. only. Orders to Canada or Mexico: Please add $5 (U.S.) for each videotape. Orders to Europe, Africa, Asia or South America: SCTE will invoice the recipient for additional air or surface shipping charges (please specify). "Rush" orders: a $15 surcharge will be collected on all such orders. The surcharge and air shipping cost can be charged to a Visa or MasterCard.

To order: All orders must be prepaid. Shipping and handling costs are included in the continental U.S. All prices are in U.S. dollars. SCTE accepts MasterCard and Visa. To qualify for SCTE member prices, a valid SCTE identification number is required, or a complete membership application with dues payment must accompany your order. Orders without full and proper payment will be returned. Send orders to: SCTE, 669 Exton Commons, Exton, PA 19341 or fax with credit card information to (215) 363-5898.

Listings of other publications and videotapes available from the SCTE are included in the March and October 1993 issues of the Society newsletter, "Interval."

CALENDAR

December

1-3: The Western Show, Anaheim Convention Center, Anaheim, CA. Contact (510) 428-2225.

1: SCTE Ark-La-Tex Chapter seminar, how fiber is made and how it works with rebuilds. Contact Randy Berry, (318) 238-1361.

1: SCTE Delaware Valley Chapter seminar, digital compression technology, BCT/E exams administered, Willow Grove, PA. Contact Louis Aurely, (215) 675-2053.

1: SCTE Smokey Mountain Chapter seminar, bench repair, sweep equipment and field testing, Days Inn, Kingsport, TN. Contact Roy Tester, (615) 878-5502.

2: SCTE Chesapeake Chapter seminar, plant maintenance, sweep and CLI, Columbia, MD. Contact Scott Shelley, (703) 358-2766.

2: SCTE Great Plains Chapter meeting, Installer and BCT/E exams administered, Courtyard Cafe, Bellevue, NE. Contact Randy Parker, (402) 292-4049.

2: SCTE New Jersey Chapter seminar, FCC revisited, Installer exams administered. Contact Linda Lotti, (908) 446-3612.

2: SCTE Upper Valley Chapter seminar, headend maintenance and FCC proof-of-performance tests, Holiday Inn, White River Junction, VT. Contact Chip Winchell, (315) 682-1446.

2: SCTE Upstate New York Chapter seminar. Contact William Grant, (716) 827-3880.

6-9: ONI Fiberworks '93 training seminar, cable TV systems, fiber-optic system training, Denver. Contact (800) FIBER ME.

8: SCTE Badger State Chapter meeting, Installer and BCT/E exams administered, Fondulac, WI. Contact Brian Revak, (608) 372-2999.

8: SCTE Miss/Lou Chapter seminar, Prime Star, Ramada Inn, Slidell, LA. Contact Gary Vidrine, (504) 295-1197.

8-9: Scientific-Atlanta training seminar, 8570/8590 System operation and maintenance (System Manager 4/5), Atlanta. Contact Bridget Lanham, (404) 903-5516.

9: Society of Cable Television Engineers Satellite Tele-Seminar Program, *Ghost Cancellation*, to be shown on Galaxy I, Transponder 14. Contact SCTE national headquarters, (215) 363-6888.

11: SCTE Rocky Mountain Chapter meeting, Installer and BCT/E exams administered. Contact Ron Upchurch, (303) 790-0386, ext. 403.

12: SCTE Ark-La-Tex Chapter seminar, how fiber is made and how it works with rebuilds, Ramada Inn, Bossier, LA. Contact Randy Berry, (318) 238-1361.

13-15: Society of Cable Television Engineers Technology for Technicians II seminar, hands-on technical training program for broadband industry technicians and system engineers, San Antonio. Contact SCTE national headquarters, (215) 363-6888.

13-16: ONI Fiberworks '93 training seminar, digital systems, digital networks training, Denver. Contact (800) FIBER ME.

14: SCTE Chattahoochee Chapter annual Christmas party. Contact Hugh McCarley, (404) 843-5517.

14: SCTE Desert Chapter seminar, construction safety and OSHA, San Gorgonio Inn, Banning, CA. Contact Greg Williams, (619) 340-1312, ext. 277.

14: SCTE New England Chapter seminar, BCT/E and Installer Certification Tutoring, Greater Media Cable, Worcester, MA. Contact Brian Bedard, (508) 853-1515.

14: SCTE Southeast Texas Chapter seminar, proof-of-performance testing, Supervision III, BCT/E and Installer exams administered, Warner Cable, Houston. Contact Rosa Rosas, (409) 646-5227.

14-15: Scientific-Atlanta training seminar, distribution, Kansas City, KS. Contact Bridget Lanham, (404) 903-5516.

14-17: Siecor fiber-optic training seminar, fiber-optic installation, splicing, maintenance and restoration for cable TV applications, Hickory, NC. Contact (800) SIECOR1, ext. 5539 or 5560.

15: SCTE Central California Chapter seminar, CATV design basics for installers and technicians, Turlock, CA. Contact Jim Robinson, (209) 835-4037.

15: SCTE San Diego Chapter seminar. Contact Kathleen Horst, (310) 532-5300, ext. 250.

16: Society of Cable Television Engineers OSHA/Safety Seminar for system managers and safety coordinators on maintaining records and developing safety training programs, San Antonio. Contact SCTE national headquarters, (215) 363-6888.

16-17: Scientific-Atlanta training seminar, headend and earth station, Kansas City, KS. Contact Bridget Lanham, (404) 903-5516.

17: SCTE Greater Chicago Chapter meeting, BCT/E exams administered, Zenith Electronics, Glenview, IL. Contact Bill Whicher, (708) 362-6110.

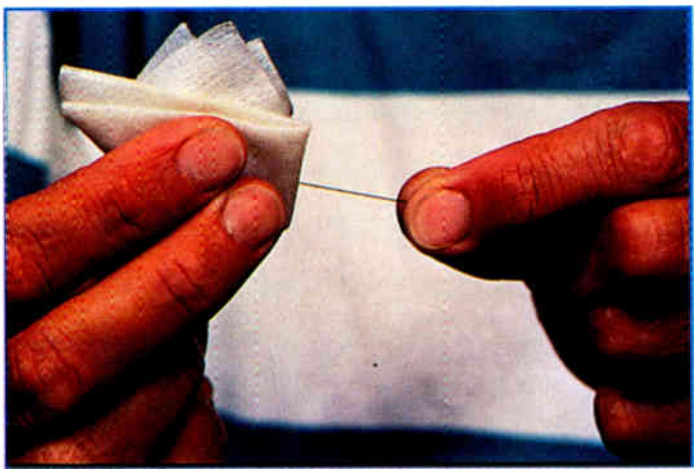
Planning ahead

Jan. 4-6: Society of Cable Television Engineers Emerging Technologies Seminar, Phoenix, AZ. Contact (215) 363-6888.

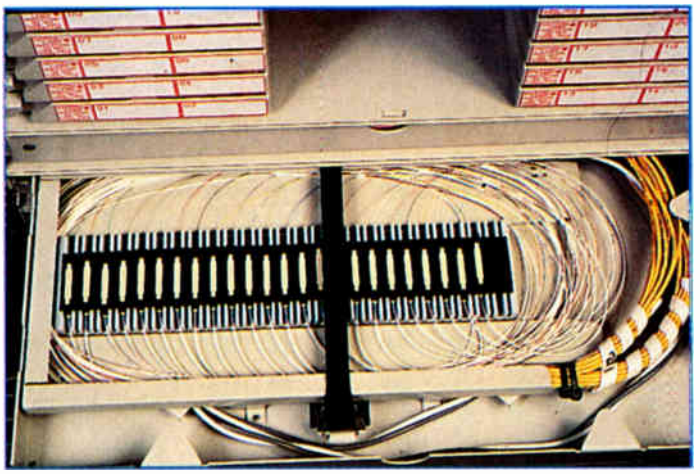
Feb. 22-24: OFC '94, San Jose, CA. Contact (202) 223-8130.

Feb. 23-25: Texas Cable Show, San Antonio. Contact (512) 474-2082.

May 2-5: Supercomm/ICC '94, New Orleans. Contact (312) 782-8597.



When you clean the fiber, use a lint-free pad soaked only with 99% pure isopropyl alcohol.



Keep the splice trays covered and sealed to protect fiber ends and avoid excess moisture, which may degrade the fiber's mechanical and handling characteristics.

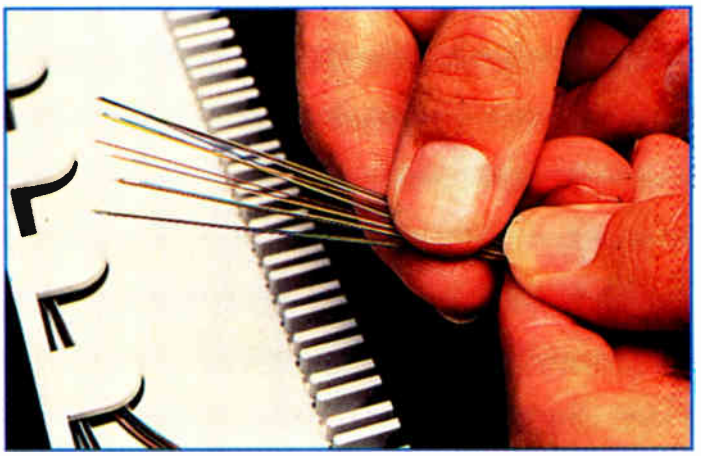
The effects of dirt, bending, water

In this month's installment, our fiber expert answers your questions about the effects of fiber handling on splicing efficiency and system reliability as well as a question on water's effect on fiber.

By Douglas E. Wolfe
Senior Applications Engineer, Corning Inc.

☛ When I'm working with optical fiber, may I touch the fiber without causing damage?

Although touching the fiber's surface may seem harmless, the dirt, moisture and oil from your fingers can make a big difference in cable TV system performance and reliability. That's why it's important to keep the fiber clean and avoid touching the glass after it has been stripped of its protective coating. Failure to clean and handle fiber properly can introduce microscopic flaws. Despite the proven strength of optical fiber, these flaws can weaken the fiber and potentially cause it to break. As in a chain, the weakest link determines the strength of the entire fiber length. The fewer the flaws, the stronger the fiber and the more reliable the system.



Although it's impossible to work with fiber and not bend it, steps should be taken to follow manufacturer's guidelines on bending.

Since fibers typically are exposed only during splicing, technicians have a great deal of impact on long-term fiber reliability. Follow these basic fiber handling guidelines to ensure reliable system performance.

• *Keep it clean.* Always keep your hands, equipment and work area clean when working with fiber. When you clean the fiber, use a lint-free pad soaked only with 99% pure isopropyl alcohol. Other grades of alcohol can leave residue on the fiber.

Also make sure your cleaving and splicing equipment is clean. A dirty

cleaver can cause mechanical damage and introduce dirt particles or contaminants to the fiber.

A dirty splicer can lead to higher splice losses and remakes, increasing your splicing costs.

• *Hands off.* Whenever possible, try not to touch the bare glass. Excessive contact can be avoided by limiting the number of stripping passes. One pass of the stripping tool should be sufficient.

Be especially careful during the cleaving process. Always cleave the fiber immediately after it has been stripped. Any dirt particles or abrasion caused by improper handling could affect splice strength and splice loss.

Also remember to be careful with the blade and clamp areas of the cleaver and minimize the number of times the clamps contact the fiber surface. Just one cleave attempt should be allowed. If there is any indication that cleaved or spliced fibers have been nicked or scratched, then start again.

• *Keep it dry.* Always make sure the fiber is dry before any handling occurs. Keep the splice trays covered and sealed to protect fiber ends and avoid excess moisture, which may degrade the fiber's mechanical and handling characteristics.

☛ Are there limits on how tightly I can bend the fiber during installation and splicing?

Although it's impossible to work with fiber and not bend it, steps should be taken to follow manufacturer's guidelines on bending. Failure to adhere to these guidelines can result in bending stress, which could reduce the lifetime of optical fiber and affect system reliability.

The recommended minimum fiber bend radius varies depending on whether you're talking about cabled or uncabled fiber.

The minimum bend radius of cabled fiber typically is of concern during cable installation and depends upon the cable design and radius. See your cable manufacturer for specific guidelines. The minimum bend radius of uncabled fiber should be no less than 1 inch. Attention to bend diameter is especially important during fiber splicing. Tighter bends could adversely impact fiber reliability.

When stripping the fiber in preparation for splicing, don't bend the fiber to get a better grip. This may exceed the maximum required bend radius.

Before you begin splicing, make sure that the fibers are neatly organized and properly coiled inside the splice tray. When closing the tray, be careful not to pinch fibers.

During splicing, keep a sufficient length of fiber in the splice tray so that you don't exceed the minimum bend requirement.

Attempting that one last splice without sufficient fiber could bend the fiber past the recommended limits, placing unnecessary stress on the fiber.

By following these guidelines, you'll achieve high-quality splices more efficiently. You'll also ensure that the fiber you install today will deliver high-capacity, reliable service to meet future cable TV system requirements.

☛ If water gets into the fiber, can it start to break down the cladding and affect the fiber performance?

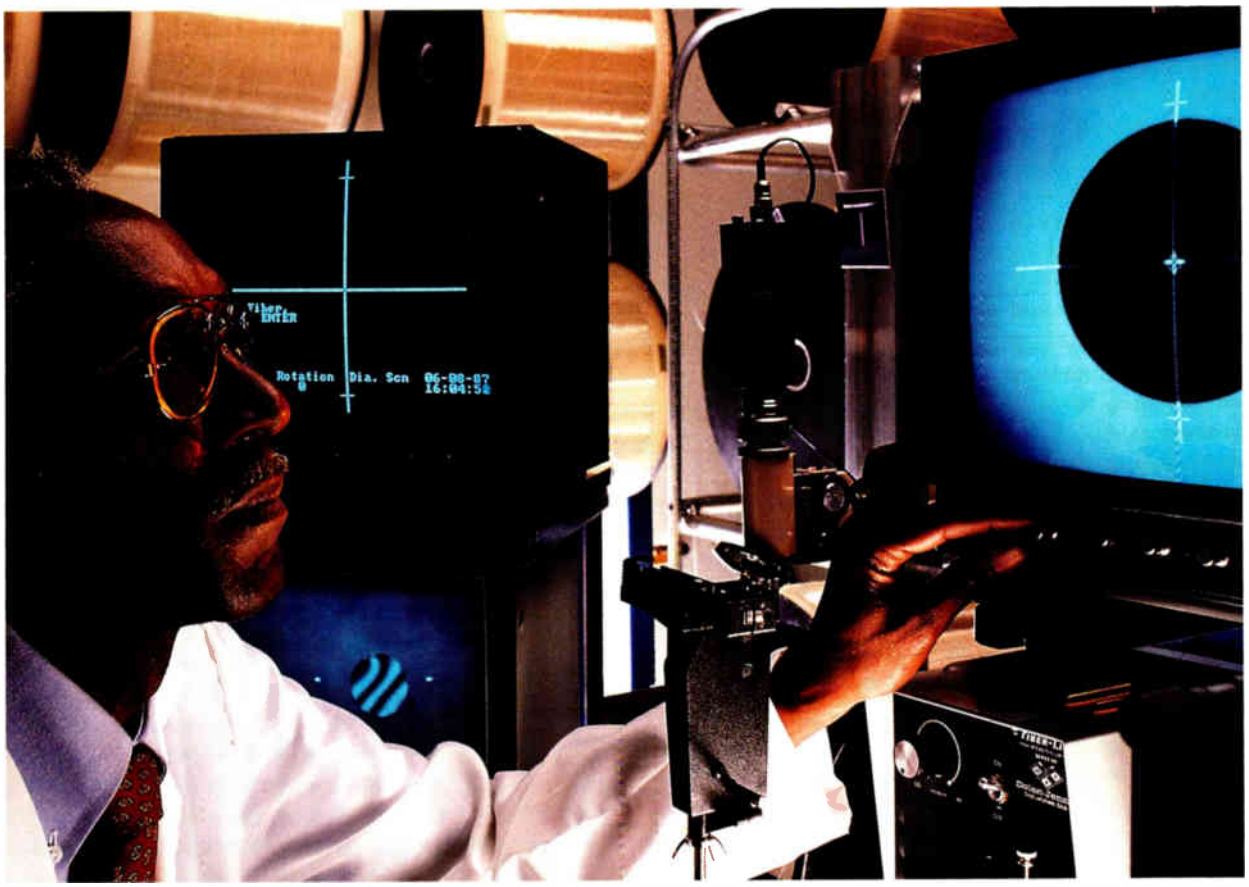
In most outside plant situations, water will have little effect on a fiber's performance. However, if fiber is under tension and in the presence of moisture, a flaw may grow, causing a fiber to break.

A fiber break requires the presence of three ingredients: moisture, tension and flaw. Without tension or stress as a factor, moisture will not cause the fiber to corrode, even if there is a flaw.

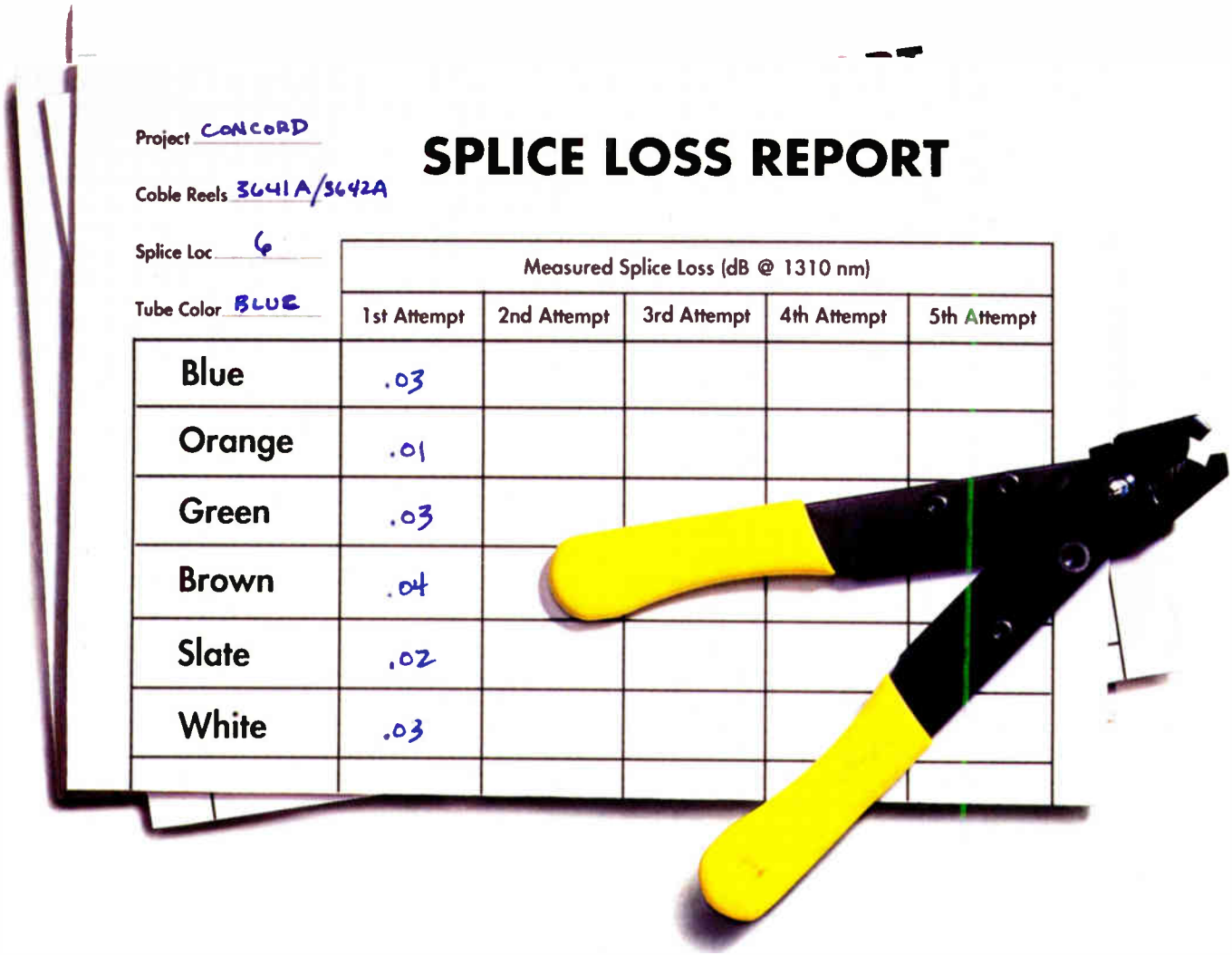
Nevertheless, it's important to seal splice cases to prevent the entry of large amounts of water, especially in climates where deep freezes occur. If a large quantity of water should freeze inside a splice enclosure, expansion forces might put stress on the fiber, leading to increased attenuation and higher splice loss.

Field experiences indicate that small amounts of water, such as atmospheric concentration, should not be a problem, provided the fiber is cabled and installed according to recommended procedures. **CT**

Questions should be directed to: Ask a Fiber Expert, c/o Communications Technology, 1900 Grant St., Suite 720, Denver, CO 80203; fax (303) 839-1564.



How we measure the consistency of our fiber.



How your splicers do.

Cable TV technicians who splice our fiber give us a consistently good report card. They tell us Corning® fiber helps them make low-loss splices — the first time, virtually every time.

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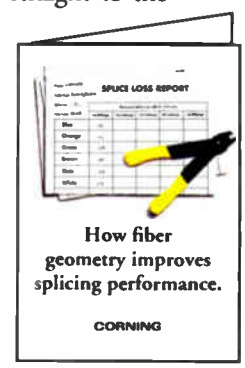
We've assembled a free kit for the cable TV industry. Just call **800-525-2524 ext.515** and ask for literature code SC529. Specify Corning. Fiber you can count on.



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21	47	73	99	125	151	177	203	229	255	281	307
22	48	74	100	126	152	178	204	230	256	282	308
23	49	75	101	127	153	179	205	231	257	283	309
24	50	76	102	128	154	180	206	232	258	284	310
25	51	77	103	129	155	181	207	233	259	285	311
26	52	78	104	130	156	182	208	234	260	286	312

A. Are you a member of the SCTE (Society of Cable Television Engineers)?
01. ___ yes
02. ___ no

B. Please check the category that best describes your firm's primary business (please check only 1):
Cable TV Systems Operations
03. ___ Independent Cable TV System
04. ___ MSO (two or more Cable TV Systems)
05. ___ Cable TV Contractor
06. ___ Cable TV Program Network
07. ___ SMATV or DBS Operator
08. ___ MDS, STV or LPTV Operator
09. ___ Microwave or Telephone Company
10. ___ Commercial TV Broadcaster
11. ___ Cable TV Component Manufacturer
12. ___ Cable TV Investor
13. ___ Financial Institution, Broker, Consultant
14. ___ Law Firm or Govt. Agency
15. ___ Program Producer or Distrib.
16. ___ Advertising Agency
17. ___ Educational TV Station, School or Library
18. ___ Other (please specify)_____

C. Please check the category that best describes your job title:
19. ___ Corporate Management
20. ___ Management
21. ___ Programming
Technical/Engineering
22. ___ Vice President
23. ___ Director
24. ___ Manager
25. ___ Engineer
26. ___ Technician
27. ___ Installer
28. ___ Sales
29. ___ Marketing
30. ___ Other (please specify)_____

D. Do you plan to rebuild/upgrade your system in:
31. ___ 6 months
32. ___ 1 year
33. ___ 2 years
34. ___ 5 years

E. In the next 12 months, what cable equipment do you plan to buy?
35. ___ Amplifiers
36. ___ Antennas
37. ___ CATV RF Distribution/ Distribution Electronics
38. ___ CATV Passive Equipment Including Cable
39. ___ Cable Tools
40. ___ Compression/Digital Equip.
41. ___ Computer Equipment
42. ___ Connectors
43. ___ Converters
44. ___ Controllers
45. ___ Descramblers
46. ___ Fiber-Optic Cable
47. ___ Fiber-Optic Electronics
48. ___ Headend Equipment
49. ___ Interactive Software
50. ___ Lightning Protection
51. ___ MMDS Transmission Equip.
52. ___ Microwave Equipment
53. ___ Other Security Equipment
54. ___ Receivers and Modulators
55. ___ Remotes
56. ___ Safety Equipment
57. ___ Satellite Equipment
58. ___ Splitters
59. ___ Subscriber/Addressable Security Equipment
60. ___ Telephone/PCS Equipment
61. ___ Power Suppls. (Batteries, etc.)
62. ___ Vehicles
63. ___ VideoCiphers
64. ___ 2-Way Radio

F. What is your annual cable equipment expenditures?
65. ___ up to $50,000
66. ___ $50,001 to $100,000
67. ___ $100,001 to $250,000
68. ___ $250,001 to $500,000
69. ___ $500,001 to $1,000,000
70. ___ over $1,000,001

G. In the next 12 months, what cable test & measurement equipment do you plan to buy?
71. ___ Fiber Optics Test
72. ___ Oscillators
73. ___ Service Monitors
74. ___ Signal Level Meters
75. ___ Spectrum Analyzers
76. ___ Sweep Tester
77. ___ CATV RF Test Equipment

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I. In the next 12 months, what cable services do you plan to buy?
84. ___ Consulting/Brokerage Services
85. ___ Contracting Services (Construction/Installation)
86. ___ Technical Services/ Engineering Design

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A new year: A new Emerging Technologies seminar

By Bill Riker
President, Society of Cable Television Engineers

The Society's national headquarters staff has been busy preparing for the 1994 Conference on Emerging Technologies (ET) to be held from Jan. 4-6 in Phoenix, AZ. Based on the work of the Program Subcommittee, we created an ET registration brochure with a southwestern flair that has been mailed to over 15,000 prospective attendees. We also have been finalizing plans for housing and reservations at the Pointe Hilton Resort on South Mountain in Phoenix, the site of this year's conference.

The Emerging Technologies Program Subcommittee, which includes Ted Hartson, Post-Newsweek Cable (chairman); Dean DeBiase, Zenith; Mike Kaus, AT&T; Harold Mackey, Times Mirror Cable; Dan Pike, Prime Cable; Rex Porter; and myself, has spent many hours scheduling speakers and topics for what we consider to be one of the most important conferences to be offered for cable engineers, system managers, manufacturers and consultants involved in broadband communications. Our second largest annual event, originally known as SCTE's Fiber-Optics Seminar, was expanded to incorporate other important technological advances impacting the cable industry. We are especially anticipating this year's conference as it will serve to be a starting point for celebrating the Society's 25th year as a leader in technical training for CATV personnel.

At the forefront of the future

Recent mergers within the cable and telephone industries have confirmed the importance of being in the forefront of future technological advances. ET '94 will serve to inform attendees of the latest developments and trends. For the second year, three optional preconference tutorials will be offered on Jan. 4, prior to the technical sessions, to give additional background information on the technologies to be discussed during the conference. Also, tours of Motorola and Gilbert manufacturing facilities will be available on a first-come, first-served basis with reservations being taken on-site during attendee registration.

The two conference days are packed with over 25 presenters. On Jan. 5, Session A, Digital Compression and Transmission Techniques will feature speakers Tom Elliot (TCI); Didier LeGall (C-Cube); Kenneth Metz (AT&T); Clive Holborow (AT&T); Geoff Roman (Jerrold); Bill Nash (TCI); Brian Bauer (Raychem); and Jack Terry (Bell Northern Research). Session B, Advances in Fiber-Optic Technology, includes the following presenters: Dan Pike (Prime Cable); Andy Paff (ONI); Charles Mogray (Comm/Scope); James Refi (AT&T); Douglas Wolfe (Corning); Mike Sparkman (ANTEC); Yaron Simler (Harmonic Lightwaves); Donald Raskin (Texscan); and Lawrence Lockwood (TeleResources).

On Jan. 6, Session C, Delivering Enhanced Services Over Advanced Networks features Dean DeBiase (Zenith); Jim Chiddix (Time Warner); Hank Kafka (AT&T); Leo Hoarty (ICTV); Michael Harney (Scientific-Atlanta); Earl Langenberg (Telewest International);. and Karl Buhl (Microsoft). Session D, "Who Are Those Guys?" features Gary Arlen (Arlen Communications) and Aleksander Futro (CableLabs).

Everyone who attends the event will receive a copy of the *Emerging Technologies 1994 Proceedings Manual*, a collection of papers presented at the conference.

In addition to the preconference tutorials and four technical sessions, luncheon each day will feature a keynote speaker, Jerrold Communications and Comm/Scope will host an Arrival Night Reception, and Corning and *CED* magazine will host a Welcome Reception. A continental breakfast will be offered on both conference days as well, with ANTEC and Scientific-Atlanta as sponsors.

An added feature at the event will be the presentation of the annual Polaris Award. This award, sponsored by Corning, *CED* and the Society, recognizes individual achievement in the deployment of optical fiber for cable TV applications.

"Recent mergers within the cable and telephone industries have confirmed the importance of being in the forefront of future technological advances."

The entire conference will take place at the Pointe Hilton Resort on South Mountain. Located at the boundary of Phoenix and Tempe, AZ, this luxury all-suite resort offers four award-winning restaurants, exercise facilities and the Pointe Riding Stables, home to more than 100 horses. The Pointe Golf Club offers professional clinics and equipment rental for those of you who are golf enthusiasts.

We believe this to be an important, valuable conference and we urge you to take advantage of the opportunity to interact with others in the industry who want to be on the cutting edge of an exciting time for our industry. For further registration information, please contact SCTE at (215) 363-6888. I hope to see you in Phoenix. **CT**

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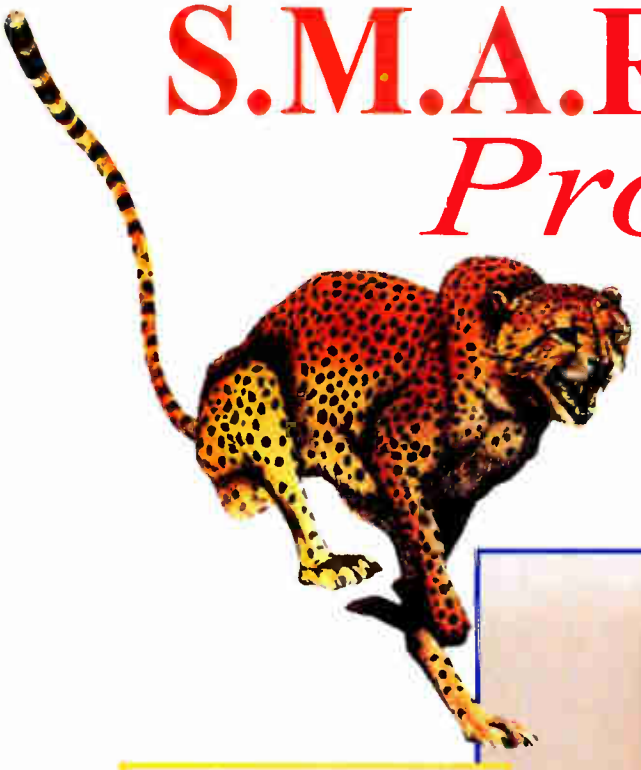

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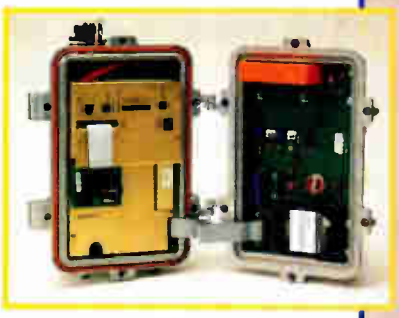

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