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Official trade journal of the Society of Cable Television Engineers

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Bandwidth: The expanding challenge

Troubleshooting tips for fiber

November 1994

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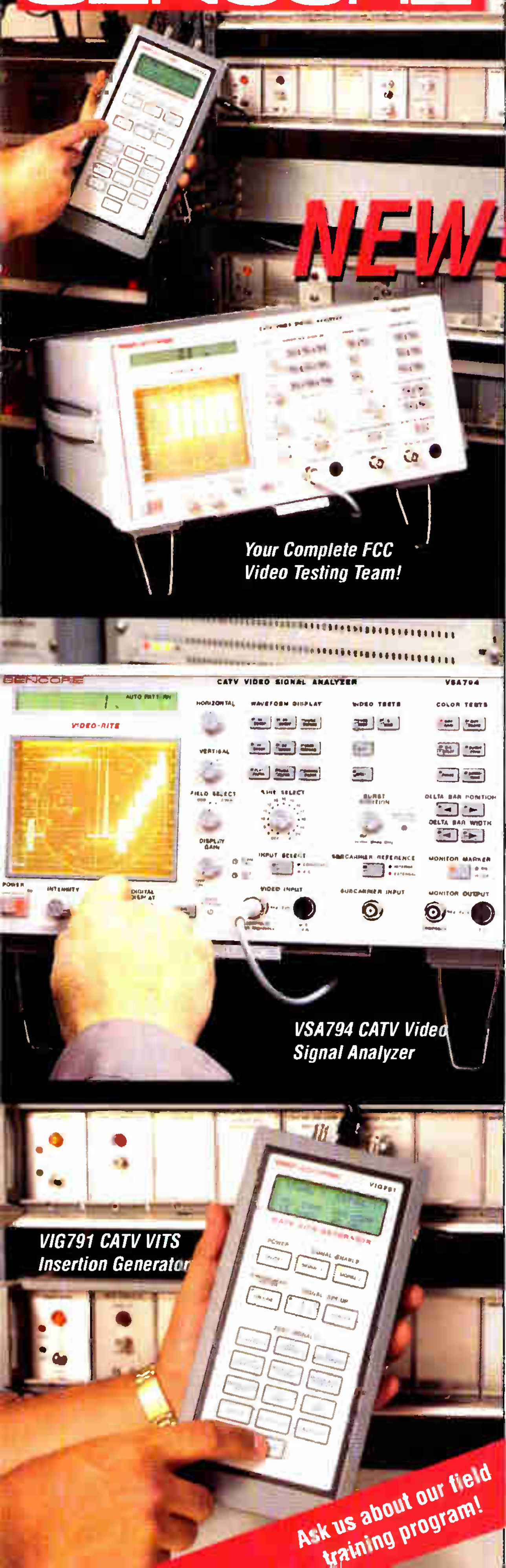

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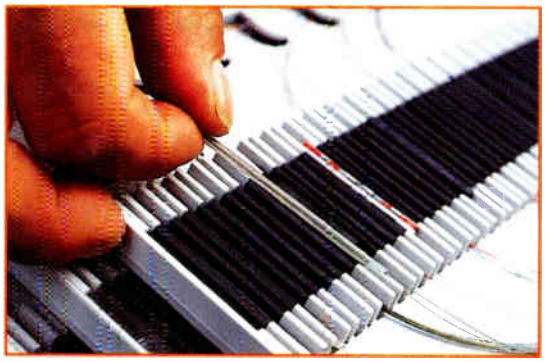
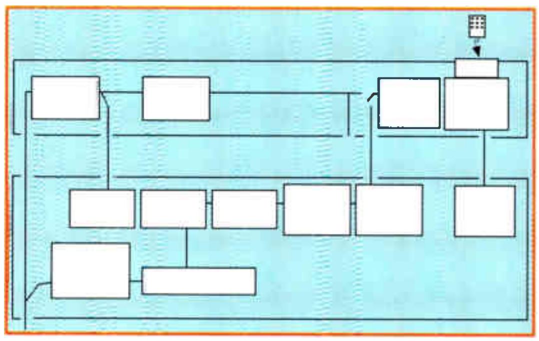
CONTENTS NOVEMBER 1994

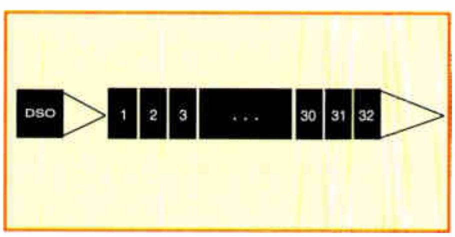
Departments



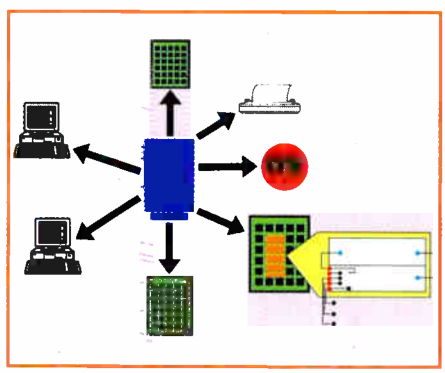
Handling fiber 48



Cable Act 20



Toward FSN 40



Fiber care and feeding 54

Features

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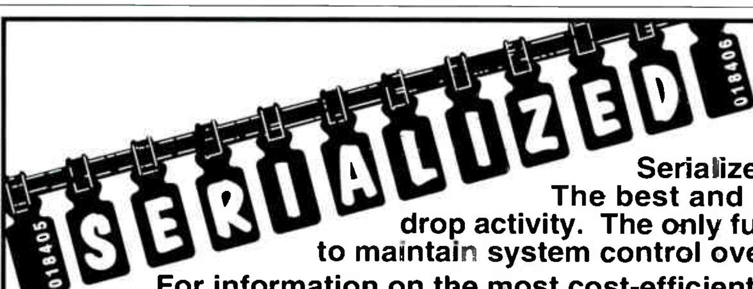
Communications Technology™ (ISSN 0884-2272) is published monthly by Phillips Business Information Inc., 1201 Seven Locks Road, Suite 300, Rockville, MD 20850. Editorial and sales offices located at 1900 Grant St., Suite 720, Denver, CO 80203, (303) 839-1565. November 1994, Volume 11, Number 9. Second class postage paid at Rockville, MD, and additional mailing offices. POSTMASTER: Send address changes to *Communications Technology*, Phillips Business Information Inc., 1201 Seven Locks Road, Suite 300, Rockville, MD 20850. Printed in U.S.A.



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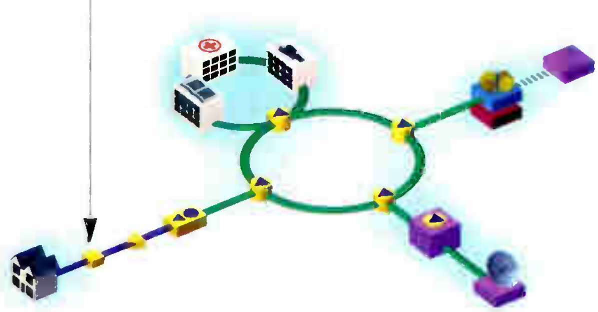

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EDITOR'S LETTER

Politics, competition, babies

Babies. I'm going to use this opportunity to brag a little. You see, I just became a grandfather for the first time. Yes, you read that right. Grandfather. On Oct. 6 at 10:24 p.m., my son David's lovely wife gave birth to a 6 pound, 9 ounce boy.

I had an odd but proud feeling as I watched my son hold his newborn son shortly after delivery. It doesn't seem all that long ago I was holding David in the hospital delivery room. Time goes by way too fast. But I'm smiling. I think I'll make a fun grandpa!

Politics. OK, back to business. Will the demise of S1822 bode well for cable? Now, telecommunications reform will have to wait at least one more year. And for at least the next year — possibly two or three — we won't be doing telephony and telcos won't be doing cable, other than in our respective trials and experiments. (Just a side note: Telcos could get into our business more easily if court challenges to federal restrictions continue to be successful.)

In other words: business as usual. Unfortunately, the derailment of S1822 also means that competitors such as DirecTv and USSB have the same amount of time to strengthen their foothold. After all, without the ability to offer alternative services such as telephony, what incentive do we have to further upgrade our networks? I'm worried that some in the industry may take a wait-and-see attitude. This would not be a good idea.

Wake up call. Speaking of competition, I installed my Digital Satellite System (DSS) equipment to receive DirecTv. The more I watch it, the more I'm convinced that this is the most serious competition we've ever faced. Consider the following:

When I called the 800 number to activate my DSS receiver/decoder, the customer service representative was pleasant and knowledgeable. Picture quality is excellent. Barring occasional digital artifacts (can't compression do better than this?), overall picture quality is as good or better than what's in most headends! No direct pickup or ingress. No composite triple beat, cross-modulation or carrier-to-noise problems. During a weekend thunderstorm with moderate rain and hail (about half an inch per hour rainfall rate), the pictures remained unaffected. Heavier rain probably will result in a brief outage, but light to moderate rain is not a problem, even with the 18-inch dish and Ku-band transmission.

The service features an excellent on-screen program guide. You can see what's on any or all channels now, or several hours from now. Pay-per-view or near video-on-demand ordering is transparent to the user. (Yes, they have NVOD today — typically 30-minute staggered starts.) Pick what you want from an on-screen menu, and the receiver/decoder dials a special number and orders the event (all in about 20 seconds). This time direct broadcast satellite is for real, folks. And it doesn't make me smile. I think I'll go visit my new grandson. That will make me smile.

Ronald J. Hranac
Senior Technical Editor

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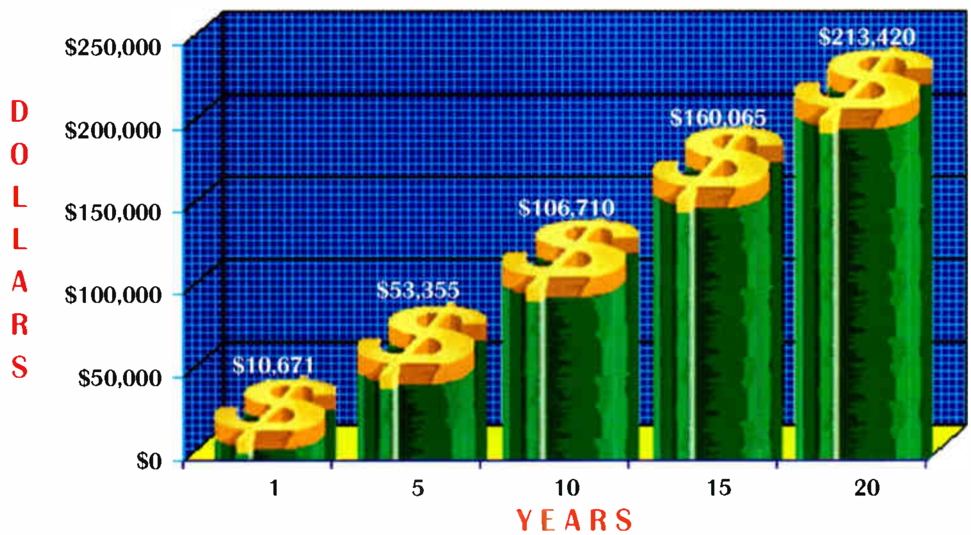

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Reader Service Number 13

National Show call for papers

The National Cable Television Association is developing a series of technical sessions and a conference proceedings text for the 1995 National Show to be held May 7-10 in Dallas. Potential authors/speakers should submit proposed material by Dec. 2, 1994. Six NCTA Engineering Committee members will judge the submission in mid-December.

Proposals should provide enough specifics to indicate premise, reference value, content and intended audience. Multiple proposals from an individual or company are allowed. No previously published texts, "vaporware" or marketing pieces will be accepted.

Proposals should be sent to: Katherine Rutkowski, Director, Technical Services, National Cable Television Association, 1724 Massachusetts Ave. NW, Washington, DC 20036; phone, (202) 775-3637.

Tek Labs teams up with telcos

Tek Labs, the research and development arm of Tektronix Inc., in partnership with Bellcore, Southwestern Bell, AT&T's Bell Labs, Rockwell International and Washington University at St. Louis, won a multimillion dollar contract to develop new fiber-optic communications network standards and equipment for the national information infrastructure (NII), or "information superhighway."

The contract, awarded by the Advanced Research Projects Agency under the terms of the federal Technology Reinvestment Program, calls for the partnership to develop products and standards that will support a new high-speed network based on synchronous optical network (SONET) and asynchronous transfer mode (ATM) standards. Under the two-phase, four-year program, the project partners will design and install an experimental three-site SONET/ATM network capable of data rates up to 10 gigabits per second (Gb/s), four times the current SONET standard of 2.5 Gb/s.

LSI Logic and H-P get interactive

LSI Logic Corp. signed a memorandum of understanding with Hewlett-Packard Co. to develop key digital audio/video decompression technology for H-P's first-generation interactive TV set-top boxes.

The digital set-top boxes will be able to provide on-screen display of program guides, customized channel selection, video-on-demand, home shopping, banking and other financial services and interactive games (including sporting events and quiz shows).

The quad-mode decompression chip incorporates both MPEG-2 and DigiCipher II video standards, and Musicam and Dolby AC-3 audio standards. It is a customized extension of the L64002, which LSI says is the industry's first single-chip MPEG-2 audio/video decoder. The company has the right to sell this customized integrated circuit as a standard product to General Instrument and Dolby licensees, which H-P says complies with its own open-architecture approach and will help it achieve its goal of interoperability.

The jointly developed chip is based on LSI Logic's CoreWare program, in which high-level, pretested building blocks or "cores," are stitched together on a chip to form a highly integrated device.

In other news, Tele-Communications Inc. placed an order for 500,000 H-P set-top boxes for use in two-way interactive communication on a cable TV system.

☛ Trilogy Communications Inc. undertook a project to expand its manufacturing facilities and increase production capacity. Over 100,000 square feet are being added to the combined Pearl and Flowood manufacturing sites, a 60% capacity increase in the air-dielectric MC^2 product line. The target completion date is December 1994.

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Reader Service Number 20

Director of Cable-Tec Games Wendell Woody (left) congratulates the Michigan team (Frank Gadberry, Adam LaRose, Mike Heinze and Tim Jurmo) as overall Games winners at this year's Great Lakes Cable Expo.

Midwest techs compete in Games

INDIANAPOLIS — Four teams of cable technicians from Illinois, Indiana, Michigan and Ohio gathered here in September at the Great Lakes Cable Expo to vie for best of the Midwest bragging rights.

The three events were fiber splicing (sponsored by AMP), test equipment (sponsored by Riser-Bond and CaLan) and signal level meters (sponsored by Wavetek and Trilithic). Phillips Business Information's *Communications Technology* provided T-shirts, medals and the overall team winner plaque.

The very close fiber splicing event finally wound up with Frank Gadberry of Michigan taking first. Steve Creech (Indiana) and Tim Jurmo (Michigan) came in second and third respectively. Jurmo won the test equipment event with second and third going to Steve Strouth (Ohio) and Frank Adams (Ohio) respectively. In the signal level meter competition, Adams took first, Mike Heinze of Michigan won second and Gadberry took third. Congratulations to the Michigan team that nabbed the overall team winner plaque. — Laura Hamilton, *Communications Technology*

Tech sessions: Great Lakes Expo

INDIANAPOLIS — The Society of Cable Television Engineers sponsored five technical sessions at the Great Lakes Cable Expo held here in September.

Wendell Woody of Sprint/North Supply kicked off the "Fiber Architectures Today" session with the simple premise that even though our industry has been hyping fiber use for several years, "We're just now getting started." Comcast's Doug MacLeod covered optical system architectures with an emphasis on larger systems' fiber use. He also took up the 1,310 nm vs. 1,550 nm debate. Bob Luff of Scientific-At-

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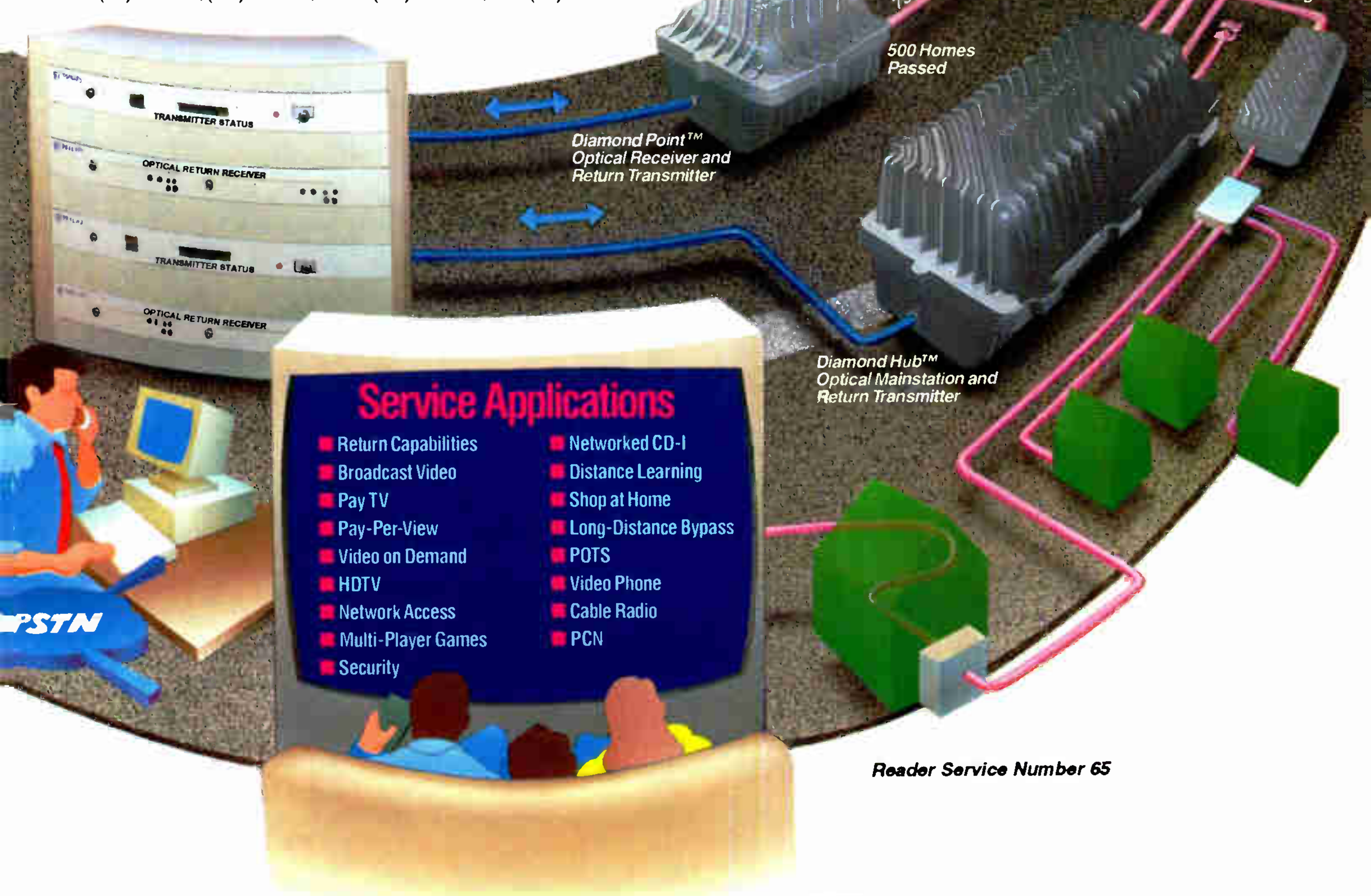

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Bob Luff, Doug MacLeod and Wendell Woody presented the "Fiber Architectures Today" technical session at the Great Lakes Cable Expo.

lanta asked "What's driving cable toward fiber architectures?" The answer is a common one in cable today: convergence, convergence, convergence.

With the Federal Communications Commission video test requirements looming less than a year away, the SCTE offered two proof-of-performance (POP) sessions at the show. A hands-on system testing workshop was run by CaLan's Jerry Green. Attendees had the opportunity to ask system-specific questions as well as take a look at CaLan's test equipment that could be used for POP purposes. Paul Raymond of Tektronix offered a general overview of the FCC testing requirements at the POP hands-on headend testing session.

"Interactive Video in CATV" was covered by General Instrument's Tony Filanowski. He focused on how set-top converters will handle such interactive services as games, contests, polls, home shopping, banking, medical information, etc.

Wrapping up the technical agenda for the confab was "The Digital World" session moderated by Jim Kuhns of Comcast. Jeff Razey of Texscan set the table for the next two speakers with a back to basics primer on digital transmission. HBO's John Vartanian took up the discussion with digital compression schemes and Tony Filanowski of GI went a step further detailing transmission formats. — Laura Hamilton, *Communications Technology*

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Commentary on conditional access

By Dan Pike
Vice President of Science and Technology
Prime Cable

Which is the better way to control signals — addressability, traps or interdiction? The question is concise, but the answer may not be. It's like asking where the best restaurant in town is located.

Until HBO launched in 1975, there was no need to control individual signals offered to the consumer. (This is the general industry case, although it is acknowledged that in the years prior to the HBO launch there were localized efforts requiring signal control, such as the Z Channel in the Los Angeles area.) For several more years only one or two premium signals were generally offered that needed to be controlled separately from the rest of the service. During this time frame, traps, addressable traps and one- or two-channel descramblers were offered to meet the needs of the industry.

Functions and requirements

It is important at this point to separate the functions and requirements of a simple converter, which had been in use in the cable industry several years before, from the devices needed to achieve conditional access of one or more premium signals. When the cable industry began to outgrow its 12-channel boundary in the late '60s, it was universally true that the consumer electronics equipment offered at the time didn't tune the frequencies that the extra channels were on. It was common for cable companies to provide a converter with every subscription.

Occasionally, programming intended to be separated was carried in the midband via "soft security" (i.e., no ability to tune) but it was quickly learned that not enough security existed there for most commercial purposes. As the need for the security of several signals or packages of signals evolved in the late '70s with the growth of the satellite networks, the two needs converged and a variety of programmable converter/decoders were offered that evolved in short time to an addressable series of converter/decoders.

"The trends shift sooner than equipment can be deployed and amortized over its useful life."

During that same time frame various improvements were made to consumer electronics equipment that allowed it to tune the different channels offered, though not always with adequate quality. This led to a variety of circumstances where converters and/or decoders were required to facilitate satellite, premium and traditional cable channels. It also must be mentioned that the regulatory climate affected those business and technological decisions then, as now, and that control over pricing generally rested with local franchise authorities for the fundamental signal package, while the premium signals were free of regulation.

After the Cable Act of 1984, rate regulation concerns no longer dominated the technical choice of equipment nor the service offerings, and companies put forth a variety of methods made up of traps (in some cases making use of those that had been in service for many years) and terminals, depending on each operating company's marketing needs, demographics and plant characteristics. During the '80s, multiple set connections grew, TV receivers that were deemed "cable-ready" were widely purchased and VCRs were bought by most cable consumers.

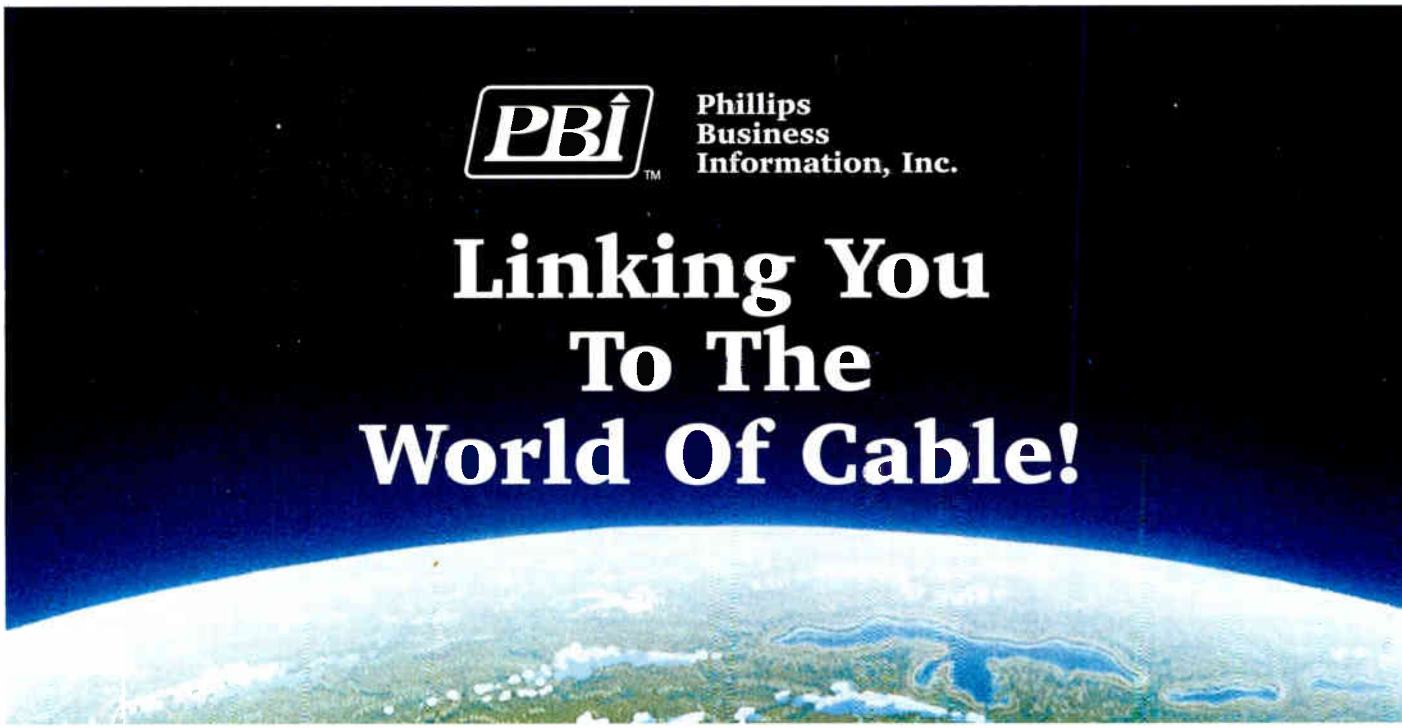
New equipment challenges

All of the solutions that were deployed made considerable technical or business sense in their day and most still do. It is common, still, to find TV sets in service that do not tune all of the cable channels or do not tune them with adequate quality, where the addition of a channel selector is an added value. As we all know, as the TV equipment became more sophisticated it became more common that the addition of a decoder made its operation more complicated or obsoleted some of its functionality. In an environment where the same solution can be beneficial in one room of the home and detrimental in another, it is most difficult to characterize the one that should be chosen.

In market research, focus groups, encounters with consumers and discussions with interested parties, there often is the expression of desire for a single simple answer and more often than not the cable service is likened to utility service such as telephone or electricity or gas (where service is metered or billed in some way by usage). These expressions come from a great many complexities faced by a modern day consumer: value points, price perceptions, disposable income, available time, personal interest, etc. They are much too complex and dynamic to map out into a technical solution that can be solved like an equation.

Moreover, the trends shift sooner than equipment can be deployed and amortized over its useful life. So if a solution would be possible, it wouldn't last. The added complexity of the regulatory changes that occur make this further complicated.

A study of the history of others is always useful in cases such as this. We find that in the early days of electric power generation, a number of experiments were conducted with flat rate service or with other pricing schemes before the metering method of today came to be popularized, and it was only popular after a number of evolutions of distribution equipment.[1] Similarly, a variety of methods were used to control telephony until the methods often quoted by subscribers of today became commonplace — of the flat rate local service and toll long distance service.[2] The time and history of both of those industries taken at the approximate maturity stages of the cable industry today shows that as they



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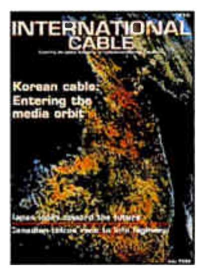

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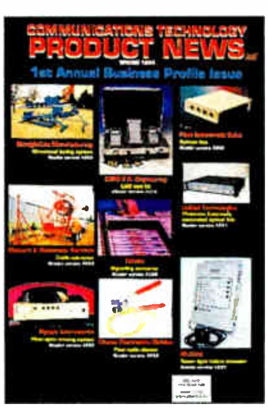

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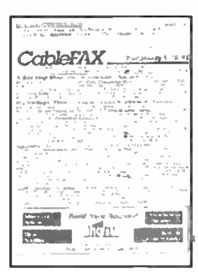

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evolved and as the service offerings were solidified and as social trends changed, a number of different methods were used. We see then that we're really not that different after all.

Regulatory factors

Today, new regulatory structures in place require fundamental unsecured service offerings, and generally favor control by a single channel or narrow groups of channels within the residence. New methodologies involve the interdiction method, and the method used in some new trials consist of a virtual circuit path set up via terminal for the individually controlled channels. (Again this is the general case, although it is recognized that some broadband control solutions have been offered that do not require terminals.) These would appear to meet a consumer request of more individual channel choice, which in various studies often shows up as the item of the greatest consumer concern next to the overall issue of pricing (and more than the issues of picture quality and equipment inconvenience).[3]

Extended bandwidth

With the multiple channel offering that comes about with extended bandwidth platforms or compressed channel service it is considered necessary by most marketing approaches to provide various instructions and navigation services toward usage of the product. This tends to disfavor the interdiction solution and, if the offering was digital, render questions about its efficacy with those signal formats.

One must seek a simultaneous solution set involving wide and disparate ages and quality of equipment in the home owned by the consumer with multiple TV sets. These TV sets are used for many hours per evening and dozens or hundreds of channel selections are made nightly. There is ever-increasing concern about costs and reliability and there is the changing regulatory and technological climates and consumer trends. (More than half the TV receivers remain in service more than a decade. There are many sets in service today that were used to watch the cable company's first HBO launch.)

No simple solution

It is little wonder that no single, simple solution has emerged. (There have been many alternate views not fully discussed here in keeping with the "general industry practice" objective of this discussion. For sake of completeness, however, we must note that one company offered a metered service and the associated hardware for it in the early control days. There have been many ideas floated involving electronic "tagging" of pictures to be read by usage, boxes with "tickets" or "debit cards," etc. Also, many ingenious solutions for multiple channel control of "boxless" apartment house service have been deployed involving "wall box" hardware. For a short time, strand-mounted converters were thought to offer advantages, and as far back as the "Rules Thaw," ideas were advanced involving switched service. Though ideas have abounded, practical solutions have not.)

"Which is the best way to control signals ... Where is the best restaurant in town? The answer for both has to be conditional. It depends on your timing, your appetite, your budget and your preference."

Each choice involves serious considerations on marketing, packaging and pricing, customer service requirements, billing and control systems, the fundamental transportation and decoder investments and technology. It is not a question to be asked and answered simply in the realm of a technical journal but rather can only be answered after lengthy consideration of all the involved areas of the company.

So we return to the original question of which is the best way to control signals, and the original analogy of where is the best restaurant in town? The answer for both has to be conditional. It depends on your timing, your appetite, your budget and your preference. **CT**

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[1]Nye, David E., 1991, *Electrifying America: Social meanings of a new technology, 1880-1940,* Cambridge, MA, MIT Press.

[2]Fischer, Claude S., 1992, *America calling: A social history of the telephone to 1940,* Berkeley, CA, University of California Press.

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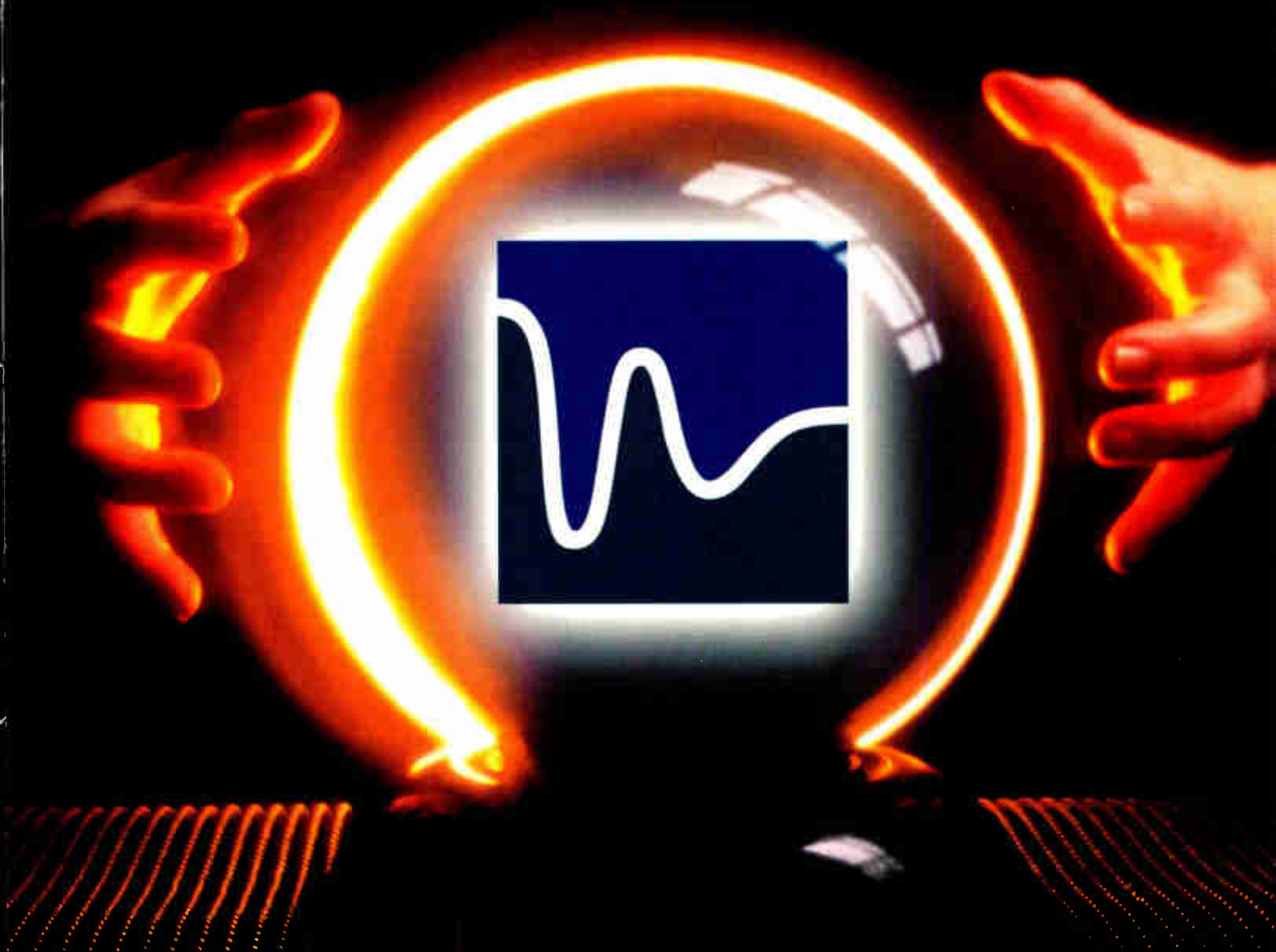

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Reader Service Number 26

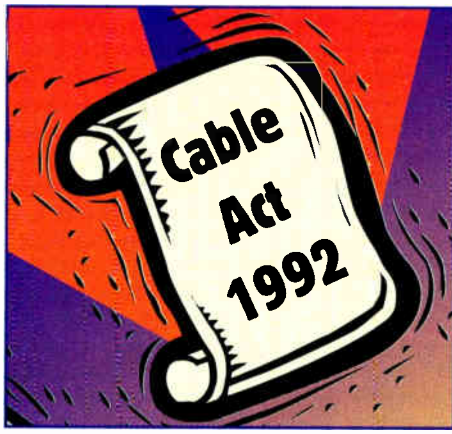
New video services and the Cable Act of 1992

By David Large
Principal, Media Connections Group

The evolution from traditional "tree-and-branch" to hybrid fiber/coax (HFC) networks has been driven primarily by the need to increase system bandwidth while maintaining noise and distortion levels. The hundredfold difference in loss of fiber-optic cable compared with coaxial cable has allowed signals to reach distant parts of networks without requiring long cascades of linear amplifiers.

The capabilities of HFC networks, dramatic advancements in the art of digital compression, efficient modulation schemes and equally dramatic lowering of the costs of computers and various forms of digital memory have all combined to create many new options for cable operators.

Simultaneously, however, the Federal Communications Commission, in enacting regulations mandated by the Cable Act of 1992, has placed many constraints on those options and is considering additional regulations.



Renée Peterson

Limitations of coaxial networks

In order to meet customers' expectations for video quality and the FCC's minimum performance levels, cable systems must provide very quiet, distortion-free channels. To ensure meeting those requirements under all conditions, including the contribution of headend and set-top equipment, operators typically design distribution networks for approximately 48 dB carrier-to-noise ratio and 53 dB carrier to composite second- or third-order distortion levels.

Demands for ever-increasing bandwidth to support new services led amplifier vendors to provide 450 MHz, then 550 MHz and now 750 MHz equipment. A number of factors, however, limit the ability to expand bandwidth in a purely coaxial distribution system, given a constant end-user quality requirement. These include:

- Coaxial cable losses increase with frequency, forcing closer amplifier spacing.
- Amplifier distortion increases with the number of channels carried and operating level.
- Distortion and noise both increase logarithmically with the number of amplifiers cascaded.

Thus, bandwidth, noise, distortion, power consumption and size may be traded, but an increase in one mandates a decrease in another. Furthermore, economic limits have been reached in parameters such as noise figure, amplifier output power and coaxial cable loss.

Fiber to the rescue

The rapid pace of development of linear fiber-optic transmitters and receivers along with the equally rapid decline in the cost of both active components and cable has led to the nearly universal adoption of hybrid fiber/coax architectures.

Although HFC networks come in many flavors, each with its own mnemonic, all have the property that the coaxial network is divided into small sections, typically passing 500-2,000 homes (one "serving area"). Each serving area is fed from a dedicated fiber-optic cable and optical receiver ("node"). In the simplest version, each cable emanates directly from a headend. In more complex versions, the headend may actually be a master node on a larger network and there may be another level of nodes between the headend and the coaxial plant sections.

In HFC networks, the cascade of active devices between the optical receiver and subscriber is typically less than 10, with some architectures totally passive beyond the node amplifier itself. Even when the noise and distortion of the fiber-optic link is included, it is possible to realize the required end-of-line performance with an upper bandwidth limit of 750-1,000 MHz.

The combination of wider forward bandwidth and small, independently fed sections of plant has led to two service-enabling consequences:

1) The relatively small size of the plant in each serving area, limited number of termination points, and limited number of active devices has made two-way operation practical. In fact, it is gen-

Figure 1: Analog decoder connected to analog TV receiver

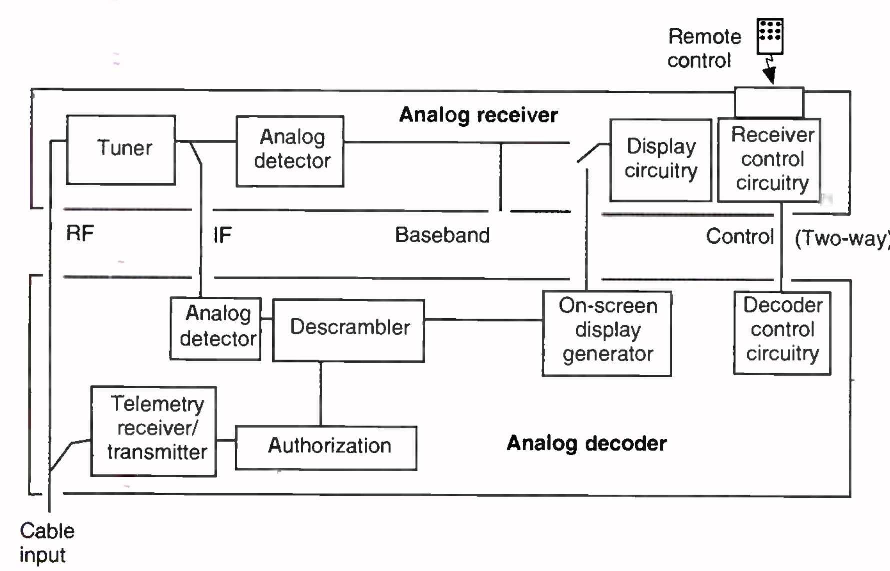


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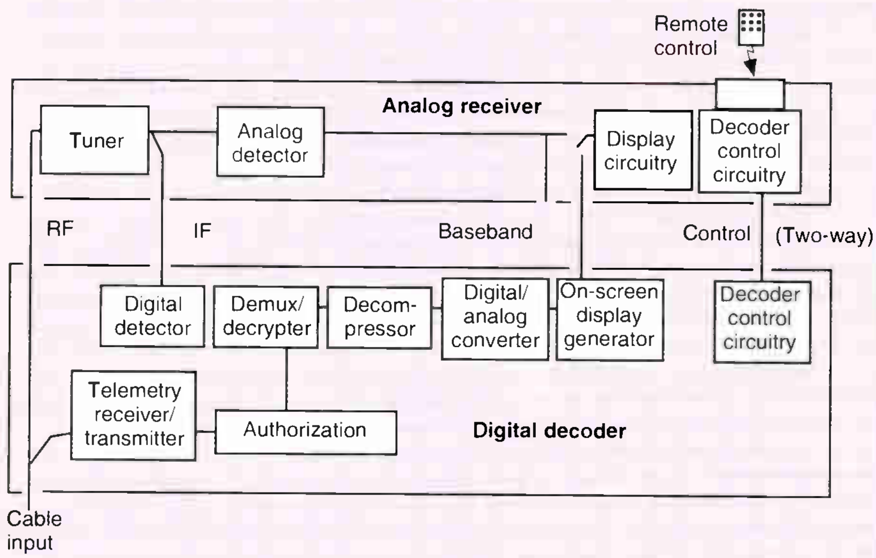
Figure 2: Digital decoder connected to analog TV receiver



erally possible to increase the upper frequency of the return spectrum to about 41 MHz, from the previous standard of 30 MHz.

2) It is possible to configure at least a part of the bandwidth in each direction for exclusive use by individual subscribers on a demand basis. Thus the network can be evaluated on the basis of bandwidth per customer, rather than just raw bandwidth.

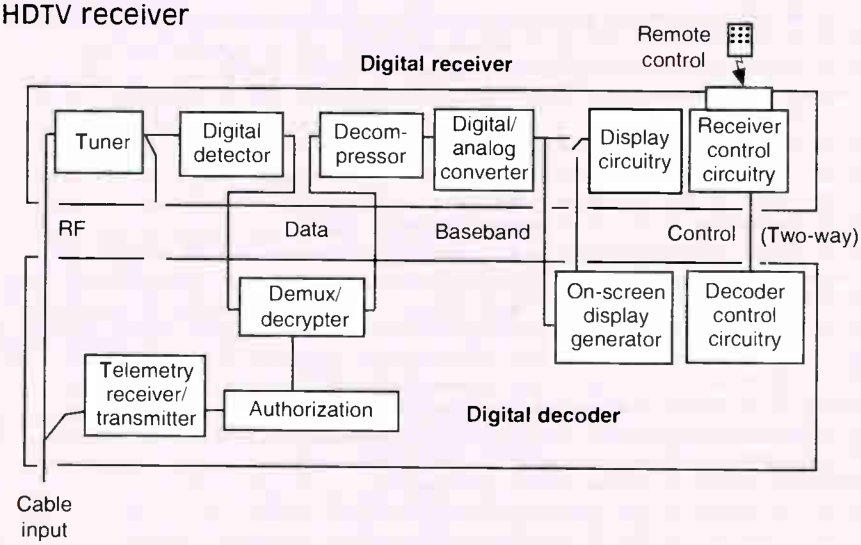
Digital video compression

Equal in importance to network evolution is the development of aggressive digital compression of video signals, combined with bandwidth-efficient digital modulation of RF carriers.

Two similar, but competing, compression schemes have emerged — MPEG-2 and General Instrument's DigiCipher. The first is a hierarchical standard being developed by the Moving Picture Experts Group, an international technical organization, and the second is a similar (but proprietary) standard developed by General Instrument Corp.

The Advisory Committee on Advanced Television Service, charged with recommending a standard for advanced (high definition TV — HDTV) in the United States, along with the "Grand Alliance" of proponents, has embraced a profile of MPEG-2 for compression after many years of wrangling with the issue.

Figure 3: Second-generation digital decoder connected to HDTV receiver



Both MPEG-2 and DigiCipher work by: a) removing redundant picture elements; b) motion prediction; and c) very efficient code generating algorithms. While digitized, uncompressed NTSC TV requires a data rate of about 100 Mb/s, acceptable quality encoded pictures have been reduced to 3-6 Mb/s.

Bandwidth-efficient digital modulation

At the same time, modulation schemes have been developed that take advantage of the quiet communication channels created by cable systems to accommodate analog TV signals.

As with the encoding schemes, two competing, but similar modulation methods have been developed, vestigial sideband (VSB) and quadrature amplitude modulation (QAM). As with MPEG, either of these are scalable, depending on the quality of the available communications path. A detailed discussion of the relative merits of QAM and VSB is beyond the scope of this article.

After extensive testing, the Advanced Television Consortium selected 8 VSB for over-the-air transmission of HDTV, providing a data rate of about 20 Mb/s in the same 6 MHz bandwidth used for standard NTSC TV. It is anticipated that cable systems may utilize 16 VSB for HDTV transmission, providing a 43 Mb/s data rate and thereby allowing two programs to share a single channel.

While there is no standard for transmission of digitally compressed, standard resolution TV, virtually all publicly announced orders for descramblers use the General Instrument system that employs 64 QAM or 256 QAM, depending on channel quality. These allow data rates of up to 43 Mb/s, so that six-10 or more NTSC programs can share one 6 MHz channel.

It is expected that systems will begin to deploy this technology in late 1994 or early 1995. The implications for delivery of video services are immense. It is theoretically possible for a 750 MHz system to deliver approximately 1,000 programs simultaneously to subscribers. If each 500-home serving area in an HFC system were independently programmed (technically feasible with a separate fiber cable to each optical receiver), it would be possible to offer each household two private channels downstream. Additionally, with a penetration rate of 80% and a 5-40 MHz return bandwidth, each customer could be allotted (on average) 88 kHz return bandwidth in such a sys-

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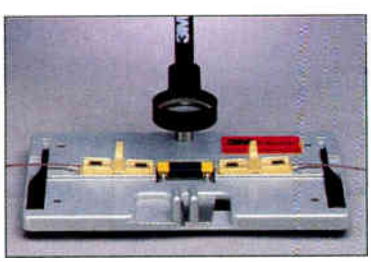

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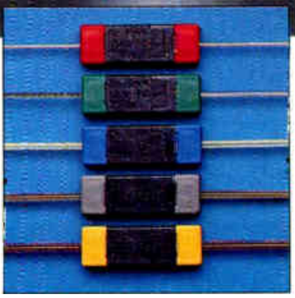

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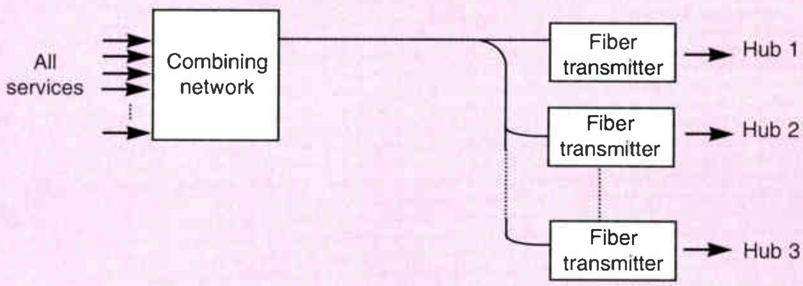
Figure 4: Nonswitched cable headend



tem. While such a use of the technology is unlikely, it is illustrative of the possibilities.

Advances in digital storage and playback

The third relevant technology evolution is in the cost of digital storage and retrieval. Early experiments in interactive video and video-on-demand (VOD) relied on analog videotape storage and playback machines. These are limited to a single user per tape, so that multiple showings of a single film required separate machines, with high capital and maintenance costs.

With video compressed to 3 Mb/s, an entire two-hour movie requires a storage capacity of only 2.7 GB. If the source movie is film with a frame rate of only 24 frames/sec, the storage drops to around 2 GB. The cost of disk drives has dropped to approximately 50 cents/MB, so an entire movie can be stored on one or two drives for about $1,000. Furthermore, the speed of access is such that several users can simultaneously access the stored movie with different, nonsynchronized play times.

Specialized computers are being developed to manage banks of disk drives and archival tape storage so as to create many independent video data streams simultaneously.

New video-related services

Combined with high effective bandwidth per customer, digital storage and retrieval make possible interactive, customer-configured video offerings.

Many new services will be nonvideo-oriented, such as wired or PCS telephony, packet communication, etc. Among video services, the major growth will be in transactional services of many types, including VOD, near-VOD (NVOD), video want ads, interactive shopping, information retrieval, etc.

Along with the wider choice of entertainment services will be tools for selecting and ordering programming. Already being introduced are set-top boxes and companion software that allow directed searches among available program categories, with single-button instant tuning access or recording of selections. With two-way cable systems, ordering of transactional services, such as VOD or NVOD is equally simple, requiring only the entry of a security code after the selection is made.

Cable Act of 1992

The Cable Act of 1992 is the most comprehensive cable TV legislation ever enacted. It touches on nearly every aspect of operations: rate control; programming; access to both programming and the distribution system; required carriage of broadcast stations; sales of systems; obscenity; franchising; and the interface between cable systems and customers' TV equipment.

The act required the FCC to hold 24 separate rule making proceedings to determine the necessary regulations. Several of these are still incomplete or have led the FCC to determine that future rule makings will be required. As expected, several of those that are complete are being challenged in the courts.

Cable participated in these rule makings through its participation in the Cable/Consumer Electronics Compatibility Advisory Group (C3AG) and the National Cable Television Association/Electronic Industries Association Joint Engineering Committee (JEC), as well as numerous filings made by both manufacturers and operators.

In the customer interface area, the act required the FCC to deal with: incompatibility problems caused by the presence of set-top converters; availability of converters and remote controls

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from third-party suppliers; channel positioning; ownership of in-house wiring; fees for converters and remote controls; and program scrambling. Perhaps most importantly, the legislation requires the FCC to maintain an oversight over technology developments to prevent future incompatibilities.

Enacted regulations

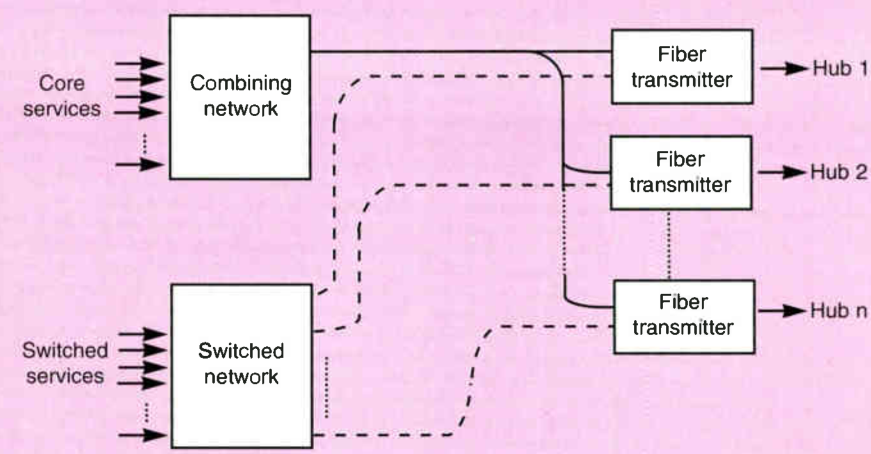
In response to the customer interface provisions of the act, the FCC has promulgated a number of rules. While a comprehensive review is beyond the scope of this article, several of them directly affect the choices a cable operator may make in offering new services. It should be emphasized that these rules currently apply only to franchised cable operators. Their extension to other video service providers has been suggested but so far rejected by the FCC.

Key regulations affecting future service options are as follows:

• *Basic service:* All operators must offer a basic service consisting of local broadcast stations and mandated public, educational and governmental access channels. This service must be analog and unscrambled and broadcasters are given the choice of channel position, within certain constraints. Subscription to this service is required as a precursor to ordering any optional services.

• *Set-top converters:* The FCC affirmed cable operator's rights to scramble programming to protect intellectual property rights, but required cable operators to allow subscribers to use third-party remote controls and nondescrambling converters. In order to alleviate incompatibility problems (such as simultaneous recording and viewing of different channels) with the existing base of converters and customer-owned receivers, operators must furnish, on request, various bypass switch and/or dual tuner configurations to subscribers.

Figure 5: Hybrid switched/nonswitched cable headend



The FCC has a strong preference for solutions, such as traps or interdiction, in which all subscribed programming is delivered to TV sets simultaneously in nonscrambled format (so-called "clear signal" solutions) and therefore do not require a set-top box at all. Unfortunately, digital signals that time-share a single RF channel cannot be economically controlled by any available "clear signal" technology.

Prices operators may charge for leased in-home equipment, both converters and remotes, are now regulated so as to provide a limited rate of return on the capital investment. On the other hand, current rate regulations do not allow operators to charge for equipment that is connected to the plant (such as strand-mounted interdiction, for instance), which creates a disincentive for use of anything mounted outside the home.

• *"Cable-ready" receivers:* As a companion to requirements encouraging technologies that allow direct connection to customers' receivers, the FCC enacted rules designed to ensure that equipment marketed as "cable-ready" will, in fact, work in that environment. At the suggestion of the C3AG and the JEC, those receivers will have two sets of requirements. First, their tuners will be adequately specified for the expected signal conditions and, second, a post-tuner

jack will be provided so that descrambling can take place without inhibiting receivers' other features. The tuner requirements have been enacted while the "decoder interface" connector is still under consideration and is discussed later.

Over the protests of many cable operators, the FCC declined to extend the tuner performance requirements to all receivers that tune the cable channels, though it did agree to at least require labeling of nonconforming, extended tuning range equipment.

"Video service providers should be mindful of the vagaries that will be introduced by the FCC when it chooses a digital transmission standard in light of the competing interests."

Pending regulations

As noted before, programming provided on the mandatory basic service tier may not be scrambled. The FCC will in the future decide whether programming on optional tiers may be scrambled. This could affect the ability of operators to, for instance, convert all such programming to digital form for delivery to the home.

The FCC regards the decoder interface as key to allowing a migration away from set-top descramblers. By providing a loop-out after the receiver's tuner (Figure 1 on page 20), such features as timed, multichannel recording in VCRs and independent channel selection for recording and viewing can be preserved. The FCC is depending on guidance from the Decoder Interface Subcommittee of the JEC in defining this interface and has strongly suggested that membership of that group be expanded to include other potential multichannel video providers such as telcos and direct broadcast satellite (DBS) operators.

A major focus of the FCC's attention is on preventing future incompatibilities arising from the introduction of digitally compressed programming and HDTV. It is taking a two-pronged approach to achieving this. First, it desires a decoder interface that will accommodate digital set-back decoders attached to analog "cable-ready" TV receivers (Figure 2 on page 22) and, second, it will, in the future, set standards for cable transmission of digital programming. Electronics manufacturers anticipate that such standards will allow much of the digital processing to migrate from the set-back device to the receiver itself (Figure 3 on page 22). Some operators and manufacturers believe that the use of set-top hardware is inevitable and that their complexity will increase. Some believe that the logical progression is for all the digital circuitry and tuning functions to be contained in the "set-top," while the consumer's receiver is reduced to display functions.

It is worth noting, however, that the FCC may require cable operators to deliver all future video services, both analog and digital, in a form that is compatible with the decoder interface.

In setting standards for the transmission of digitally compressed TV over cable systems, the FCC will consider many factors, including:

- A desire to eliminate set-top hardware that interferes with features of consumers' video equipment.
- The standard being finalized for HDTV and the receiver economies possible as a result of commonality between HDTV and compressed digital transmission of standard resolution programming.
- The possible defacto standard for cable programming if, for instance, wide deployment of GI's DigiCipher compression and QAM modulation occurs before the rule making.
- Various interindustry standardization efforts taking place in this field, such as those by the National Renewable Security System Subcommittee of the JEC, the Interactive Multimedia Association, the Video Electronics Standards Association, the Corporate Open Standards Group and the Interactive Service Association.
- The advantages to be gained from integrating video with other services delivered via a common ATM data stream to the home, as is being tested by Time Warner Cable in its Orlando, FL, system. Potentially, a common format data stream could deliver multimedia video that could be displayed on either a TV receiver or a computer terminal, depending on the application.

Several of these factors are clearly conflicting, with different RF channel bandwidths, compression standards and modulation methods. A transmission standard very close to that for HDTV has the greatest potential for allowing migration of digital processing circuitry into consumers' receivers, while ATM on nonstandard RF channels (the TWC trial system uses 12 MHz RF channels) has the least.

Technical choices

Against this technology and regulatory background, operators have several options for provision of video programming over hybrid fiber/coax networks. The choices that must be made include:

- Methods for achieving effective programming choice increase. There are three, nonexclusive choices for achieving greater effective bandwidth:

1) *Increase in system RF bandwidth.* While most new construction and rebuilds are now at 750 MHz, with digital compression 550 MHz may be adequate in some markets. As well, 1,000 MHz may allow the operator to delay the use of compression. However "cable-ready" receivers are only required to tune to 806 MHz.

2) *Use of digital compression.* As discussed before, six-10 programs may share a single 6 MHz RF channel using digital compression.

3) *Use of headend switching and space division multiplexing.* Since each HFC network serving area may be independently programmed, headend switching can be utilized to feed to each node only those programs in immediate demand by the subscribers there. Thus the same RF spectrum can be used differently in individual network sections. Figures 4 and 5 on pages 24 and 25 illustrate the difference in signal handling in the headend. Since the input to the switching network can be arbitrarily large, the potential programming choice is limitless, regardless of system bandwidth.

- MPEG-2 vs. DigiCipher compression. Although MPEG-2 has the advantage of international standardization, DigiCipher is lower cost, uses a similar encoding system and the manufacturer has designed the decoders to be upgradable to MPEG-2.
- MPEG-2 vs. ATM packetization. The choice is between an efficient video-optimized format and a more expensive, but multiservice, data stream.
- QAM vs. VSB modulation. The leading, but not the only, contenders are various levels of QAM and VSB modulation. Not only compatibility with HDTV is at stake, but also bandwidth efficiency, total data rate and relative immunity to

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noise, distortion, multipath, group delay, passband response and other network impairments. It is not clear yet what incremental cost is required to make a receiver multiformat.

• Access security. There is much disagreement over whether a standard scrambling algorithm with "smart card" keys is adequate or whether operators must control the entire scrambling and key process to ensure adequate programming security. The former results in lower initial hardware costs (assuming that the actual descrambler is built into receivers), while the latter is much cheaper to replace if the security is breached. Operators are leery of reported breaches of existing "smart card" security systems used for video security in Europe.

• VOD vs. NVOD. VOD is by nature interactive. Therefore a VOD service requires:

1) Either servers at the headend or provision of a two-way data stream from the subscriber back to where the server is located.

2) The server and modulators must provide sufficient independent data streams to handle the peak number of simultaneous users.

3) The system must have sufficient instantaneous RF bandwidth to handle the simultaneous users.

NVOD is essentially noninteractive (except for order entry). Thus, servers can be located where convenient and their use shared among a large subscriber base. Sufficient system bandwidth must be available for simultaneous showings of all offered video products. (For instance, if the top 10 films were offered with start times every 15 minutes, 40 program channels would be required.)

Division of intelligence

Some interactive services may require a significant amount of computing capability dedicated to the user. That hardware may be located at the headend and shared among users (but require a relatively high-speed return channel from the user) or may be in the home. The in-home option has higher initial cost but may allow stand-alone or multiservice applications that increase its utility. FCC cost recovery regulations currently favor the in-home hardware.

Some examples

Given these options, it is instructive to examine three of the current cable industry trials and experiments to see what choices have been made. It should be noted that in each case the operators in question will have implemented an HFC network and will have a full analog NTSC service in accordance with FCC regulations. The options discussed will be applied only to some new, transactional services. It also must be emphasized that the trials do not necessarily indicate a full-scale deployment strategy (though the TCI system is nearing operational status) or for that matter the operator's only strategy.

Time Warner full service network

Time Warner Cable chose to integrate several services into 45 Mb/s ATM data streams to homes. Each of 20 data streams occupies 12 MHz of bandwidth and so are not compatible with current or contemplated consumer tuners. For the downstream data stream 64 QAM is used. Upstream communication is at DS-1 data rate using QPSK modulation.

The Orlando system has been upgraded to 750 MHz. For standard analog channels, 50-450 MHz will be used, while 450-750 MHz will be dedicated to

Reader Service Number 64

digital services including (potentially) video, wired telephony, ISDN and Ethernet. The architecture is a ring-star-bus with a master headend tied to distribution hubs using a redundant ring. Each distribution hub serves 30-40 fiber nodes in a star configuration and each node feeds a coaxial distribution system passing about 500 homes. Switching is employed to achieve space division multiplexing. The "home communications terminal" (set-top converter) contains a sophisticated graphics workstation, three tuners and two upstream data transmitters and reportedly costs several thousand dollars in trial quantities.

TCI headend in the sky

TCI has developed a solution that may be cost-effective for smaller cable systems. It will offer (from a single nationwide server and satellite uplink site) a full NVOD service. Individual cable systems will only have to provide satellite receivers and cable modulators at their headends and relatively "dumb" digital set-top boxes for subscribers desiring the optional services. Not only programming but, optionally, enabling services (such as ordering) will be available to operators from TCI, which is offering to provide programming to nonaffiliated operators as well as its own systems.

> ***"To the extent that the FCC wants to promote set-back descramblers as a compatibility solution, it will be tempted to at least mandate 6 MHz channelization just as it did for HDTV."***

Although they are not yet deployed, TCI has ordered over 1 million digital set-top decoders for its own systems. General Instrument and several cross-licensed vendors reportedly had total orders or letters of intent for almost 2.5 million units as of February 1994.

Programming will be delivered to homes in DigiCipher format, but may be changed later to MPEG-2. Modulation will likely be 64 QAM initially, but may be upgraded to 256 QAM. In either case, the RF bandwidth used will be 6 MHz so that set-back or set-integrated evolution is a possibility. Since the service is NVOD, no headend switching or node-specific programming is required. The service is noninteractive.

ICTV interactive trial

Interactive Cable Television has announced a trial with Cox Cable in Omaha, NE, and a second trial with InterMedia Partners in Milpitas, CA.

The ICTV system places nearly all the intelligence in the headend and transmits to the home either a conventional NTSC analog video signal for display or, if required to achieve sufficient simultaneous program capacity on the system, a digitally compressed signal.

ICTV expects that 20 noncompressed channels per 500-home node will be sufficient up to moderately high usage levels. The operator, however, has the choice of using analog modulation and a high degree of node-specific programming or use of compression and a lesser degree of node specificity and/or bandwidth.

The advantages of the ICTV approach are: a) sharing of the expensive interactive hardware; b) easier upgrading and service at the centralized location; and c) a high degree of modularity whereby most system parameters can be changed from the headend as the service penetration

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grows. Finally, it allows use of conventional, inexpensive descramblers in the home (with an added reverse direction data transmitter) unless digital compression is required.

Against these advantages must be weighed the cost of many RF modulators and scramblers to provide the node-specific channels. Also, it remains to be proven that the required latency and communications reliability in the reverse direction can be provided.

Conclusions

Unlike telephone backbone networks that typically contain one high-speed, time-shared baseband digital data stream, cable systems have traditionally been built using highly linear RF components and carry a spectrum of signals that may have widely differing content and modulation methods.

The advantages of a single ATM data stream are: a) it can be statistically shared among many services; b) it is easier to provide redundancy; and c) a baseband digital optical signal path has a greater loss budget than an equivalent linear analog path.

On the other hand, a wideband linear network can handle any mix of signal formats and bandwidths without format conversion. Thus, wired telephony, personal communications services (PCS), TCP/IP packets, analog video, digital music, HDTV and digitally compressed video can share a single communications path without any synchronization or format conversion whatsoever. Individual data streams are not subject to data jitter (variable packet delay due to statistical multiplexing) as can occur with ATM.

Completely aside from technical superiority or cost-effectiveness, video service providers should be mindful of the vagaries that will be introduced by the FCC when it chooses a digital transmission standard in light of the competing interests. There will certainly be political pressure to mandate a high degree of commonality with the HDTV standard so as to provide the lowest cost multiresolution receiver.

To the extent that the FCC wants to promote set-back descramblers as a compatibility solution, it will be tempted to at least mandate 6 MHz channelization just as it did for HDTV. It is in the interest of any potential video service provider to participate in the JEC process to ensure that the decoder interface is adequately flexible to handle the full range of service possibilities. **CT**

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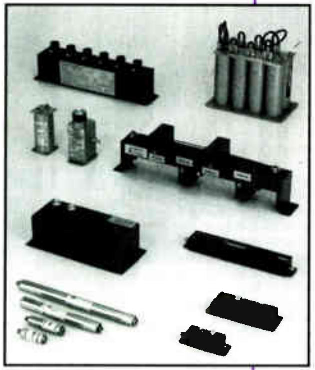

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Reader Service Number 49

Addressable set-tops: Signal security for today and the future

By Dario L. Santana
Director, Analog Addressable Systems
General Instrument Communications Division

Signal security technology today consists of three primary systems: traps, nonaddressable descrambling converters (NDCs) and addressability. Traps and NDCs were first deployed many years ago and although the use of these technologies has undergone a steady decline during the last few years, there are still enough trapped and NDC systems in operation that these products deserve mention in any article discussing signal security.

Traps

Traps are single-channel security devices that are usually small and cylindrical in shape — 2 to 3 inches long and about 3/4 inch in diameter. Positive traps remove a jamming signal from a specific channel while negative traps block a specific channel or group of channels. In both cases the trap is designed to deny or enable a specific signal frequency or channel, therefore multiple channel control usually requires deploying multiple traps.

The selection of positive or negative traps is usually made on the basis of pay channel penetration. Services purchased by most subscribers are usually controlled using negative traps because only the few nonsubscribers require the device. Using the same logic, services purchased by few subscribers are usually controlled using positive traps. Negative traps are located off-premises at an inaccessible or secure location. Positive traps, on the other hand, can be issued directly to the subscriber for deployment behind the TV set.

The advantages of traps are low cost, simplicity of operation and the ability to provide "whole house" solutions. Traps are inexpensive, selling for $5 to $10 each. They can be easily installed and network audits can be performed visually. Finally, the entire spectrum of authorized signals is available to every TV set in the home.

Despite these advantages, the uses of traps has rapidly declined for a number of reasons. Most systems today are moving to multiple premium services, tiering and pay-per-view (PPV). In this type of environment, signal control using traps can be awkward and expensive: multiple low penetration services might require a bulky set of traps hanging from a tap port or behind the TV set.

Additionally, any change in service, including PPV, requires a trip by the subscriber or system installer. Traps also are limited in their operating frequency ranges, representing yet another limiting factor in the management of multiple pay services.

Finally, there is no automated auditing capability in a trapped system. This impacts operational efficiencies and signal security. In fact, trapped systems are not very secure. Traps can be easily defeated by physically disconnecting the negative trap or by simply installing a stolen positive trap.

Nonaddressable descrambling converters

As with traps, the use of NDCs has declined dramatically in the past few years. NDCs are set-top devices that can descramble multiple TV signals. The map of authorized signals is programmed into a PROM (chip) that resides in the converter. Changes in service authorizations are accomplished by exchanging the PROM.

NDCs facilitate multipay control and offer a higher level of security relative to traps. However, as in the case of traps, service changes require a truck roll or visit to the operator's office. Central automation is nonexistent and stolen converters can be effective pirate devices.

Addressability

Addressable systems represent today's state-of-the-art in signal security. As in the case of the NDC, addressable set-tops can descramble multiple TV signals. But what truly sets this technology apart is its ability to change authorization maps and other parameters from a central office and the benefits in operational flexibility, efficiency and accountability inherent in this centralized control. Addressable systems consist of three primary elements: the addressable controller, the scrambler and the set-top converter.

Scrambling

The most common type of scrambling in use today is RF scrambling. This is accomplished by altering the signal's synchronization pulses so the TV set cannot provide a stable picture. The most advanced addressable systems combine various modes of RF scrambling with dynamic video inversion.

Systems capable of this type of mixed scrambling are called baseband systems and are far more secure than any scrambling technique used by traps or NDCs.

Other, yet more elaborate, scrambling techniques exist including line manipulation and digital compression. Line manipulation has not been significantly deployed because of its high cost and incompatibility with existing scrambling techniques. Digital compression, on the other hand, offers many advantages beyond just scrambling, including the ability to deliver more TV signals to the home and improved picture quality. Large-scale deployment of this technology will begin during the second quarter of 1995.

Access control: Addressable controller

Scrambling is just one of two security elements in an addressable system. The other — access control — refers to the data stream that originates in the addressable controller and communicates changes in service status to the set-top. This data stream contains service authorization, change orders, connect/disconnect, PPV orders, feature enable/disable, subscriber messages and more. The information carried in this data stream can be conveyed in its original format or, for a higher level of security, encrypted using elaborate dynamic encryption key techniques.

The addressable controller also contributes to signal security

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Expanding the bandwidth

Covering all the topics of expanding system bandwidth could fill a book. This article, based on experience, details some of the problems and solutions occurring during a system upgrade from 330 to 750 MHz.

By Leslie W. Read
Field Service Engineer, Sammons Communications

It is Monday morning, you are the chief technician in a classic 330 MHz system that is running very smoothly, and your boss calls you in to say: "We are going to upgrade this system to 750 MHz. And we are going to use as much of the existing equipment as possible. Let me know what we keep and what we discard." For a few seconds you marvel how so few words can initiate so much work. (Similar to "Will you marry me?") Then you begin to start the project.

What do we mean by 550/750?

Many systems, anticipating digital services in the future, are reserving the top 200 MHz for those digital services. Since level requirements for digital signals are not yet known, but are probably going to be more flexible than for NTSC, systems are not specifying tap output levels for the 550-750 MHz frequency band. However, the system *is* unity gain out to 750; that is, amplifier station gain must numerically equal the loss of the preceeding cable.

Basic ingredients

A cable TV system's outside plant consists of:

- The cable, strand and lashing wire.
- The passives — splitters, couplers, power inserters, taps.
- The amplifiers and line extenders.

Will the system "pass" 750 MHz?

The answer that Monday morning is "of course not." But the next question should be, "Will any part of it work at 750?" The term "pass" 750 MHz really means that a component: 1) is predictable at 750 MHz — you know how it is going to perform, and 2) does not have excessive loss. For example, if the taps all have 20 dB through loss, they are predictable, but not usable.

The cable, passives and amplifiers are the three items in question. Let's look at those individually:

- *Cable.* Can the existing cable be used? You may have to measure some samples to be certain. Go into the system and choose some test runs that are as long as possible without *any* passives, and are typical of the system cable type. (You need to choose a long run so any errors that occur will be a small percentage of the total loss measured.)

Attach cable F-fittings at each end of the cable. Using either system sweep equipment, or a spectrum analyzer and sweep generator, measure the end-to-end loss of the cable. (Read about "normalizing" below.) Print out the display for your measurements. Don't rely on memory or scribbled notes. Measure the length of the cable using a wheel. Do not rely on maps (I really didn't need to tell you that, did I!) Another hint: With a vernier caliper or micrometer measure the dimensions of the cable center conductor and inner diameter of the outer conductor. This will help verify the cable type if questions arise. Make a note of the condition of the cable (e.g., clean, corroded, wet, etc.).

If you are measuring feeder cable, the runs will probably be short and it will be absolutely necessary to compensate for the effect of any drop cable used. All modern sweep systems allow a person to "normalize." That is, to subtract or compensate for the effect of the extra length of drop cable.

When you get the measurements, divide the total cable loss by the length (in 100s of feet) to get the actual loss in dB/100 feet. You will, of course, refer back to the manufacturer's specifications to see if the loss you measured agrees with the manufacturer's data. But if this cable was manufactured in 1978, will it have published data to 750 MHz? However, most manufacturers have developed data on their older cables that they will share with you.

In addition, if you have a computer with a spreadsheet program, do some "curve fitting." The cable loss as a function of frequency generally follows an equation:

$$\text{Loss} = K_1 + K_2 \times f^{-5}$$

Where K_1 and K_2 are arbitrary constants, and f is the frequency in MHz. By properly choosing K_1 and K_2 to generate the loss at the known frequencies you can then calculate the loss at other frequencies. A graphical display of loss vs. frequency helps to choose the right values.

Cable types PI and PIII are generally well-behaved up to 750 MHz; you may not be so lucky with other types.

- *The passives.* Will the passives — splitters, directional couplers, taps and power inserters — work at 750 MHz? If your system is 15 years old, the chances are they will not. But they need to be measured to be certain. Bench sweep samples of these passives to see how well they work at the highest frequency. When you set up the bench sweep there are several warnings you should be aware of:

1) Most test equipment has BNC connectors. When you use F-to-BNC adapters it is necessary for you to use 75 ohm BNCs in the RF portions of the test. It wasn't so important at 330 MHz but can make a big difference at 750. These are, by the way, easy to identify: the 50 ohm devices have a plastic insert on the inside of the outer conductor and the 75 ohm devices do not. A side-by-side comparison shows this obvious difference.

2) Since you are probably going to measure low loss values (the through loss of taps, for example) you need to "normalize out" the effect of generator variation and lead loss for accurate numbers, just as you did for cable losses.

3) Terminate unused ports on splitters, directional couplers and low value taps. It is not as important on high value taps. It also is not necessary to terminate the AC input port of a power inserter.

4) It is highly advisable to print out the

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response characteristics of the component measured.

5) Also, if you do plan to replace taps and have a choice of the new taps, choose some (all else being equal) that have a longer body so extension fittings are not required.

• *Amplifiers.* Will you have to replace the amplifiers or will a plug-in upgrade be adequate? At this time, plan to replace them. There is no cost-effective way to upgrade amplifiers used in the late 1970s and early 1980s to 750 MHz. Sorry. It should be noted that some companies are working on plug-in upgrades; check it out before plans are set in concrete.

Implementing the upgrade

An upgrade is, by nature, different from a rebuild. A classic rebuild is replacement of strand, cable and all passives and actives. The old cable remains on the poles still serving customers until the drops are swung to the new system. Customer outages are (or should be) nil.

During an upgrade, however, the new system is being created out of the old and customers are going to experience many more outages as components are changed out up and down the line. It has been our experience that customer aggravation can be minimized by the following plan for upgrade:

1) Each day choose a small area (maybe one or two feeder runs) where the upgrade can be accomplished in about a 4-hour time period using all the available personnel, and where all customers will be on-line when the crews leave.

2) Make the customers in that area aware that their cable will be off completely for that time.

3) Work in from the extremities of the system. If the input levels of the old amplifiers are similar to those of the new amplifiers, this makes the job much easier.

4) Do not put new channels on the system until the upgrade is complete. This eliminates service calls on channels that may be in the rolloff of the old system.

5) Trunk amplifier turnarounds should be done at night (early morning hours).

Testing the system

• *Meter balancing.* There may be locations where a 750 MHz amplifier will be fed with only 330 MHz signals and it has to be balanced. This is analogous to balancing a 330 system with no channel

"During an upgrade ... the new system is being created out of the old and customers are going to experience many more outages (than with a rebuild)."

higher than Ch. 7. You will need to calculate the proper levels at the highest channel now in use so you can make a reasonable guess about pad and equalizer in the new amplifiers. And resign yourself to the fact that there will be changes when the system is complete and you *can* test out to 750. It also is recommended that you put a signal on the system at 750 MHz when the whole system is complete. This will aid in meter balancing and sweeping.

• *System sweep.* After the upgrade is complete you will want to sweep the system to 750 MHz. There is no magic here — a system sweep to 750 is no different than a system sweep to 300, except that the components are more critical. If you have installed fiber nodes and upgraded the service area you can insert the sweep at the headend but you need to normalize the sweep response to the node output — it will make life much easier.

To measure accurate sweep response regardless of output termination, the amplifier must have directional coupler test points. If the amplifier has only resistive test points and if there is any kind of passive (splitter, power inserter, tap, etc.) close to the output, the sweep display may show some degradation that doesn't really exist. One solution is to install a high value tap at the output of the amplifier and use one of the ports as a test point. *(Editor's note: If the amplifier has an AGC or bridger module, the module input port is fed via a DC in the chassis. This will make a good temporary test point.)*

What can go wrong?

"It's not what I know that scares me, it's what I *don't* know." You will face problems, some common and some unique. Years from now, as you lean back in the rocking chair and discuss retirement plans, your geriatric medicine and are showing pictures of your great grandchildren, you will look back with a rosy glow at the challenge you encountered and the success you had. In the meantime, remember: All problems have solutions. **CT**

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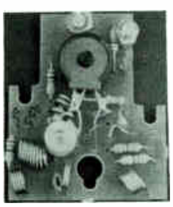

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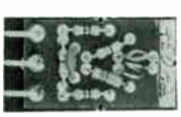

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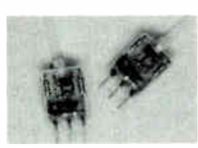

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Reader Service Number 68

Moving toward the full service digital network

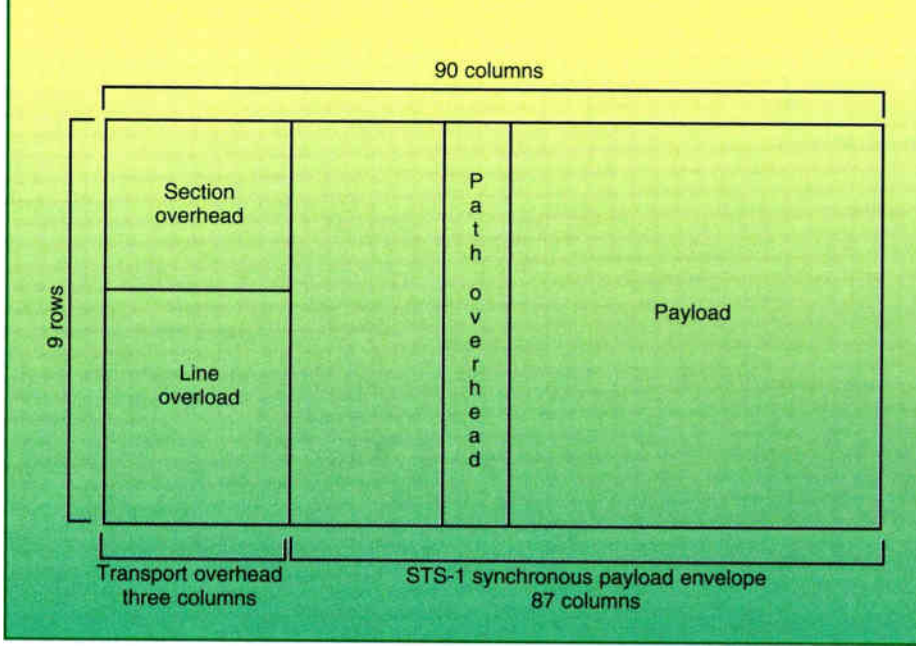
By Scott Nelson
Digital Engineer, ANTEC

Many issues face cable operators planning to build a full service network capable of providing an integrated set of voice, video and data services. The most important decisions lie in how the network can be designed to remain transparent to both current and future signal formats, how and to what degree new services can be deployed, and how a diverse and growing traffic load can be most efficiently managed given the network's capacity.

Today, SONET (synchronous optical network) offers the means to regionally interconnect headends, using the cost savings of improved economies of scale and new revenues from alternate access and regional advertising to fund expansion. In the future, this same SONET platform can expand further, transmitting not only video programming but any number of other bandwidth-hungry interactive services, including residential telephony, high-speed data transmission and video-on-demand (VOD).

SONET's standardized, open architecture means the network can handle voice, video, data and combinations of all three types of traffic, regardless of the whether that traffic is based on today's DSn telecommunication rates or other technologies, such as asynchronous transfer mode (ATM). As an enabling technology in itself, SONET represents a powerful medium that, when implemented today, can position cable systems for any new demands placed on the network in the future.

Figure 1: STS-1 signal format



SONET's structure

In late 1984, work began to develop a standard for optically interconnecting telecommunications equipment. This initial effort lead to the formation of the ANSI SONET Committee T1X1, which consisted of various vendors and service providers within the telecommunications industry.

In February 1988, T1X1 agreed on the initial Phase 1 set of specifications that defined the optical parameters, signal format and processing requirements for carrying digital signals used by the U.S. telephone industry. Since then, the SONET standard process has diversified into a number of committees that have produced a new set of specifications loosely titled Phase 2. Work continues to further define SONET to encompass new service applications and technology.

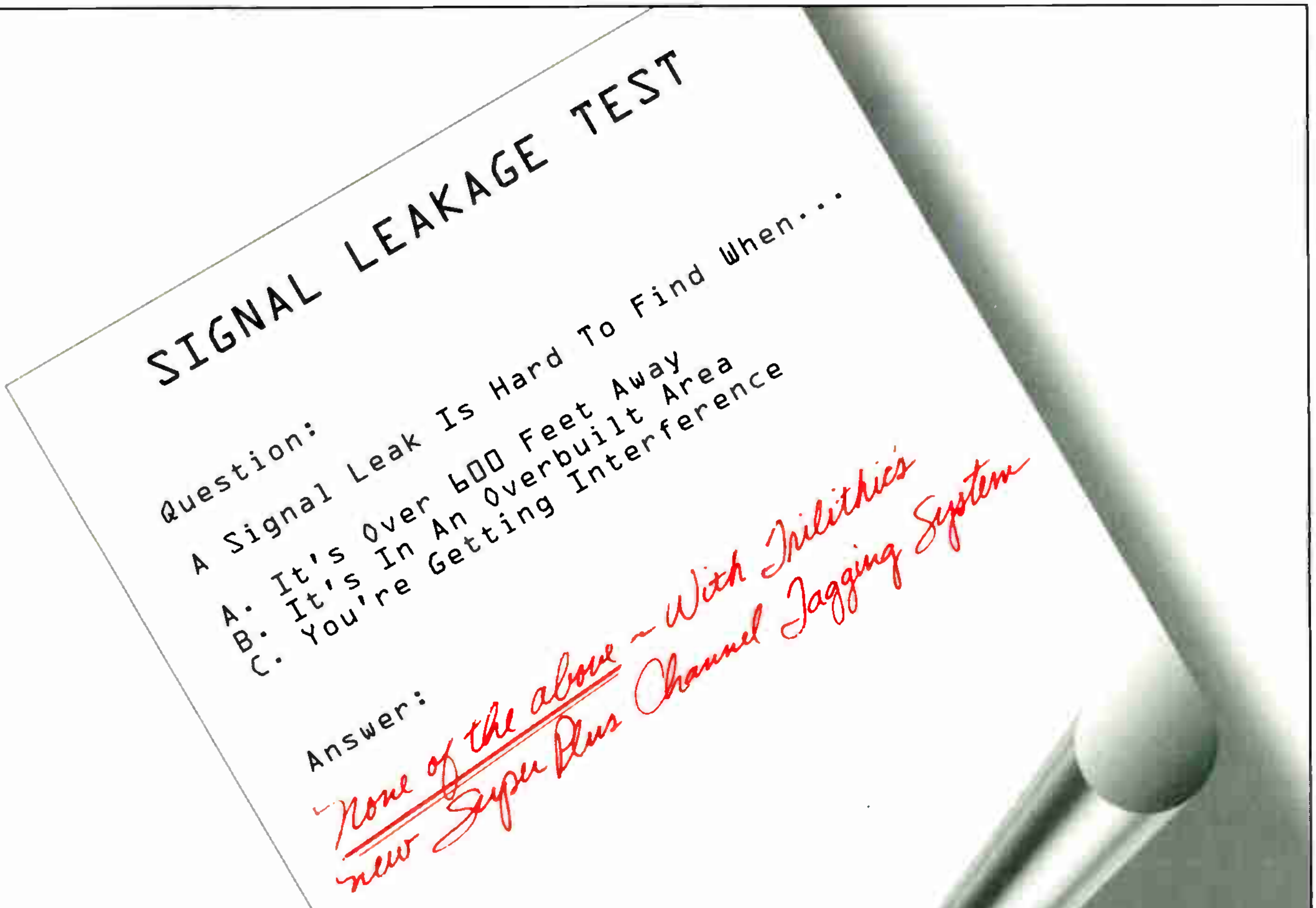
SONET's base signal is the Synchronous Transport Signal, Level 1 (STS-1), which has a rate of 51.84 Mb/s and a frame that repeats every 125 microseconds. This STS-1 signal is broken into two parts: the synchronous payload envelope (SPE), an area allocated for the actual voice, video and data signals, and the transport overhead (TOH), as shown in Figure 1. The TOH carries the operations, administration, maintenance and provisioning (OAM&P) functions required to manage and monitor the network from central or remote locations.

As shown in Figures 2 and 3 on pages 42 and 44, SONET's payload mapping allows transport of a variety of signal formats: traditional DSn signals, digitally compressed video and ATM packets. DS1 signals (24 single voice channels or 1.544 Mb/s data) are packed into SPE containers called virtually tributaries (VTs). VTs optimize DS1 transport and allow single DS0 circuits to be switched without the need to disassemble the STS-1. DS3 signals, higher rate circuit groups and packetized ATM are mapped directly into the SPE.

Due to the highly adaptable STS design, SONET can provide site-to-site connectivity regardless of the original signal format. This makes SONET ideal for carrying broadcast-quality video on DS3 circuits, video conferencing on DS1 and subrate DS1 circuits, MPEG video on ATM or VT6 circuits, as well as a whole host of traditional voice and data services for alternate access business. Furthermore, these various signal types can all be carried on the same fiber using a single SONET transport system.

SONET devices

SONET standards specify the optical interfaces and arrangement, called multiplexing, of signals. SONET does not, however, specifically define a class of telecommunications devices. As a result — and to our good fortune — SONET product development has been driven by real-world applications. The evolutionary process began with products to interconnect telephone company central offices. Further enhancements added



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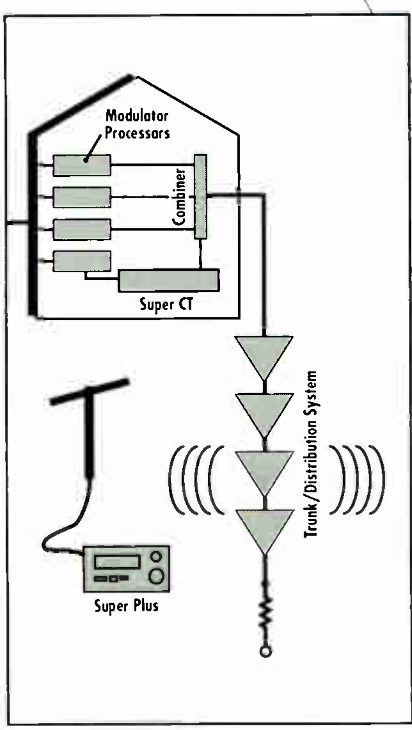

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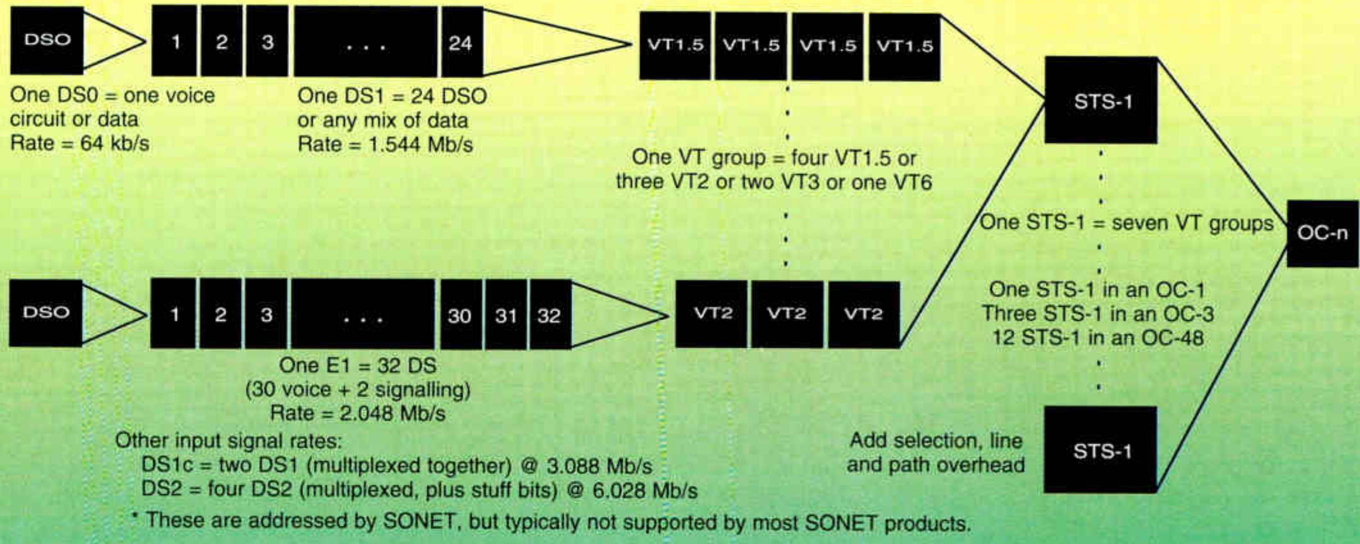
Figure 2: SONET payload mapping



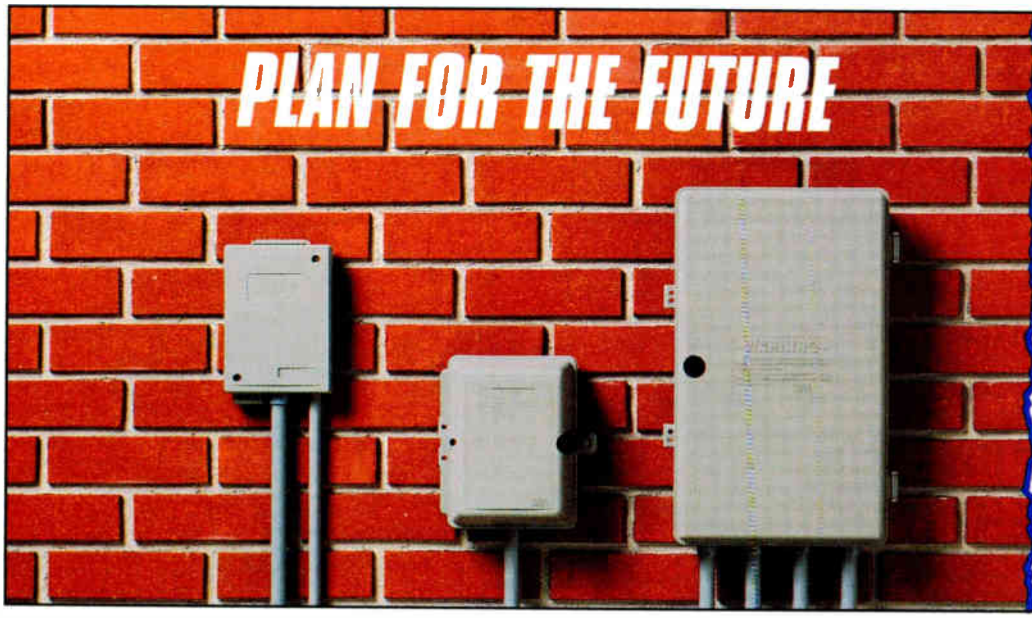
bandwidth management capabilities as well as stand-alone bandwidth management products such as digital crossconnects. Now the industry is beginning to see entirely new classes of SONET products designed to deliver and process new types of services.

The predominant SONET products today are still lightwave transmission systems used to connect Point A to Point B. These devices began as simple terminals that multiplexed DS1 and DS3 circuits into STS-1 frames, multiplexed several STS-1 signals into higher rate STS-n signals, then converted those electrical signals to light and transported them through optical carriers at OC-n rates. Close on the heels of this development was the add/drop multiplexer (ADM). ADMs provide an easier and less expensive alternative to back-to-back terminals for accessing circuits along an optical span. Finally, requirements for outage protection and disaster recovery came into the picture, so ring systems were introduced for automatic rerouting of signals in the event of a fiber cut or node failure.

Inherent in these lightwave transport products are varying capabilities for monitoring, rerouting and managing individual circuits; however, these devices do not have the horsepower to manage traffic at larger hub sites in SONET networks. Digital crossconnect systems (DCSs) were developed for special bandwidth management situations.

Just as ADMs provide cost-effective control, access and management of circuits along a single fiber route, a SONET DCS provides similar functions at sites where fiber routes make their crossroads.

A DCS acts like a matrix of patch panels to allow system operators to electronically access or connect circuits without having to demultiplex down to their original signal format. The ability to complete this switching electronically means there's no loss of original signal quality by converting signals back to analog, switching those circuits and converting them back to digital. Furthermore, the DCS eliminates an otherwise



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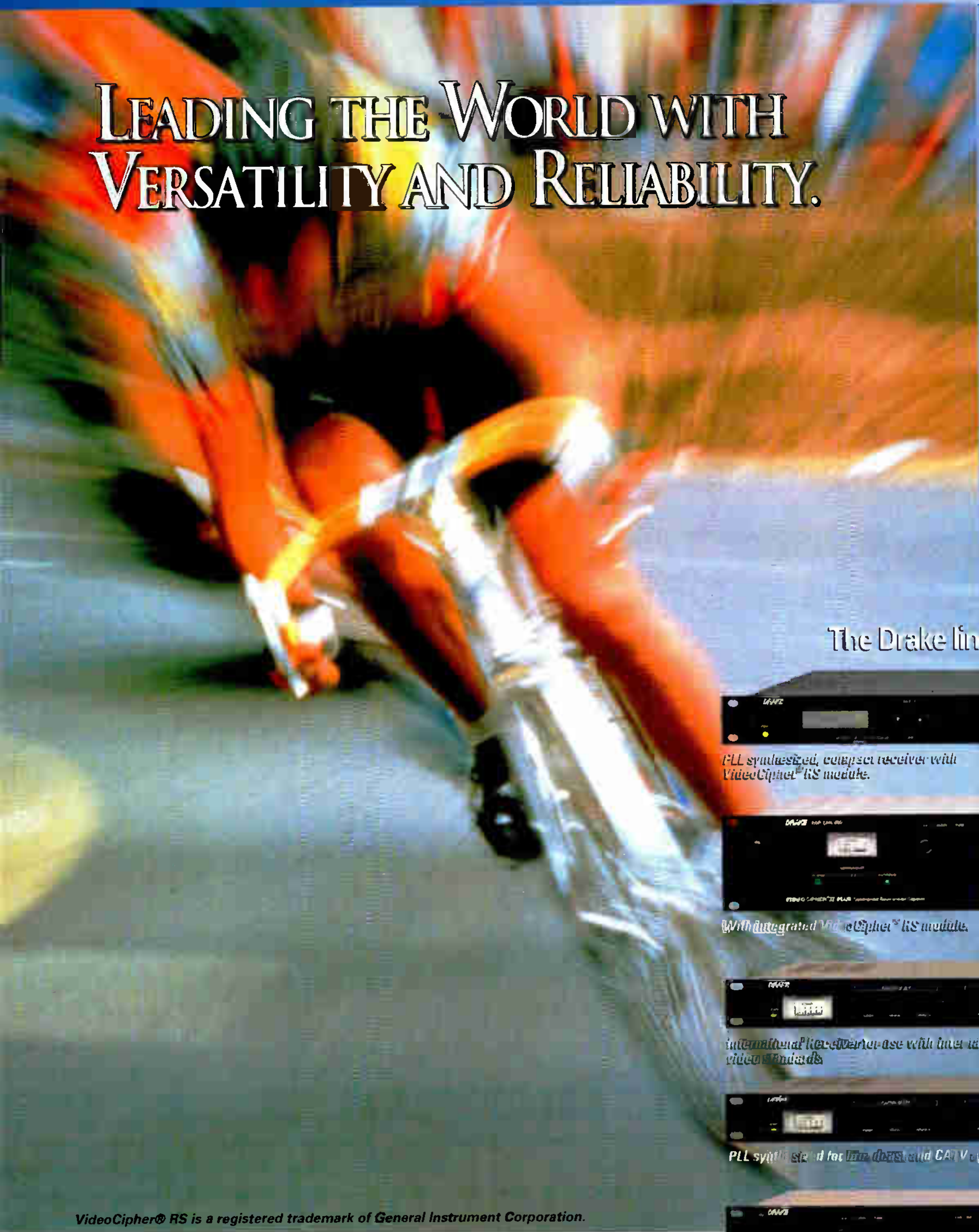

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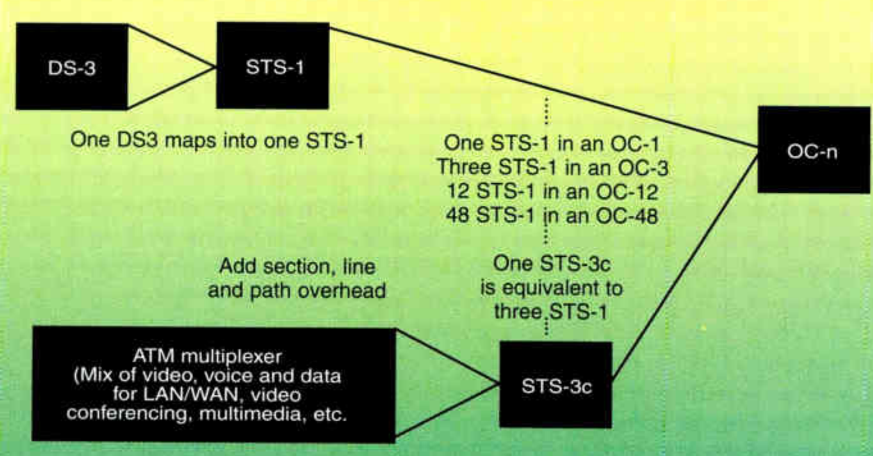
Figure 3: SONET payload mapping



unmanageable jumble of patch cords previously used by channel banks and multiplexers at hub locations.

As individual networks grow and come together, SONET digital crossconnects can be used to link and manage those networks. A DCS performs a number of functions such as simplifying ring interconnections, grooming and filling circuits to maximize capacity on the fiber, managing individual cable TV channel lineups for separate areas, monitoring performance for all traffic, and acting as a centralized gateway for providers of bandwidth-on-demand services.

As a multitude of higher bandwidth services such as video conferencing, medical imaging, compressed broadcast video, high-speed data, encryption and private digital networks start to appear in the network, the advantages provided by a DCS become even more important. Current DCSs feature SONET switching matrices as well as DS1 and DS3 interfaces, allowing crossconnections to be made at the DS3, DS1 and DS0 levels. Further innovations in digital crossconnects will add electrical STS-1 interfaces, optical interfaces at OC-3, OC-12 and OC-48 rates, and STS or VT switching matrices. Possible future generations of digital crossconnects will have ATM-based switching cores and optical interfaces optimized for connections to switches and other network elements.

As the development of SONET-based equipment continues on its evolutionary track, entirely new classes of products capable of delivering and processing a variety of new services will emerge. Many devices currently used in today's telecommunications network also will be completely re-engineered to take full advantage of SONET's frame structure and overhead capabilities. Developments like these will further leverage the SONET networks put into place, offering network providers opportunities to provide virtually any new service.

Initial SONET applications for cable TV

SONET can be initially used as part of a headend consolidation plan to eliminate duplicate equipment and personnel by distributing video programming from a master site to remote hubs. Using digital video codecs, two NTSC broadcast-quality video signals can be digitized and compressed at the master headend to form a single DS3. An OC-48 SONET system can therefore distribute 96 video channels to multiple remote headends. At these remote sites, the video is converted back to its original analog format for transport over the hybrid fiber/coaxial distribution network.

A regional headend interconnect using SONET also provides opportunities outside of the current entertainment video business. While an OC-48 SONET system can carry up to 96 video channels, a lower count — say 60 channels, requiring 30 DS3s — should suit most cable programming needs. The remaining 18 DS3s would then be available for other services. If SONET's ring protection scheme is used, the remaining 18 DS3s offer a high degree of reliability that

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would make this additional capacity a very valuable service to interexchange (e.g., long distance) carriers and businesses with their own private networks. This capacity could be used for traditional telephony, local area network (LAN) connections, video conferencing, high-speed data transport and ATM access. Operators also could allocate bundles of circuits for individual customers to control, offering them virtual private networks as well as interconnection to the regional network. SONET's flexibility makes the delivery of all these services possible.

Eventually, video programming can remain digital from source to subscriber, with advertising insertion and other manipulation of program material performed right on the digital bit streams. Services such as video games, home shopping, information retrieval and other interactive programs also will be originated and processed digitally. This will be a transition process that SONET can adapt to readily.

Advanced bandwidth management capabilities

As cable programming shifts from a continual broadcast format to entertainment-on-demand, the demands for network capacity will become more complex. Just as the volume of telephone traffic has daily peaks and valleys, so will entertainment services. The presence of a variety of other demand-based services will further complicate bandwidth management capabilities. This is where SONET networks using digital crossconnects can help to balance demand against the overall capacity of the network.

A simple analogy for this bandwidth

"In a market where the cable and telephone industries are converging, there is an obvious need for cable operators to migrate from analog to digital platforms to prepare for the future."

management capability lies in the moveable high occupancy vehicle lane on an urban freeway. During the morning rush hour, the HOV lane is partitioned off and allocated for use by inbound priority traffic (typically vehicles with two or more passengers). Then, during the evening rush hour, outbound priority traffic may use the HOV lane.

In the same way, a DCS can be used to anticipate and avert cyclical overload and under utilization of facilities. For instance, a regional network might be used for business telecommunications as well as the distribution of program material for video-on-demand. The business usage would primarily peak during working hours — weekdays, from 7 a.m. to 6 p.m. The VOD usage would peak primarily on evenings and weekends. Furthermore, assume that both the business and VOD customers share the network after midnight to get the lowest rates (large data base downloads for the businesses and reception of specially requested VOD movies from a national file server for the subscriber).

In this scenario, the DCS would allocate the bulk of the network circuit capacity to the business trunks during working hours. It would then reallocate the same circuits to the local VOD server on evenings and weekends. After midnight, the DCS would balance circuit demand between both applications.

Convergence — Tying it together with SONET

In a market where the cable and telephone industries are converging, there is an obvious need for cable operators to migrate from analog to digital platforms to prepare for the future. The increasingly competitive environment will require cable operators to find the best way to serve new and existing subscribers while developing the most effective digital platform. SONET's unique ability to handle the combination of video, voice, data — in any type of signal format — makes it an ideal digital platform for the future. Through the use of SONET-compatible equipment, operators will be able to efficiently manage and control usage on their networks.

Today, SONET can regionally interconnect headends, resulting in significant operational savings and providing immediate revenue opportunities. As additional services come into cable's arena, that same SONET network can be incrementally expanded to meet the new service requirements. Therefore, SONET can play a key role as a means to develop the high-speed, highly efficient platform needed for cable systems to survive in an increasingly competitive telecommunications industry. **CT**

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Fiber installation: It's in your hands

By William T. Morris
Cable Applications Engineering Manager
Corning Inc.

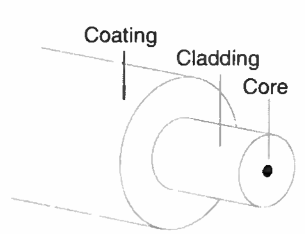
Optical fiber is changing the way America views cable TV. Fiber's operational benefits — such as increased channel capacity, improved reliability and reduced maintenance — have made it cable TV's transmission medium of choice. As more operators deploy fiber to deliver new services, it's very likely that cable TV engineers and technicians will be handling even more fiber under increasing time pressures in the next few years.

This means cable TV techs will be splicing and connectorizing more fiber and working with higher fiber count cables in a variety of emergency or restoration situations. Naturally, techs will want to make high-quality, low-loss splices the first time, every time. The best way to accomplish this is to use proper fiber handling techniques. How fiber is handled when it's first installed can make a big difference in the network's performance and long-term reliability.

Optical fiber design

An optical fiber is slightly larger than a human hair. The light-carrying region of the fiber, called the core, is smaller (only 8 to 9 microns or 0.0003 of an inch) in diameter. Surrounding the core is a cladding glass and a protective acrylate coating (Figure 1). Individual fibers are further protected by enclosing them in optical cable. These cables isolate and protect the fiber from environmental and mechanical damage during and after installation.

Figure 1: Single-mode optical fiber



Fiber strength

Despite that it's made of glass, optical fiber is both strong and durable — its resistance to pulling, or tensile strength, is much greater than the same size wire made from steel, copper or aluminum alloys (Figure 2). But even with its inherent strength, fiber can be weakened. Microscopic flaws introduced to the bare glass through surface defects, or by abrasions caused by improper handling, can weaken a fiber and may cause it to break prematurely.

Figure 2: Comparison of tensile strengths

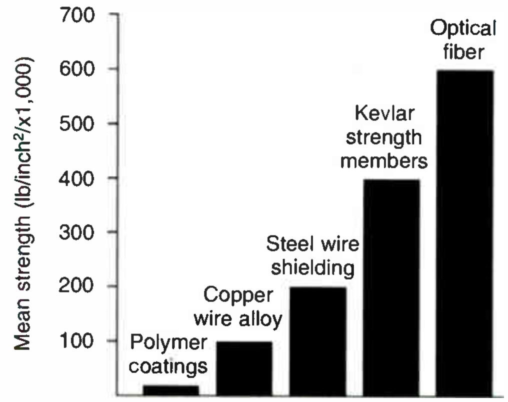


Figure 3

Before fiber is cabled, it is proof-tested during initial manufacturing to assure a minimum strength. In the field, flaws can be introduced during cable installation, splice preparation or termination, or during network re-entry or reconfiguration. Cable TV technicians can avoid damaging the fiber and prevent the introduction of flaws by handling the fiber carefully, and by keeping it clean and dry.

Organizing the work area

It pays to keep the work area organized, clean and dry. This can help techs avoid problems when splicing, connectorizing, terminating or storing fiber. It's a good idea to prearrange the storage racks and splice enclosures that will contain the completed splice. Fibers can be damaged if they are bent or twisted too tightly. Or, fibers can be abraded as they are placed or moved around in the enclosures.

Make sure the equipment is clean and in good condition, and avoid touching the exposed glass surface of stripped fibers. Once the protective coating is removed, dirt, moisture or even oil from your fingers can affect the mechanical strength or optical quality of the completed fiber splice. Pay special attention to splice protection sleeves, if you use them. Make sure they are stored properly and are clean. Otherwise, the sleeves can introduce dirt that can damage the fiber.

Cable sheath removal

When removing the cable sheath, first make sure there's no damage to the external cable layer (and armor, for armored cables) and that there are no kinks in the buffer tubes. Next, cut away the cable materials carefully, taking care not to nick the fiber with the cutting tool or knife blade (Figure 3).

Once the sheathing is removed, don't bend the buffer tubes or the fiber to a radius tighter than 1 inch; this can stress the fiber and potentially weaken it.

Buffer tube removal

Before removing the buffer tubes, clean off any residue. Always wipe away from the butt end of the cable. After making the ring cut to scribe around the buffer tube, flex the tube until it separates away from the fiber. Don't cut all the way through the tubes since this could damage the fiber. Then, pull the buffer tubes straight off, trying not to bend the fiber. Remove only a few inches at a time to avoid subjecting the fiber to excessive stress (Figure 4).

To remove the filling compound from the fibers, wipe away from the end of the buffer tubes, apply light pressure and always use a clean portion of an approved wipe. Also, avoid harsh solvents or excessive soaking — follow your cable supplier's recommended procedures.

Stripping

Use an approved mechanical stripping tool that's the right size for the fiber. Using the correct tool minimizes the risk of nicking or abrading the surface of the fiber as the coating is removed. It's important to check all tools periodically and replace those that are worn out — even your favorite ones. Tools with burrs, or that are worn out, can cause significant damage each time they are used.

To remove the coating, pull the stripping tool away from the butt end of the cable using a straight, smooth motion. Hold onto the fiber, not the cable, but don't bend the fiber to get a grip on it — you may exceed the recommended bend limits (Figure 5). The acrylate coating is designed for this mechanical removal, so one pass of the stripping tool generally is enough. Additional passes could introduce flaws or inadvertent stresses, thereby damaging the fiber.

Cleaning

Cleaning removes any remaining coating or residual debris from the fiber surface. To clean the fiber properly, gently wipe it with a clean, lint-free tissue or pad soaked with 99% pure isopropyl alcohol. Other grades of alcohol can leave residue on the fiber. One or two wipes will get the fiber clean — anymore could cause damage. Always use a clean portion of the pad, because dirt left on the pad could abrade the next fiber (Figure 6).

Cleaving

Always cleave and splice the fiber right after it's been stripped — bare fiber can be damaged or contaminated by airborne dirt particles or can be abraded if handled incorrectly. As discussed, this abrasion, or surface contamination could adversely affect splice strength or splice loss (attenuation).

It's critical to keep equipment clean. A dirty cleaver can introduce mechanical damage, dirt or contaminants to the fiber. Pay special attention to the blade and clamp areas, which contact the bare glass. It's also a good idea to minimize the number of times the clamps contact the fiber surface.

Placing the fiber in the cleaver takes a steady hand, but with some cleavers resting your hand on the side of the device can help guide

Figure 4

Figure 5

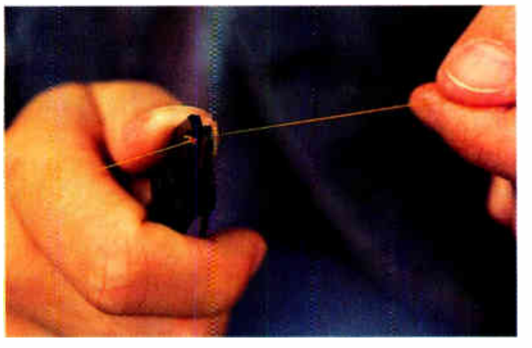
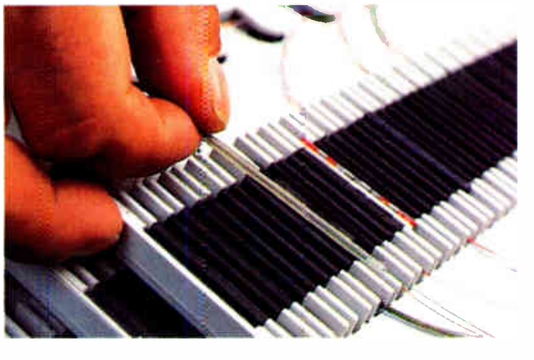


Figure 6

Figure 7



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the fiber into position without accidentally nicking it. Technicians don't have to worry about the length of fiber cleaved

"If at any point during the cleaving or

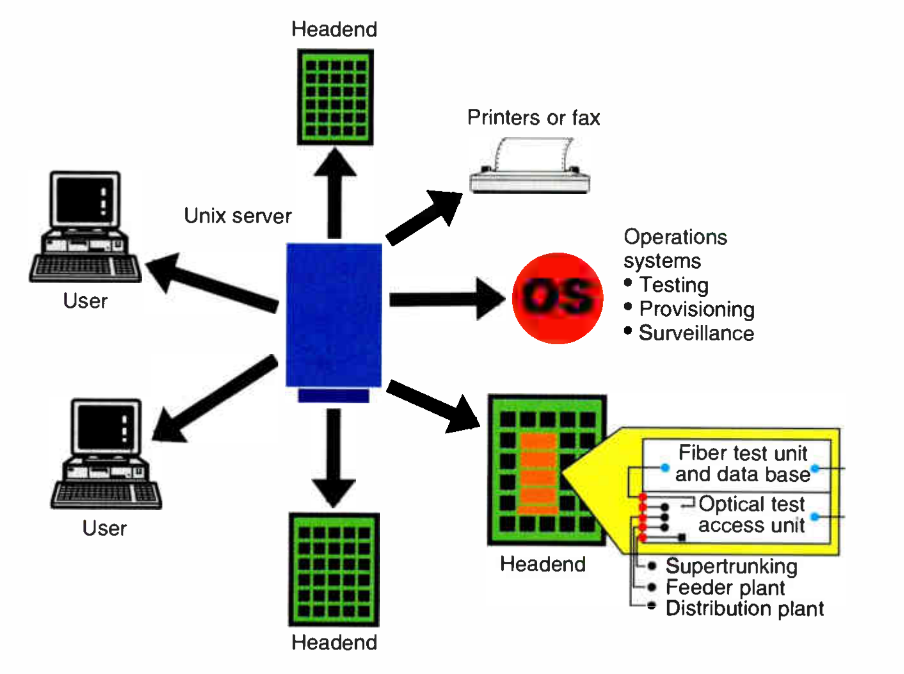
ing grooves and gently press the fibers into place (Figure 7 on page 49). It's important to pay attention to the un-

BACK TO BASICS

An HMO for fiber-optic networks

By Jeffrey L. Korkowski
Senior Market Manager
ADC Telecommunications Inc.

Figure 1: Fiber administration system



Do any of the following observations sound familiar?

- Complex organisms in which a malfunction can be a matter of life and death.
- An increasingly complex technology for maintaining function, which demands ever higher skill levels at ever increasing costs.
- Possible rationing of the services of the most highly trained service providers.
- Disagreement over the respective roles of generalists and specialists.
- An ongoing debate over issues of prevention vs. cure.

It sounds a lot like the current national debate over health care, but it isn't. These are the issues in the maintenance and support of the nation's growing fiber network.

Today, much of the country's long-haul telecommunications service is over fiber-optic cables. As fiber expands into the serving area, the same will become true of local service. Fiber carries voice, data and video, and as new services appear — unless they are wireless — they will almost certainly place additional demands on the fiber infrastructure. With individual fiber segments carrying hundreds or even thousands of signals, a loss of service can literally be a matter of life and death; at minimum, it is almost certain to cause pain to the affected users. Needless to say, even when life and death are not the issues, users are neither understanding of — nor patient with — service disruption.

As in medicine, the technology for fiber fault diagnosis has grown steadily and with it the amount of training required to effectively use it. An excellent example is the optical time domain reflectometer (OTDR). In both function and operation, the OTDR is analogous to two widely used pieces of diagnostic medical equipment: the computer-aided tomography scanner, commonly known as the CAT scan, and the magnetic resonance imager or MRI. Each is designed to create a picture of the inside of a functioning system, without physically invading or damaging the system. Each does so by sending a signal into the system and creating a computer-generated image of the returned signal. The CAT scan uses X-ray, the MRI a magnetic field, and the OTDR, pulsed laser light.

The resulting images are as complex as they are detailed and require great skill to interpret. It can be argued that such interpretation is as much an art as a science. Like the two medical devices, the OTDR is expensive to buy, expensive to use and of little use in the hands of an inexperienced operator, which brings us to the third point: rationing of service.

Today, when a disruption or degradation of service is identified, a trained expert will typically pick up an OTDR and drive to the vicinity of the problem. There, the OTDR will be interfaced to the circuit and the expert will proceed to "shoot" the line, interpreting the images created by the returned laser pulses to determine the nature and exact location of the problem. If the right starting point was chosen, the process can go fairly quickly; if not, it can drag on for hours.

Of course, the whole process of resolution is delayed until the limited resource — expert or machine, or both — can be transported to the scene. If the resources are already in use elsewhere, crises begin to queue, while revenue is lost and customers fume. Presumably, there would be more $40,000 OTDRs and more experts, had not some financial analyst determined the most cost-effective "balance of pain," the point at which additional expensive equipment and expensive staff cease to pay for themselves.

Unfortunately, the complexity of fiber networks has been such that nonspecialists can do very little to pinpoint the problem. Their broader but less specialized skills are better used in other areas, leaving the patient to suffer until the specialized "doctor" is available. In other words,

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nonOTDR-trained technicians may be sent to handle less critical outages while a major one sits waiting for resources that are otherwise occupied.

Finally, there is the matter of prevention or, at least, early detection. This can be a very complicated issue, dealing as it does with events that may or may not occur. An ounce of prevention may, in fact, be worth a pound of cure when it's a simple matter of a single childhood immunization. If prevention required a shot every day or even every week for an ailment that you had not yet contracted, you might decide to skip the shots and take your chances. Since fiber failure can appear virtually anywhere and resources are already busy keeping up with actual faults, the process of frequent, preventive testing has been far too demanding for implementation.

Figure 2: Sample GUI

Employing a graphical user interface (GUI) permits quick analysis by technicians and can support advanced tools such as mapping software.

Health care for all

So, with all these obstacles, what can be done to provide a "health care system" for a fiber network? In the analogous world of medicine, it might require most or all of the following:

1) Reduce the cost of specialized equipment.

2) Simplify its operation, so it could be used by a general practitioner, instead of requiring a specialist.

3) Figure out a way to administer sophisticated tests over the phone instead of requiring an office visit or house call.

4) Increase the emphasis on prevention, so problems could be headed off before they did damage.

That's a tall order, but it is being done today for fiber networks, in precisely the manner just described.

The development of new, OTDR-like test units has resulted in a more sensitive, compact and self-contained device that is much easier to use than traditional equipment. This is, of course, typical of the trend in the hardware components of most advanced systems. While some of the "simplicity" features are inherent in the devices themselves, the biggest change is in the way they can now be used.

For example, a drop in unit cost enables the deployment of more OTDR-like test units. They no longer have to be carried to a site; instead, they are permanently deployed in the field as integral components of the network, and can be remotely accessed by a technician. Modular switches, which provide an optical test access capability, can be located in a fiber distribution frame lineup in order to connect the test units to a number of fiber cables, each of which can be individually tested.

When deployed in a multitiered cascading configuration, the optical test access devices enable a single OTDR test unit to access over 5,000 fiber cables. A technician can reach any number of test units and, through each one, test all the individual cables to which the optical test access units are connected. In other words, each technician has access to the entire network without the need to travel.

The "art" involved in interpreting OTDR data became necessary because no two cable segments are alike. The technician/specialist looks at a cable that he or she has never seen before, and must determine whether the profile being displayed is "healthy" or not. In the case of a clear break in the line, this may be relatively easy. In other cases, it may be extremely difficult, especially if there is simply a degradation of service. Without the knowledge of what it looked like when it was fully functional, the technician's extensive and expensive training can be sorely tested.

Today, more powerful tools are taking the place of educated guesswork. Fiber administration systems are available that allow the construction of huge relational data bases of information about every inch of the network. (See Figure 1 on page 52.) These systems can store in inventory every component, every external landmark and in some cases a signature trace of a fiber segment at the time of installation. This trace becomes the baseline against which future tests can be measured for signs of deterioration.

The technician is, in essence, a family doctor whose detailed knowledge of the patient provides insight that a specialist might never have. Instead of looking for profiles that indicate something wrong, the technician is simply looking for a trace that is "wrong for this segment," in comparison to previous readings. Fiber administration systems become an extension of the technician.

In addition to providing the baseline trace, these systems will walk the technician through the fault identification and location process. By "riding the network" from central server to a fiber test unit, then through the optical test access unit to a specific fiber, a technician can narrow the location and then locate it exactly in terms of fiber feet from specific landmarks in the data base. When a crew is dispatched, it is not to find the problem, but to fix it.

Clearly, the ability to pinpoint trouble reduces the fault identification and location process from hours to minutes and greatly increases the number of technicians who can perform them. The result is a huge increase in the number of tests that can be performed and a reduction in their cost. This in turn makes it possible to implement a program of preventive testing.

Preventive testing techniques that technicians might want to perform include scheduling individual fibers for testing at predetermined intervals. Or, if a particular run seems vulnerable, it can be scheduled for daily testing, while others are tested weekly or monthly. In this way, administration systems become a management tool for the network, administering "checkups" as a family doctor might. If the patient is in a high risk category for a particular ailment, the doctor might recommend more frequent checkups. The checkups can be completely automated, being run on schedule with no human involvement. Unless, of course, a problem is detected; then the "doctor" is equipped to deal with patient complaints.

Some networks have built-in alarm capabilities. Administration systems can work with these alarm systems, collecting alarm reports, evaluating them and investigating those that exceed set thresholds. All of this can be done without interrupting the operation of the fiber network. The entire operation becomes a hierarchy of response, with perceived issues being escalated — based on the severity of the problem — from alarm system to test administration system to technician.

As a result, the maintenance effort becomes proactive rather than reactive. Problems are more often resolved before they impact customers and revenues. The entire operation becomes, in a sense, an HMO, providing health maintenance for the network. The same effort that had previously been directed toward restoring service is now aimed at preventing interruptions.

Managed implementation

Such administration tools are not installed and made operational overnight. The collection of baseline information into a single data base can take months or even years. Fortunately, there are modular approaches available so the changeover can be managed in steps. Users can start by managing fiber frames and expanding coverage from there. They can start archiving detailed information on newly installed fiber, while retroactively accumulating data on the existing network. The archive and administration system can be run, initially, on a PC and later upgraded to multiuser, multitasking operating system. An effective system is one that gives the user choices.

> ***"Fiber administration systems are available that allow the construction of huge relational data bases of information about every inch of the network."***

There are many ways to implement an administration system but, ideally, it will meet the following criteria:

1) Large capacity for archived information, with a relational data base for data management.

2) Adequate security capabilities for protection of the data.

3) Ease of access by users. A graphical user interface (GUI) allows intuitive operation and reduces training time. (See Figure 2.)

4) Capability of centralized control. The less travel required, the better use you can make of your resources.

5) Programmable system intelligence. If the system can make preliminary decisions, technical staff can focus on the most serious problems.

6) Highest available sensitivity of attached test equipment.

7) High capacity switching to allow each of the testing units to cover a large segment of the network. This allows you to deploy the best testing units, while getting maximum coverage from each.

8) Choice of operating systems, including a multiuser, multitasking system capability.

9) Capability of fully automated testing.

10) The ability to test active fiber segments without service interruption.

11) An open architecture, using industry standard interfaces. This will give you flexibility in choosing components now and in the future.

Summary

As fiber networks continue to expand, maintenance becomes more critical and, potentially, more difficult. Fortunately, as fiber technology develops, administration systems are being developed that allow you to keep up with, or even pull ahead of, the growing network — as well as help you keep a healthy network *and* a healthy bottom line. **BTB**

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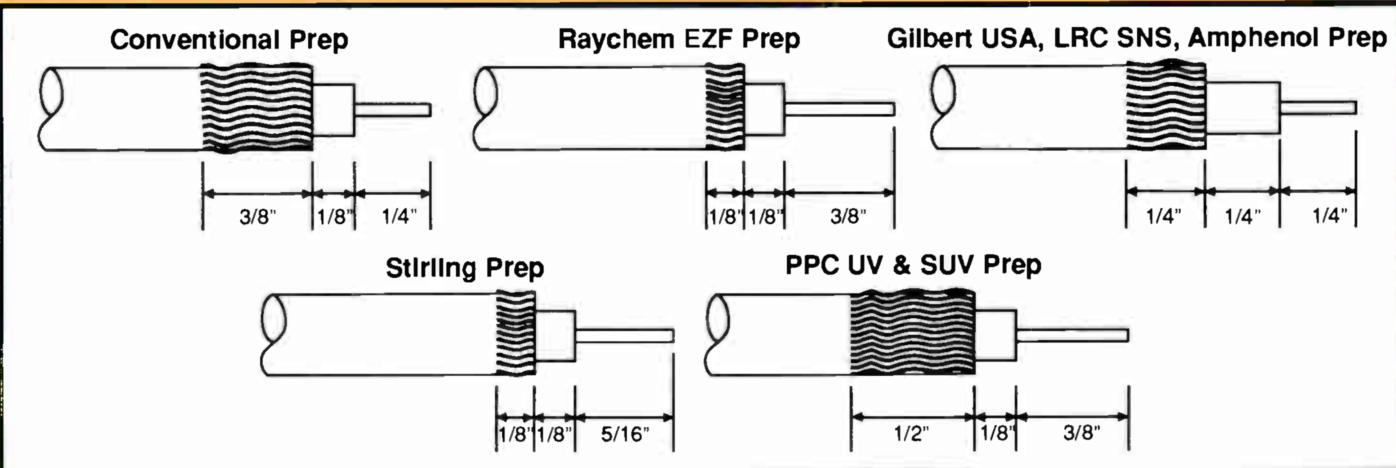

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May require special cable prep dimensions and/or tools.

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95% Braid	9108 9109	F-59-UNI	.360	GF-59-AHS-312 GF-59-AHS-USA	.324 .360	F-59-QS AMF-59	.324 .360	CFS-59-UV CFS-59-U	.360 .360	QF-59-RNS	SPP-59-I
Tri- (67%) Shield	9050 9110 9111	F-59-ALM F-59-UNI	.324 .360	GF-59-AHS-290 GF-59-AHS-USA	.324 .360	F-59-CH AMF-59	.324 .360	CFS-59-UV CFS-59-U	.360 .360	QF-59-RNS	SPP-59-I
(77%)	9052 9053 9063	F-59-ALM F-59-UNI	.324 .360	GF-59-AHS-312 GF-59-AHS-USA	.324 .360	F-59-CH AMF-59	.324 .360	CFS-59-UV CFS-59-U	.360 .360	QF-59-RNS	SPP-59-I
Quad-Shield	1186A 1187A 1188A	F-59-UNI	.360	GF-59-AHS-312 GF-59-AHS-USA	.324 .360	F-59-QS AMF-59	.324 .360	CFS-59-UV CFS-59-U	.360 .360	QF-59-RNS-QD	SPP-59-IQ

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90% Braid	1530A 1531A 1532A	F-56-UNI	.360	GF-6-AHS-342 GF-6-AHS-USA	.324 .360	F-56-CH AMF-6	.324 .360	CFS-56-UV CFS-56-U	.360 .360	QF-56-RNS	SPP-6-I
Tri- (61%) Shield	9118 9119	F-56-ALM F-56UNI	.324 .360	GF-6-AHS-342 GF-6-AHS-USA	.324 .360	F-56-CH AMF-6	.324 .360	CFS-56-UV CFS-56-U	.360 .360	QF-56-RNS	SPP-6-I
(77%)	9058 9059 9062	F-56-UNI	.360	GF-6-AHS-342 GF-6-AHS-USA	.324 .360	F-56-CH AMF-6	.324 .360	CFS-56-UV CFS-56-U	.360 .360	QF-56-RNS	SPP-6-I
Quad-Shield	1189A 1190A 1191A	F-56-UNI	.360	GF-6-AHS-342 GF-6-AHS-USA	.324 .360	F-56-QS AMF-6	.360 .360	CFS-56-UV CFS-56-U	.360 .360	QF-56-RNS-QD	SPP-6-IQ

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95% Braid	F5995BV F5995BVM F5995BEF	F-59-UNI	.360	GF-59-AHS-312 GF-59-AHS-USA	.324 .360	F-59-HB AMF-59	.324 .360	CFS-59-UV CFS-59-U	.360 .360	QF-59-RNS	SPP-59-I
Tri- (67%) Shield	F59TSV F59TSVM	F-59-ALM F-59-UNI	.324 .360	GF-59-AHS-312 GF-59-AHS-USA	.324 .360	F-59-HB AMF-59	.324 .360	CFS-59-UV CFS-59-U	.360 .360	QF-59-RNS	SPP-59-I
Quad-Shield	F59SSV F59SSVM F59SSEF	F-59-UNI	.360	GF-59-AHS-312 GF-59-AHS-USA	.324 .360	F-59-QS AMF-59	.324 .360	CFS-59-UV CFS-59-U	.360 .360	QF-59-RNS-QD	SPP-59-IQ

Non-Sealed F-Fittings

TIMES FIBER

Foam Dielectric, APA Bonded Foil Tape, includes CATV (UL).

May require special cable prep dimensions and/or tools.

59 Series

Braid Coverage	Part Number	Cabelcon Fitting	Cabelcon Crimp	Gilbert Fitting	Gilbert Crimp	LRC Fitting	LRC Crimp	PPC Fitting	PPC Crimp	QF Fitting	Stirling Fitting
67% Braid	2183 2185 2186	F-59-ALM F-59-UNI	.324 .360	GF-59-AHS-290 GF-59-AHS-USA	.324 .360	F-59-CH AMF-59	.324 .360	CFS-59-UV CFS-59-U	.360 .360	QF-59-RNS	SPP-59-I
95% Braid	2545 2547 2574	F-59-UNI	.360	GF-59-AHS-312 GF-59-AHS-USA	.324 .360	F-59-HB AMF-59	.324 .360	CFS-59-UV CFS-59-U	.360 .360	QF-59-RNS	SPP-59-I
Tri- (53%) Shield	2602 2603 2604	F-59-ALM F-59-UNI	.324 .360	GF-59-AHS-290 GF-59-AHS-USA	.324 .360	F-59-CH AMF-59	.324 .360	CFS-59-UV CFS-59-U	.360 .360	QF-59-RNS	SPP-59-I
(80%)	2607 2608 2609	F-59-ALM F-59-UNI	.324 .360	GF-59-AHS-312 GF-59-AHS-USA	.324 .360	F-59-HB AMF-59	.324 .360	CFS-59-UV CFS-59-U	.360 .360	QF-59-RNS	SPP-59-I
Quad-Shield	2245 2247 2274	F-59-UNI	.360	GF-59-AHS-312 GF-59-AHS-USA	.324 .360	F-59-QS AMF-59	.324 .360	CFS-59-UV CFS-59-U	.360 .360	QF-59-RNS-QD	SPP-59-IQ

6 Series

Braid Coverage	Part Number	Cabelcon Fitting	Cabelcon Crimp	Gilbert Fitting	Gilbert Crimp	LRC Fitting	LRC Crimp	PPC Fitting	PPC Crimp	QF Fitting	Stirling Fitting
60% Braid	2360 2364 2386	F-56-ALM F-56-UNI	.324 .360	GF-6-AHS-322 GF-6-AHS-USA	.324 .360	F-56-CH AMF-6	.324 .360	CFS-56-UV CFS-56-U	.360 .360	QF-56-RNS	SPP-6-I
90% Braid	2560 2564 2586	F-56-UNI	.360	GF-6-AHS-342 GF-6-AHS-USA	.324 .360	F-56-CH AMF-6	.324 .360	CFS-56-UV CFS-56-U	.360 .360	QF-56-RNS	SPP-6-I
Tri- (53%) Shield	2622 2623 2624	F-56-ALM F-56-UNI	.324 .360	GF-6-AHS-322 GF-6-AHS-USA	.324 .360	F-56-CH AMF-6	.324 .360	CFS-56-UV CFS-56-U	.360 .360	QF-56-RNS	SPP-6-I
(80%)	2627 2628 2629	F-56-UNI	.324	GF-6-AHS-342 GF-6-AHS-USA	.324 .360	F-56-CH AMF-6	.324 .360	CFS-56-UV CFS-56-U	.360 .360	QF-56-RNS	SPP-6-I
Quad-Shield	2260 2264 2286	F-56-UNI	.360	GF-6-AHS-342 GF-6-AHS-USA	.324 .360	F-56-QS AMF-6	.360 .360	CFS-56-UV CFS-56-U	.360 .360	QF-56-RNS-QD	SPP-6-IQ

F-Fittings

6 Series

60% Braid	F660BV F660BVM F660BEF	F-56-ALM F-56-UNI	.324 .360	GF-6-AHS-322 GF-6-AHS-USA	.324 .360	F-56-CH AMF-6	.324 .360	CFS-56-UV CFS-56-U	.360 .360	QF-56-RNS	SPP-6-I
90% Braid	F690BV F690BVM F690BEF	F-56-UNI	.360	GF-6-AHS-342 GF-6-AHS-USA	.324 .360	F-56-CH AMF-6	.324 .360	CFS-56-UV CFS-56-U	.360 .360	QF-56-RNS	SPP-6-I
Tri- (60%) Shield	F6TSV F6TSVM	F-56-ALM F-56-UNI	.324 .360	GF-6-AHS-322 GF-6-AHS-USA	.324 .360	F-56-CH AMF-6	.324 .360	CFS-56-UV CFS-56-U	.360 .360	QF-56-RNS	SPP-6-I
Quad- Shield	F6SSV F6SSVM F6SSEF	F-56-UNI	.360	GF-6-AHS-342 GF-6-AHS-USA	.324 .360	F-56-QS AMF-6	.360 .360	CFS-56-UV CFS-56-U	.360 .360	QF-56-RNS-QD	SPP-6-IQ

Non-Sealed F-Fittings

TRILOGY
59 Series

Foam Dielectric, APA Bonded Foil Tape, includes CATV (UL).

May require special cable prep dimensions and/or tools.

Braid Coverage	Part Number	Cabelcon		Gilbert		LRC		PPC		QF	Stirling
		Fitting	Crimp	Fitting	Crimp	Fitting	Crimp	Fitting	Crimp	Fitting	Fitting
67% Braid	5910 5911 5912	F-59-ALM F-59-UNI	.324 .360	GF-59-AHS-290 GF-59-AHS-USA	.324 .360	F-59-CH AMF-59	.324 .360	CFS-59-UV CFS-59-U	.360 .360	QF-59-RNS	SPP-59-I
95% Braid	5960 5961 5962	F-59-UNI	.360	GF-59-AHS-312 GF-59-AHS-USA	.324 .360	F-59-HB AMF-59	.324 .360	CFS-59-UV CFS-59-U	.360 .360	QF-59-RNS	SPP-59-I
Tri- (67%) Shield	5970 5971 5972	F-59-ALM F-59-UNI	.324 .360	GF-59-AHS-290 GF-59-AHS-USA	.324 .360	F-59-CH AMF-59	.324 .360	CFS-59-UV CFS-59-U	.360 .360	QF-59-RNS	SPP-59-I
(95%)	5990 5991 5992	F-59-UNI	.360	GF-59-AHS-312 GF-59-AHS-USA	.324 .360	F-59-HB AMF-59	.324 .360	CFS-59-UV CFS-59-U	.360 .360	QF-59-RNS	SPP-59-I
Quad- Shield	5950 5951 5952	F-59-UNI	.360	GF-59-AHS-312 GF-59-AHS-USA	.324 .360	F-59-QS AMF-59	.324 .360	CFS-59-UV CFS-59-U	.360 .360	QF-59-RNS-QD	SPP-59-IQ

6 Series

60% Braid	6000 6001 6002	F-56-ALM F-56-UNI	.324 .360	GF-6-AHS-322 GF-6-AHS-USA	.324 .360	F-56-CH AMF-6	.324 .360	CFS-56-UV CFS-56-U	.360 .360	QF-56-RNS	SPP-6-I
90% Braid	6060 6061 6062	F-56-UNI	.360	GF-6-AHS-342 GF-6-AHS-USA	.324 .360	F-56-CH AMF-6	.324 .360	CFS-56-UV CFS-56-U	.360 .360	QF-56-RNS	SPP-6-I
Tri- (60%) Shield	6070 6071 6072	F-56-ALM F-56-UNI	.324 .360	GF-6-AHS-312 GF-6-AHS-USA	.324 .360	F-56-CH AMF-6	.324 .360	CFS-56-UV CFS-56-U	.360 .360	QF-56-RNS	SPP-6-I
(90%)	6090 6091 6092	F-56-UNI	.360	GF-6-AHS-322 GF-6-AHS-USA	.324 .360	F-56-CH AMF-6	.324 .360	CFS-56-UV CFS-56-U	.360 .360	QF-56-RNS	SPP-6-I
Quad- Shield	6050 6051 6052	F-56-UNI	.360	GF-6-AHS-342 GF-6-AHS-USA	.324 .360	F-56-QS AMF-6	.360 .360	CFS-56-UV CFS-56-U	.360 .360	QF-56-RNS-QD	SPP-6-IQ

Environmentally Sealed F-Fittings

BELDEN

Foam Dielectric, APA Bonded Foil Tape, includes CATVX and CATV (UL).

May require special cable prep dimensions and/or tools.

59 Series

Braid Coverage	Part Number	Amphenol		Cabelcon		Gilbert		LRC		PPC		Raychem	Stirling
		Fitting	Crimp	Fitting	Crimp	Fitting	Crimp	Fitting	Crimp	Fitting	Crimp	Fitting	Fitting
67% Braid	9104 9105 9067	6531-59	.276R	EPA-FM59R	.360	GFWL59-AHS-USA	.360	SNS-59-NS AMF-59S	 .360	CFS-59-SUV CFS-59-SU	.360 .360	EZF-59	SPP-59-O
95% Braid	9108 9109	6531-59	.276R	EPA-FM59Q	.360	GFWL59-AHS-USA	.360	SNS-59-NS AMF-59S	 .360	CFS-59-SUV CFS-59-SU	.360 .360	EZF-59	SPP-59-O
Tri- (67%) Shield	9050 9110 9111	6531-59	.276R	EPA-FM59R	.360	GFWL59-AHS-USA	.360	SNS-59-NS AMF-59S	 .360	CFS-59-SUV CFS-59-SU	.360 .360	EZF-59	SPP-59-O
(77%)	9052 9053 9063	6531-59	.276R	EPA-FM59Q	.360	GFWL59-AHS-USA	.360	SNS-59-NS AMF-59S	 .360	CFS-59-SUV CFS-59-SU	.360 .360	EZF-59	SPP-59-O
Quad-Shield	1186A 1187A 1188A	6531-59	.276R	EPA-FM59Q	.360	GFWL59-AHS-USA	.360	SNS-59QS-NS AMF-59S	 .360	CFS-59-SUV CFS-59-SU	.360 .360	EZF-59	SPP-59-OQ

6 Series

Braid Coverage	Part Number	Amphenol		Cabelcon		Gilbert		LRC		PPC		Raychem	Stirling
		Fitting	Crimp	Fitting	Crimp	Fitting	Crimp	Fitting	Crimp	Fitting	Crimp	Fitting	Fitting
61% Braid	9116 9117 9066	6531-6	.325R	EPA-FM06R	.360	GFWL6-AHS-USA	.360	SNS-6-NS AMF-6S	 .360	CFS-56-SUV CFS-56-SU	.360 .360	EZF-6	SPP-6-O
90% Braid	1530A 1531A 1532A	6531-6	.325R	EPA-FM06Q	.360	GFWL6-AHS-USA	.360	SNS-6-NS AMF-6S	 .360	CFS-56-SUV CFS-56-SU	.360 .360	EZF-6	SPP-6-O
Tri- (61%) Shield	9118 9119	6531-6	.325R	EPA-FM06R	.360	GFWL6-AHS-USA	.360	SNS-6-NS AMF-6S	 .360	CFS-56-SUV CFS-56-SU	.360 .360	EZF-6	SPP-6-O
(77%)	9058 9059 9062	6531-6	.325R	EPA-FM06Q	.360	GFWL6-AHS-USA	.360	SNS-6-NS AMF-6S	 .360	CFS-56-SUV CFS-56-SU	.360 .360	EZF-6	SPP-6-O
Quad-Shield	1189A 1190A 1191A	6531-6	.325R	EPA-FM06Q	.360	GFWL6-AHS-USA	.360	SNS-6QS-NS AMF-6S	 .360	CFS-56-SUV CFS-56-SU	.360 .360	EZF-6	SPP-6-OQ

Environmentally

COMM/SCOPE

Foam Dielectric, APA Bonded Foil Tape, includes CATVX and CATV (UL).

May require special cable prep dimensions and/or tools.

59 Series

Braid Coverage	Part Number	Amphenol		Cabelcon		Gilbert		LRC		PPC		Raychem	Stirling
		Fitting	Crimp	Fitting	Crimp	Fitting	Crimp	Fitting	Crimp	Fitting	Crimp	Fitting	Fitting
67% Braid	F5967BV F5967BVM F5967BEF	6531-59	.276R	EPA-FM59R	.360	GFWL59-AHS-USA	.360	SNS-59-NS AMF-59S	 .360	CFS-59-SUV CFS-59-SU	.360 .360	EZF-59	SPP-59-O
95% Braid	F5995BV F5995BVM F5995BEF	6531-59	.276R	EPA-FM59Q	.360	GFWL59-AHS-USA	.360	SNS-59-NS AMF-59S	 .360	CFS-59-SUV CFS-59-SU	.360 .360	EZF-59	SPP-59-O
Tri- (67%) Shield	F59TSV F59TSVM	6531-59	.276R	EPA-FM59R	.360	GFWL59-AHS-USA	.360	SNS-59-NS AMF-59S	 .360	CFS-59-SUV CFS-59-SU	.360 .360	EZF-59	SPP-59-O
Quad-Shield	F59SSV F59SSVM F59SSEF	6531-59	.276R	EPA-FM59Q	.360	GFWL59-AHS-USA	.360	SNS-59QS-NS AMF-59S	 .360	CFS-59-SUV CFS-59-SU	.360 .360	EZF-59	SPP-59-OQ

Environmentally Sealed F-Fittings

TIMES FIBER

Foam Dielectric, APA Bonded Foil Tape, includes CATV (UL).

May require special cable prep dimensions and/or tools.

59 Series

Braid Coverage	Part Number	Amphenol		Cabelcon		Gilbert		LRC		PPC		Raychem	Stirling
		Fitting	Crimp	Fitting	Crimp	Fitting	Crimp	Fitting	Crimp	Fitting	Crimp	Fitting	Fitting
67% Braid	2183 2185 2186	6531-59	.276R	EPA-FM59R	.360	GFWL59-AHS-USA	.360	SNS-59-NS AMF-59S	 .360	CFS-59-SUV CFS-59-SU	.360 .360	EZF-59	SPP-59-O
95% Braid	2545 2547 2574	6531-59	.276R	EPA-FM59Q	.360	GFWL59-AHS-USA	.360	SNS-59-NS AMF-59S	 .360	CFS-59-SUV CFS-59-SU	.360 .360	EZF-59	SPP-59-O
Tri-Shield (53%)	2602 2603 2604	6531-59	.276R	EPA-FM59R	.360	GFWL59-AHS-USA	.360	SNS-59-NS AMF-59S	 .360	CFS-59-SUV CFS-59-SU	.360 .360	EZF-59	SPP-59-O
(80%)	2607 2608 2609	6531-59	.276R	EPA-FM59Q	.360	GFWL59-AHS-USA	.360	SNS-59-NS AMF-59S	 .360	CFS-59-SUV CFS-59-SU	.360 .360	EZF-59	SPP-59-O
Quad-Shield	2245 2247 2274	6531-59	.276R	EPA-FM59Q	.360	GFWL59-AHS-USA	.360	SNS-59QS-NS AMF-59S	 .360	CFS-59-SUV CFS-59-SU	.360 .360	EZF-59	SPP-59-OQ

6 Series

Braid Coverage	Part Number	Amphenol Fitting	Crimp	Cabelcon Fitting	Crimp	Gilbert Fitting	Crimp	LRC Fitting	Crimp	PPC Fitting	Crimp	Raychem Fitting	Stirling Fitting
60% Braid	2360 2364 2386	6531-6	.325R	EPA-FM06R	.360	GFWL6-AHS-USA	.360	SNS-6-NS AMF-6S	 .360	CFS-56-SUV CFS-56-SU	.360 .360	EZF-6	SPP-6-O
90% Braid	2560 2564 2586	6531-6	.325R	EPA-FM06Q	.360	GFWL6-AHS-USA	.360	SNS-6-NS AMF-6S	 .360	CFS-56-SUV CFS-56-SU	.360 .360	EZF-6	SPP-6-O
Tri-Shield (53%)	2622 2623 2624	6531-6	.325R	EPA-FM06R	.360	GFWL6-AHS-USA	.360	SNS-6-NS AMF-6S	 .360	CFS-56-SUV CFS-56-SU	.360 .360	EZF-6	SPP-6-O
(80%)	2627 2628 2629	6531-6	.325R	EPA-FM06Q	.360	GFWL6-AHS-USA	.360	SNS-6-NS AMF-6S	 .360	CFS-56-SUV CFS-56-SU	.360 .360	EZF-6	SPP-6-O
Quad-Shield	2260 2264 2286	6531-6	.325R	EPA-FM06Q	.360	GFWL6-AHS-USA	.360	SNS-6QS-NS AMF-6S	 .360	CFS-56-SUV CFS-56-SU	.360 .360	EZF-6	SPP-6-OQ

Sealed F-Fittings

6 Series

Braid Coverage	Part Number	Amphenol Fitting	Crimp	Cabelcon Fitting	Crimp	Gilbert Fitting	Crimp	LRC Fitting	Crimp	PPC Fitting	Crimp	Raychem Fitting	Stirling Fitting
60% Braid	F660BV F660BVM F660BEF	6531-6	.325R	EPA-FM06R	.360	GFWL6-AHS-USA	.360	SNS-6-NS AMF-6S	 .360	CFS-56-SUV CFS-56-SU	.360 .360	EZF-6	SPP-6-O
90% Braid	F690BV F690BVM F690BEF	6531-6	.325R	EPA-FM06Q	.360	GFWL6-AHS-USA	.360	SNS-6-NS AMF-6S	 .360	CFS-56-SUV CFS-56-SU	.360 .360	EZF-6	SPP-6-O
Tri-Shield (60%)	F6TSV F6TSVM	6531-6	.325R	EPA-FM06R	.360	GFWL6-AHS-USA	.360	SNS-6-NS AMF-6S	 .360	CFS-56-SUV CFS-56-SU	.360 .360	EZF-6	SPP-6-O
Quad-Shield	F6SSV F6SSVM F6SSEF	6531-6	.325R	EPA-FM06Q	.360	GFWL6-AHS-USA	.360	SNS-6QS-NS AMF-6S	 .360	CFS-56-SUV CFS-56-SU	.360 .360	EZF-6	SPP-6-OQ

Environmentally

Indoor F-Fittings

TRILOGY
59 Series

Foam Dielectric, APA Bonded Foil Tape, includes CATV (UL).

May require special cable prep dimensions and/or tools.

Braid Coverage	Part Number	Amphenol		Cabelcon		Gilbert		LRC		PPC		Raychem	Stirling
		Fitting	Crimp	Fitting	Crimp	Fitting	Crimp	Fitting	Crimp	Fitting	Crimp	Fitting	Fitting
67% Braid	5910 5911 5912	6531-59	.276R	EPA-FM59R	.360	GFWL59-AHS-USA	.360	SNS-59-NS AMF-59S	 .360	CFS-59-SUV CFS-59-SU	.360 .360	EZF-59	SPP-59-O
95% Braid	5960 5961 5962	6531-59	.276R	EPA-FM59Q	.360	GFWL59-AHS-USA	.360	SNS-59-NS AMF-59S	 .360	CFS-59-SUV CFS-59-SU	.360 .360	EZF-59	SPP-59-O
Tri- (67%) Shield	5970 5971 5972	6531-59	.276R	EPA-FM59R	.360	GFWL59-AHS-USA	.360	SNS-59-NS AMF-59S	 .360	CFS-59-SUV CFS-59-SU	.360 .360	EZF-59	SPP-59-O
(95%)	5990 5991 5992	6531-59	.276R	EPA-FM59Q	.360	GFWL59-AHS-USA	.360	SNS-59-NS AMF-59S	 .360	CFS-59-SUV CFS-59-SU	.360 .360	EZF-59	SPP-59-O
Quad-Shield	5950 5951 5952	6531-59	.276R	EPA-FM59Q	.360	GFWL59-AHS-USA	.360	SNS-59QS-NS AMF-59S	 .360	CFS-59-SUV CFS-59-SU	.360 .360	EZF-59	SPP-59-OQ

BELDEN

Foam Dielectric, APA Bonded Foil Tape, includes CATVX and CATV (UL).

May require special cable prep dimensions and/or tools.

59 Series

Braid Coverage	Part No.	LRC	PPC	Raychem
		Fitting	Fitting	Fitting
67% Braid	9104 9105 9067	PNL 59	QUIK-LOK 59	EZ Twist-59-S/T
95% Braid	9108 9109	PNL 59	QUIK-LOK 59Q	EZ Twist-59-S/T
Tri- (67%) Shield	9050 9110 9111	PNL 59	QUIK-LOK 59	EZ Twist-59-S/T
(77%)	9052 9053 9063	PNL 59	QUIK-LOK 59	EZ Twist-59-S/T
Quad-Shield	1186A 1187A 1188A	PNL 59	QUIK-LOK 59Q	EZ Twist-59-S/T

6 Series

Braid Coverage	Part No.	LRC	PPC	Raychem
		Fitting	Fitting	Fitting
61% Braid	9116 9117 9066	PNL 6	QUIK-LOK 6	EZ Twist-6-S/T
90% Braid	1530A 1531A 1532A	PNL 6	QUIK-LOK 6Q	EZ Twist-6-S/T
Tri- (61%) Shield	9118 9119	PNL 6	QUIK-LOK 6	EZ Twist-6-S/T
(77%)	9058 9059 9062	PNL 6	QUIK-LOK 6	EZ Twist-6-S/T
Quad-Shield	1189A 1190A 1191A	PNL 6	QUIK-LOK 6Q	EZ Twist-6-S/T

COMM/SCOPE

Foam Dielectric, APA Bonded Foil Tape, includes CATVX and CATV (UL).

May require special cable prep dimensions and/or tools.

59 Series

Braid Coverage	Part No.	LRC	PPC	Raychem
		Fitting	Fitting	Fitting
67% Braid	F5967BV F5967BVM F5967BEF	PNL 59	QUIK-LOK 59	EZ Twist-59-S/T
95% Braid	F5995BV F5995BVM F5995BEF	PNL 59	QUIK-LOK 59Q	EZ Twist-59-S/T
Tri- (67%) Shield	F59TSV F59TSVM	PNL 59	QUIK-LOK 59	EZ Twist-59-S/T
Quad-Shield	F59SSV F59SSVM F59SSEF	PNL 59	QUIK-LOK 59Q	EZ Twist-59-Q

6 Series

Braid Coverage	Part No.	LRC	PPC	Raychem
		Fitting	Fitting	Fitting
60% Braid	F660BV F660BVM F660BEF	PNL 6	QUIK-LOK 6	EZ Twist-6-S/T
90% Braid	F690BV F690BVM F690BEF	PNL 6	QUIK-LOK 6Q	EZ Twist-6-S/T
Tri- (60%) Shield	F6TSV F6TSVM	PNL 6	QUIK-LOK 6	EZ Twist-6-S/T
Quad-Shield	F6SSV F6SSVM F6SSEF	PNL 6	QUIK-LOK 6Q	EZ Twist-6-S/T

Sealed F-Fittings

6 Series

60% Braid	6000 6001 6002	6531-6 .325R	EPA-FM06R .360	GFWL6-AHS-USA .360	SNS-6-NS AMF-6S .360	CFS-56-SUV .360 CFS-56-SU .360	EZF-6	SPP-6-O
90% Braid	6060 6061 6062	6531-6 .325R	EPA-FM06Q .360	GFWL6-AHS-USA .360	SNS-6-NS AMF-6S .360	CFS-56-SUV .360 CFS-56-SU .360	EZF-6	SPP-6-O
Tri- (60%) Shield	6070 6071 6072	6531-6 .325R	EPA-FM06R .360	GFWL6-AHS-USA .360	SNS-6-NS AMF-6S .360	CFS-56-SUV .360 CFS-56-SU .360	EZF-6	SPP-6-O
(90%)	6090 6091 6092	6531-6 .325R	EPA-FM06Q .360	GFWL6-AHS-USA .360	SNS-6-NS AMF-6S .360	CFS-56-SUV .360 CFS-56-SU .360	EZF-6	SPP-6-O
Quad- Shield	6050 6051 6052	6531-6 .325R	EPA-FM06Q .360	GFWL6-AHS-USA .360	SNS-6QS-NS AMF-6S .360	CFS-56-SUV .360 CFS-56-SU .360	EZF-6	SPP-6-OQ

TIMES FIBER

Foam Dielectric, APA Bonded Foil Tape, includes CATV (UL).

59 Series

May require special cable prep dimensions and/or tools.

Braid Coverage	Part No.	LRC Fitting	PPC Fitting	Raychem Fitting
67% Braid	2183 2185 2186	PNL 59	QUIK- LOK 59	EZ Twist- 59-S/T
95% Braid	2545 2547 2574	PNL 59	QUIK- LOK 59Q	EZ Twist- 59-S/T
Tri- (53%) Shield	2602 2603 2604	PNL 59	QUIK- LOK 59	EZ Twist- 59-S/T
(80%)	2607 2608 2609	PNL 59	QUIK-LOK 59 & 59Q	EZ Twist- 59-S/T
Quad- Shield	2245 2247 2274	PNL 59	QUIK- LOK 59Q	EZ Twist- 59-Q

6 Series

Braid Coverage	Part No.	LRC Fitting	PPC Fitting	Raychem Fitting
60% Braid	2360 2364 2386	PNL 6	QUIK- LOK 6	EZ Twist- 6-S/T
90% Braid	2560 2564 2586	PNL 6	QUIK- LOK 6Q	EZ Twist- 6-S/T
Tri- (53%) Shield	2622 2623 2624	PNL 6	QUIK- LOK 6	EZ Twist- 6-S/T
(80%)	2627 2628 2629	PNL 6	QUIK-LOK 6 & 6Q	EZ Twist- 6-S/T
Quad- Shield	2260 2264 2286	PNL 6	QUIK-LOK LOK 6Q	EZ Twist- 6-Q

TRILOGY

Foam Dielectric, APA Bonded Foil Tape, includes CATV (UL).

59 Series

May require special cable prep dimensions and/or tools.

Braid Coverage	Part No.	LRC Fitting	PPC Fitting	Raychem Fitting
67% Braid	5910 5911 5912	PNL 59	QUIK- LOK 59	EZ Twist- 59-S/T
95% Braid	5960 5961 5962	PNL 59	QUIK- LOK 59Q	EZ Twist- 59-S/T
Tri- (67%) Shield	5970 5971 5972	PNL 59	QUIK- LOK 59	EZ Twist- 59-S/T
(95%)	5990 5991 5992	PNL 59	QUIK- LOK 59Q	EZ Twist- 59-S/T
Quad- Shield	5950 5951 5952	PNL 59	QUIK- LOK 59Q	EZ Twist- 9-S/T

6 Series

Braid Coverage	Part No.	LRC Fitting	PPC Fitting	Raychem Fitting
60% Braid	6000 6001 6002	PNL 6	QUIK- LOK 6	EZ Twist- 6-S/T
90% Braid 6062	6060 6061	PNL 6	QUIK- LOK 6Q	EZ Twist- 6-S/T
Tri- (60%) Shield	6070 6071 6072	PNL 6	QUIK- LOK 6	EZ Twist- 6-S/T
(90%)	6090 6091 6092	PNL 6	QUIK- LOK 6Q	EZ Twist- 6-S/T
Quad- Shield	6050 6051 6052	PNL 6	QUIK- LOK 6Q	EZ Twist- 6-S/T

Hex Crimpers*

Lemco

Part Number	Minor Hex	Hex	Major Hex
R-360			.360
R-731	.262	.324	.384
R-953	.324		.360
R-842	.324		.360

LRC

Part Number	Minor Hex	Hex	Major Hex
CT-596	.262		.324
HCT-6QS	.324		.360
CT-611-QS	.360		.470
CT-2460	.324		.360

Gilbert

Part Number	Minor Hex	Hex	Major Hex
G-CRT-659	.262		.324
G-CRT-660	.324		.384
G-CRT-804	.262	.324	.384
G-CRT-986	.324		.360
G-CRT-USA			.360

Ben Hughes/Cable Prep

Part Number	Minor Hex	Hex	Major Hex
HCT-116	.324		.472
HCT-360	.068		.360
HCT-659	.262		.324
HCT-USA			.360
HCT-611	.324		.410
HCT-660	.324		.384
HCT-986	.324		.360
HCT-669	.262	.324	.384
HCT-775	.064/.096	.324	.384
HCT-902	.100	.324	.475

Ripley/Cablematic

Part Number	Minor Hex	Hex	Major Hex
CR-596-B	.262		.324
CR-596-Q	.324		.384
CR-596-QR	.324		.384
CR-596-11	.324		.410
CR-596-QL2	.068	.324	.360
CR-360			.360
CR-360-R			.360
CR-596-QL	.324		.360
CR-596-QLR	.324		.360
CR-611-Q	.324		.475
CR-611-Q2	.100	.324	.475
CR-611-QL	.324		.470
CR-775	.068/.100	.324	.384

PPC

Part Number	Minor Hex	Hex	Major Hex
HCT-360-SUV			.360

Sargent/Rostra

Part Number	Minor Hex	Hex	Major Hex
3150-CCT	.262	.324	.384
3152-CCT	.068	.178	.324
3154-CCT	.324		.360
3350-CCT	.262	.324	.384
3354-CCT	.324		.360
4158-CCT	.068/.100	.324	.360
6158-CCT	.068/.100	.324	.360

* Identify the fittings and hex crimp sizes you need, then find the appropriate tool from the above list.

SCTE Interface Practices Subcommittee

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While the connectors listed are the manufacturers' recommendations based on various parameters such as pull strength, esthetics, ease of assembly and cable trim specifications, etc., it is not a negative recommendation if manufacturers and connectors are not included. This tabulation is a starting point for the proper selection of a cable and connector combination.

When publishing data of this nature, problems of a remarkably short useful life occur almost immediately. Therefore the SCTE Interface Practices Subcommittee recommends contacting the appropriate manufacturer for the most current information available. Another way to determine an acceptable connector and cable combination is to send samples of the cable along with requirements to your connector supplier.

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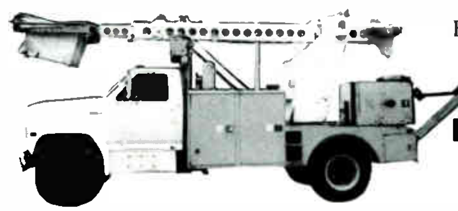

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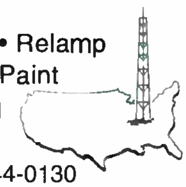

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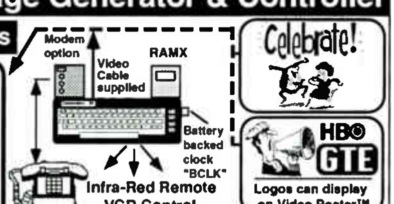

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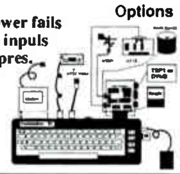

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Positions require one year minimum experience designing hybrid fiber-coax distribution systems, two years minimum experience doing coax system design using computer-aided design tools.

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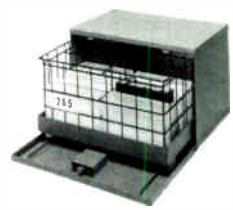
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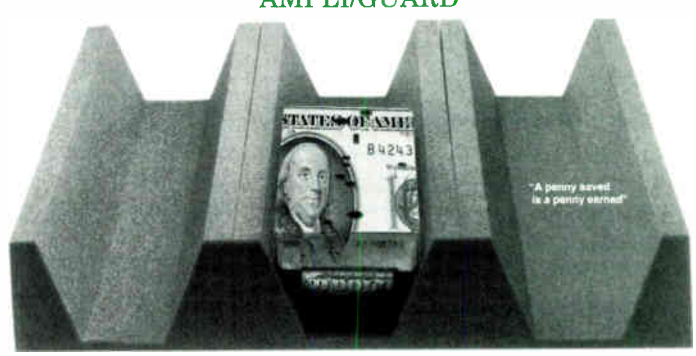


Reader Service Number 59

Test set

Noyes Fiber Systems introduced the Model OLTS 3-1 full-featured optical loss test set. The unit is designed to be a rugged, reliable, portable test instrument providing simple yet accurate loss measurements at 850 and 1,300 nm. While primarily for multimode systems, the unit will measure single-mode networks up to 10 miles (16 km).

Features include storage of 250 loss readings per wavelength, tone (2 kHz modulation and detection for fiber identification), automatic wavelength identification, auto-zero reference setting, backlit display, rechargeable NiCad battery operation and software for viewing loss data, editing information headers and printing loss reports.

Reader service #208

PAL monitor

Tektronix Inc. introduced the WFM91 hand-held waveform/vector/picture/audio monitor, a PAL version of the WFM90 NTSC monitor. The newest member of the company's line of low-cost, hand-held products is designed for audio and PAL video monitoring in field applications. The company says it is the only PAL instrument to combine the display capabilities of four TV instruments in a single palmtop unit: color picture monitor, waveform monitor, vectorscope and voltage vs. time audio monitor.

A four-inch diagonal color thin film transistor LCD provides a full-screen display of any of the four monitor display modes, which are accessed through a simple keypad and menus. Additionally, the waveform, vector or audio displays can be cut into a corner of the display for simultaneous viewing.

To identify amplitude and timing problems, the unit's waveform monitor mode provides the functionality of a basic, single-input waveform monitor: X1 and X5 vertical gain; 1H, 2H and 2F sweep rates; vertical and horizontal positioning; and a luminance filter. To simplify identification of signals with excessive gain, an amplitude alarm changes the waveform's color when the signal exceeds 100% IRE. An external reference input is included for making system timing adjustments.

The vectorscope display mode allows complete adjustment and evaluation of a video signal's color parameters. Simple on-screen menus provide access to the controls most commonly used on a vectorscope: X1, X5 or variable gain; color bar amplitudes of 75 or 100%; and a 360° phase shifter.

Audio setup and monitoring in the field are simplified by the unit's monaural audio display, which features variable reference level settings. A built-in headphone jack and an XLR input connector let the user listen to program audio and perform quick microphone checks. When teamed with the company's TSG95 NTSC/PAL test signal generator, the unit can quickly isolate video distribution system problems in the field or studio. The unit is powered by six alkaline C cells, a 12 volt AC adapter or an optional NiCad battery pack.

Reader service #180

Lapping film

Fiber Optic Center Inc. introduced a 0.3 micron calcined alumina lapping film for machine or hand final polish of multimode connectors. Particle size distribution is tightly controlled through a combination of purified alumina deposited with a proprietary binding material and coating process. Bare fibers and connectors exhibit mirror finishes on visual inspection and improved attenuation test results.

Applications include termination of connectors with all standard ferrule materials (zirconia, alumina, metal and plastic), as well as bare fibers. The calcined alumina is particularly effective in polishing large core fibers up to 1 mm. Film is in stock with and without adhesive (PSA) backing in 4-, 5- and 8-inch discs, and rectangular sheets of 3 x 6, 3 x 8 and 9 x 11 inches. Other sizes are available.

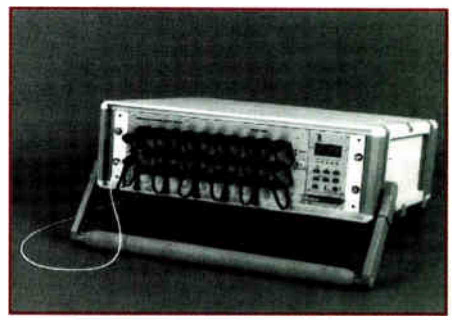
Reader service #203

Duct rodders

Condux International developed a full line of duct rodders that combine ease of operation with reliable performance to increase efficiency of rodding operations. Made of rugged steel, the cages are lightweight for easy handling in the field. They may be used in either a side or upright position. Cage sizes are matched to suit the rod ordered. All duct rods have a glass reinforced composite core surrounded by a rugged polymer jacket.

The Cobra rod is for heavy-duty applications such as long duct runs with multiple bends and sweeps. The Python rod is best suited for standard duct runs, with the Mini-Cobra devised for smaller ducts and shorter runs. All three have excellent flexural strength, compressive strength, fatigue resistance and memory. The company offers a variety of optional end fitting accessories for additional applications.

Reader service #205



Power meter

RIFOCS Corp. introduced its new 676RE 32-channel power meter. The product is said to offer 32 individual detectors, high measurement capacity, accuracy and flexibility.

The power meter accepts SM fiber as well as MM fiber. It uses one detector individually per channel at 850, 1,300 and 1,550 nm (780/850) calibrated. This is said to eliminate repeatability errors found in switched systems.

All common power meter operating modes (dB, dBm, WATT, wavelength calibration) are available on each channel. Manual operation via keyboard or remote programmability via built-in GPIB interface make it highly integrated. A dynamic range of -75 dBm to 3 dBm results in powerful performance for a wide range of testing needs.

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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
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25	51	77	103	129	155	181	207	233	259	285	311
26	52	78	104	130	158	182	208	234	260	266	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 (check only 1):

Cable TV Systems Operations

03. ___ Independent Cable TV Syst.
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 Comp.
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 Distributor
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/Marketing
29. ___ Other (please specify)_____

D. In the next 12 months, what cable equipment do you plan to buy?

30. ___ Amplifiers
31. ___ Antennas
32. ___ CATV Passive Equipment including Coaxial Cable
33. ___ Cable Tools
34. ___ CAD Software, Mapping
35. ___ Commercial Insertion/ Character Generator
36. ___ Compression/Digital Equip.
37. ___ Computer Equipment
38. ___ Connectors/Splitters
39. ___ Fleet Management
40. ___ Headend Equipment
41. ___ Interactive Software
42. ___ Lightning Protection
43. ___ Vaults/Pedestals
44. ___ MMDS Transmission Equipment
45. ___ Microwave Equipment
46. ___ Receivers and Modulators
47. ___ Safety Equipment
48. ___ Satellite Equipment
49. ___ Subscriber/Addressable Security Equipment/ Converters/Remotes
50. ___ Telephone/PCS Equipment
51. ___ Power Suppls. (Batteries, etc.)
52. ___ Video Servers

E. What is your annual cable equipment expenditure?

53. ___ up to $50,000
54. ___ $50,001 to $100,000
55. ___ $100,001 to $250,000
56. ___ over $250,000

F. In the next 12 months, what fiber-optic equipment do you plan to buy?

57. ___ Fiber-Optic Amplifiers
58. ___ Fiber-Optic Connectors
59. ___ Fiber-Optic Couplers/Splitters
60. ___ Fiber-Optic Splicers
61. ___ Fiber-Optic Transmitter/Receiver
62. ___ Fiber-Optic Patchcords/ Pigtails
63. ___ Fiber-Optic Components
64. ___ Fiber-Optic Cable
65. ___ Fiber-Optic Closures & Cabinets

G. What is your annual fiber-optic equipment expenditure?

66. ___ up to $50,000
67. ___ $50,001 to $100,000
68. ___ $100,001 to $250,000
69. ___ over $250,000

H. In the next 12 months, what cable test & measurement equipment do you plan to buy?

70. ___ Audio Test Equipment
71. ___ Cable Fault Locators
72. ___ Fiber Optics Test Equipment
73. ___ Leakage Detection
74. ___ OTDRs
75. ___ Power Meters
76. ___ Signal Level Meters
77. ___ Spectrum Analyzers
78. ___ Status Monitoring
79. ___ System Bench Sweep
80. ___ TDRs
81. ___ Video Test Equipment

I. What is your annual cable test & measurement equipment expenditure?

82. ___ up to $50,000
83. ___ $50,001 to $100,000
84. ___ $100,001 to $250,000
85. ___ over $250,000

J. In the next 12 months, what cable services do you plan to buy?

86. ___ Consulting/Brokerage Services
87. ___ Contracting Services (Construction/Installation)
88. ___ Repair Services
89. ___ Technical Services/ Eng. Design
90. ___ Training Services

K. What is your annual cable services expenditure?

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L. Do you plan to rebuild/ upgrade your system in:

95. ___ 1 year
96. ___ more than 2 years

M. How many miles of plant are you upgrading/ rebuilding?

97. ___ up to10 miles
98. ___ 11-30 miles
99. ___ 31 miles or more

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97. ___ up to10 miles
98. ___ 11-30 miles
99. ___ 31 miles or more

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☛ *SCTE Chapter Development Workshop* — SCTE Director of Training Ralph Haimowitz discusses recommended procedures for starting a local SCTE meeting group and offers tips he has used in presenting quality technical seminars to area technicians and engineers. (30 min.) Order #T-1027, $20.

☛ *Cable Preparation and Connector Installation* — This three-part presentation, produced by Augat/LRC Electronics, discusses recommended practices for preparing the ends of coax and proper methods for the installation of cable connectors. (30 min.) Order #T-1028, $35.

☛ *Video and Audio Signals and Systems (BCT/E review course)* — Category II Curriculum Committee Chairman Paul Beeman presents this overview of this category. Emphasis is placed on audio and video terminology plus test and measurement procedures. From Cable-Tec Expo '86. (1-1/2 hrs.) Order #T-1029, $45. **(Reference for BCT/E Category II)**

Note: The videotapes are in color and available in the 1/2-inch VHS format only. They are available in stock and will be delivered approximately three weeks after receipt of order with full payment.

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 (610) 363-5898.

Listings of other publications and videotapes available from the SCTE are included in the March 1994 issue of the Society newsletter, "Interval."

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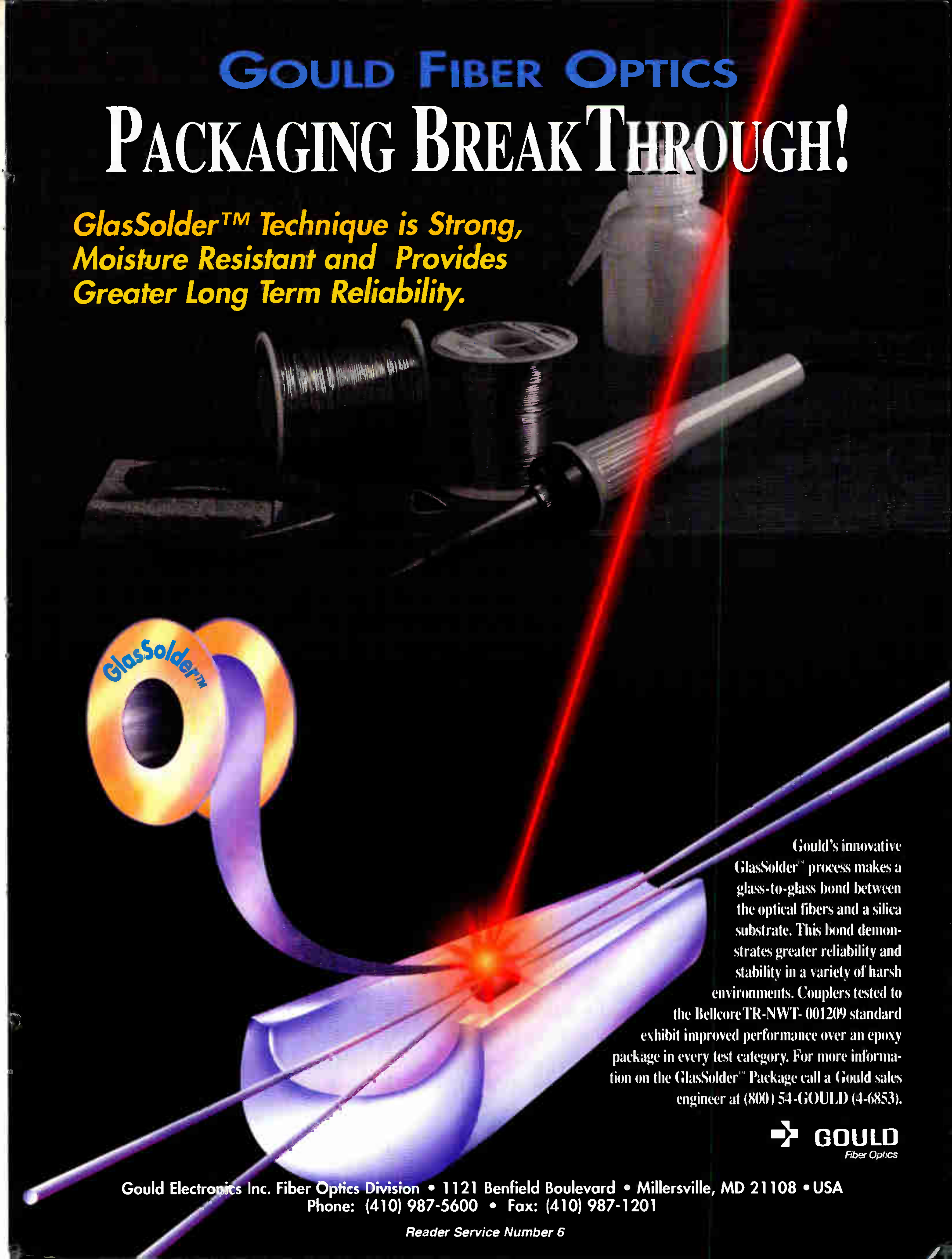
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1994

November

6-7: SCTE Old Dominion Chapter seminar, BCT/E Category II, audio and video signals and systems review, headend and earth station review, Installer and BCT/E exams to be administered, Holiday Inn, Richmond, VA. Contact Maggie Fitzgerald, (703) 248-3400.

7-9: Society of Cable Television Engineers Technology for Technicians II Seminar hands-on technical training program for broadband industry technicians and system engineers, Nashville, TN. Contact SCTE national headquarters, (610) 363-6888.

7-10: Philips Mobile Training Center, Syracuse, NY. Contact (800) 448-5171.

7-10: Siecor fiber-optic training course, Hickory, NC. Contact (800) 743-2671, ext. 5539 or 5560.

8: SCTE Cascade Range Chapter meeting. Contact Cynthia Stokes, (503) 230-2099.

8: SCTE Central Indiana Chapter testing session, BCT/E and Installer exams to be administered, Columbus, IN. Contact Gordie McMillen, (317) 353-2225.

8: SCTE Desert Chapter seminar, terminal devices, San Goronio Inn, Banning CA. Contact Greg Williams, (619) 340-1312, ext. 277.

8: SCTE Magnolia Chapter meeting, BCT/E and Installer exams to be administered, Ramada Coliseum, Jackson, MS. Contact Robert Marsh, (601) 932-3172.

8-10: SCTE Wheat State Chapter testing session, BCT/E exams to be administered, Wichita, KS. Contact Jim Fronk, (316) 792-2574.

9: SCTE Great Lakes Chapter seminar, terminal devices, Holiday Inn, Livonia, MI. Contact Mary Gilliland, (810) 578-9445.

9: SCTE San Diego Chapter seminar, BCT/E Category VI, San Diego. Contact Kathleen Horst, (310) 715-6518.

9: SCTE Sierra Chapter seminar, advanced tech, Sacramento, CA. Contact Michael Meade, (209) 943-3256.

9: SCTE South Jersey Chapter seminar, microwaves/satellites, BCT/E exams to be administered, Ramada Inn, Vineland, NJ. Contact Mike Pieson, (609) 967-3011.

10: Society of Cable Television Engineers Satellite Tele-Seminar Program, *Customer Service: Doing the Job Right the First Time (Part 1)*, to be shown on Galaxy 1R, Transponder 14, 2:30-3:30 p.m. EST. Contact SCTE national headquarters, (610) 363-6888.

Planning ahead

Nov. 30-Dec. 2: The Western Show, Anaheim Convention Center, Anaheim, CA. Contact California Cable Television Association, (510) 428-2225.

Jan. 4-6, 1995: Society of Cable Television Engineers Emerging Technologies conference, Orlando, FL. Contact (610) 363-6888.

Feb. 26-March 3: OFC '95, San Diego, CA. Contact (202) 223-0920.

Feb. 28-March 3: Satellite '95, Washington, DC. Contact (301) 424-3338.

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Another year, another incredible conference

By Bill Riker
President, Society of Cable Television Engineers

Amazing as it may seem, 1995 is nearly upon us. The coming of the new year symbolizes many things: a new beginning — a chance to resolve or solve the previous year's difficulties and questions. It is in this spirit of resolution, of new beginnings, that the Society of Cable Television Engineers will present its special contribution to ushering in the new year — our annual Conference on Emerging Technologies.

This conference, set to be held Jan. 4-6, 1995, at the Stouffer Orlando Resort in Orlando, FL, will address many of the technical issues that are currently hot topics of discussion in the world of broadband communications, including digital compression, alternative transmission techniques, telephony over cable and the very hot, very new technologies collectively known as multimedia.

While SCTE's Emerging Technologies Conference has gained a well-deserved reputation as a forum for the discussion of a wide variety of current technical topics, this event actually began with a much narrower area of focus when it was first held in January 1988.

Conference history

That first conference was billed as the Society's Fiber-Optics Seminar and it was conducted at the same setting as our 1995 event, Orlando. A capacity crowd of 412 attendees, far greater than the anticipated showing of 150, was present to participate in a technical program that focused on many facets of this exciting technology. SCTE truly was on the "cutting edge" of the industry by focusing much-deserved attention on fiber, and it was this seminar, co-sponsored by the Society's Florida Chapter, that set the wheels turning for SCTE to make this a recurring event.

Fiber Optics 1990, held March 21-23 in Monterey, CA, and Fiber Optics 1991, which was conducted Jan. 9-10 in Orlando, established the Society's fiber-optics conference as an annual event that complemented our Cable-Tec Expo by providing a setting for in-depth discussion of this still-new and relatively untapped technical innovation. Attendance figures climbed and interest continued to grow, but it was at this point that we began to feel that limiting the conference to fiber and fiber-related issues was depriving our audience of some of the other important topics of interest to industry members, such as high definition TV (HDTV), video compression and digital modulation.

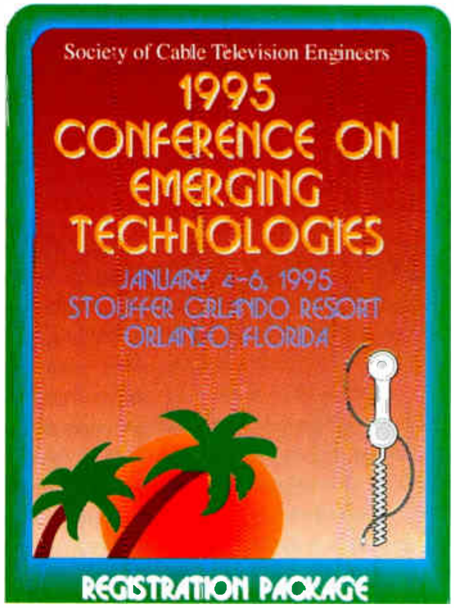
These topics were the focus of the final panel of Fiber Optics Plus 1992, held Jan. 8-9 of that year in San Diego. The "plus" referred to the broadening of the conference to incorporate these other "emerging technologies" (a phrase that first was used by the Society as the title for one of the conference's panels). This expanded focus added to the conference's popularity and positive response and it was only logical that we continue the trend of widening our technical horizons at the next annual event.

The 1993 Conference on Emerging Technologies, held Jan. 6-7 in New Orleans, was the Society's most highly attended nonExpo event yet, drawing 700 people (up from 590 at the 1992 edition). The well-rounded program continued the conference's original concentration on fiber with a panel on fiber-optic components and architectures while also devoting panels to digital compression, the industry's future opportunities through new technologies and system integration, and future telecommunications systems. The 1993 event also introduced preconference tutorials that offer attendees the opportunity to gain introductory knowledge of the topics to be discussed in greater depth during the subsequent conference.

This year's Conference on Emerging Technologies, held Jan. 4-6 in Phoenix, AZ, continued the trend of increasing prominence and success of these events coinciding with the ongoing expansion of the scope of topics. Digital compression and transmission and the delivery of enhanced services over advanced networks were the topics of panels at the conference, along with an update on the state of fiber optics through panels devoted to fiber in current use and plans for its future usage. The 1994 conference drew a record attendance of 950 people (nearly a 25% increase over the 1993 event's figure).

The next Emerging Technologies

Now a permanent staple of SCTE's an-



nual training schedule, the Emerging Technologies Conference now will incorporate the preconference tutorial sessions as a regular feature, allowing all attendees in-depth looks at several key technological advances.

The 1995 conference will feature the following panels:

- *Session A:* Digital compression and alternative transmission techniques
- *Session B:* Telephony and the cable industry
- *Session C:* Broadband multimedia via cable
- *Session D:* Technology migration into the future

Interestingly, of the more than 30 papers to be presented at this conference, only one deals with fiber optics. I feel we have a terrific program for the 1995 conference, with an incredible array of technical leaders and visionaries from the CATV and telephony industries joining forces to discuss an amazing and vast array of topics. From digital transmission to multimedia to alternative architectures, you will not find a better technical program anywhere.

We are expecting over 1,200 attendees at this year's event, so I urge you to register soon, ensuring that you won't miss this vitally important conference. To receive your registration package, call SCTE national headquarters today at (610) 363-6888. I look forward to seeing you there, so we all can ... look forward. **CT**

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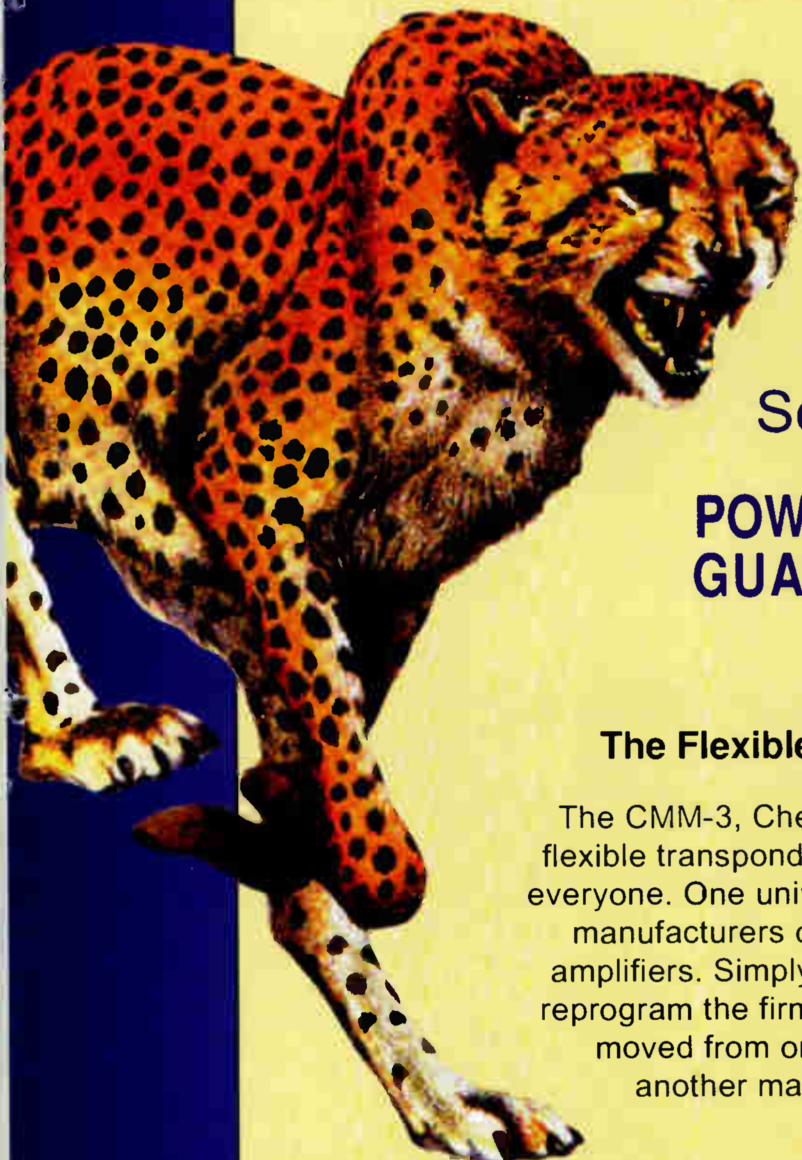

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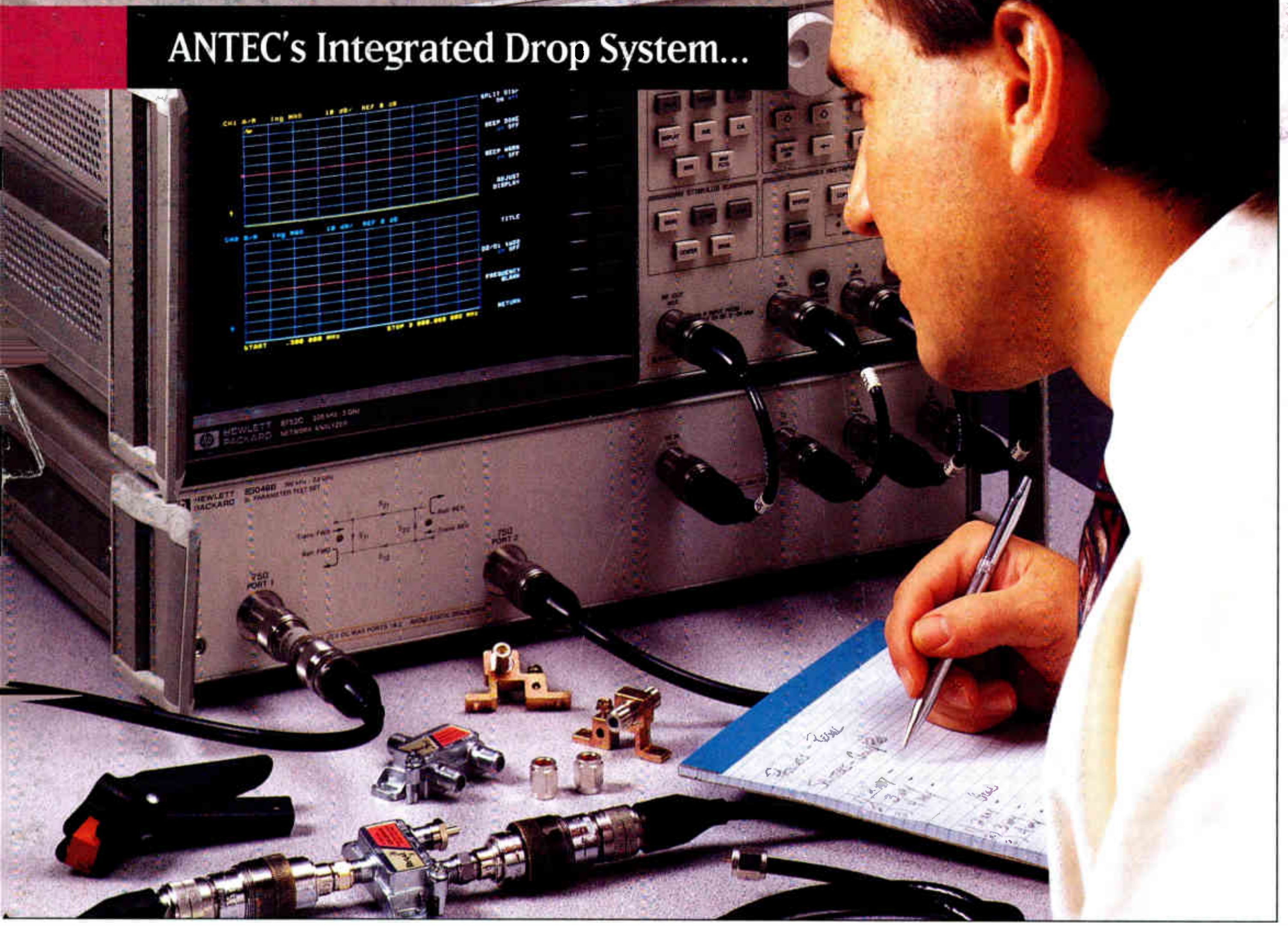

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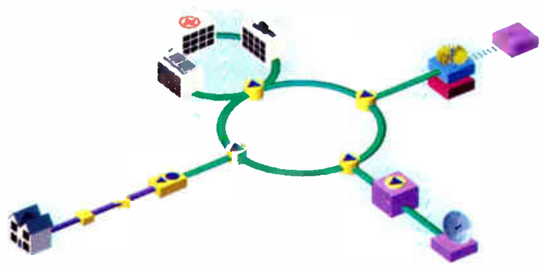

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