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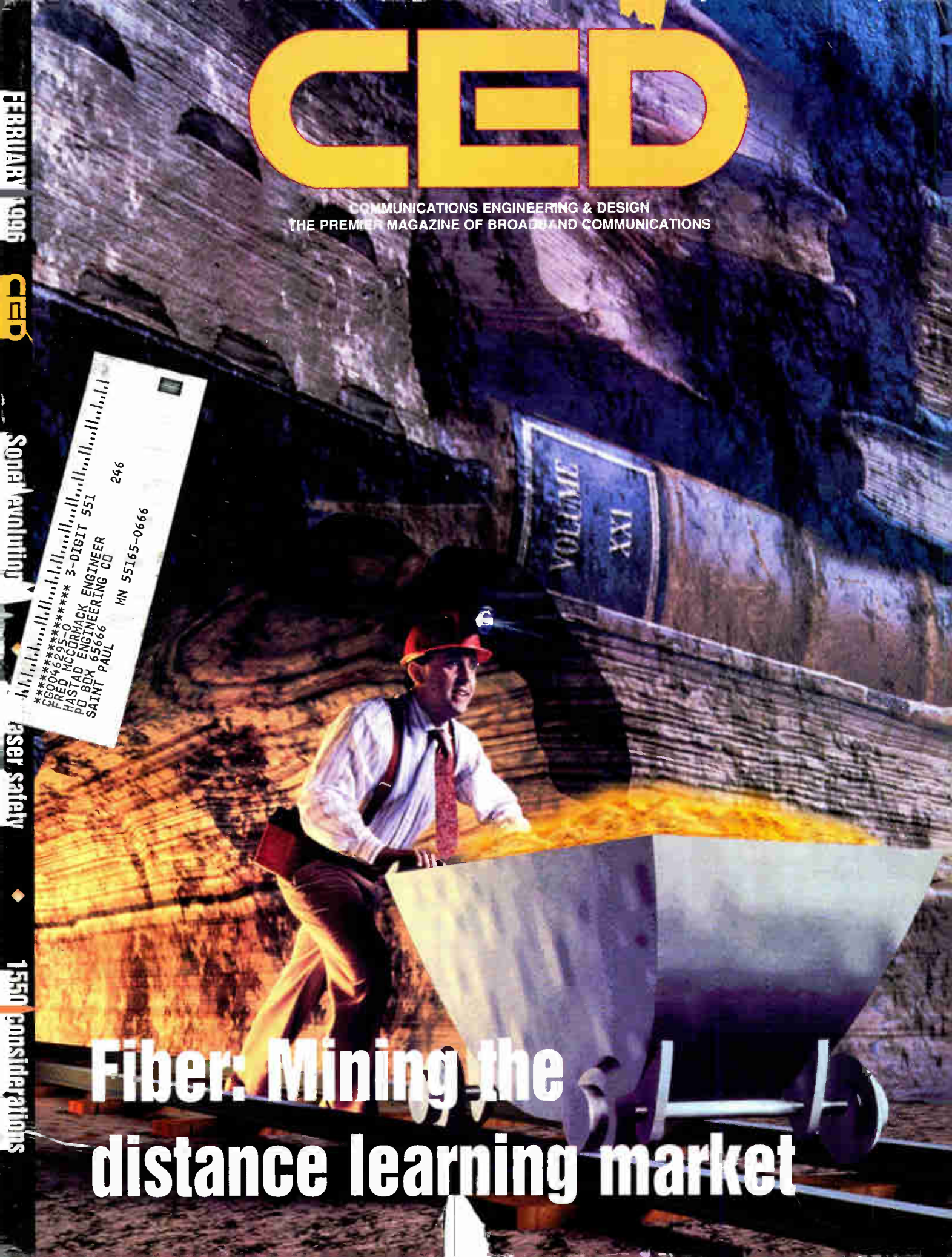

Fiber: Mining the distance learning market

FEBRUARY 1996 CED Some revolting ... laser safety ◆ 1550 considerations

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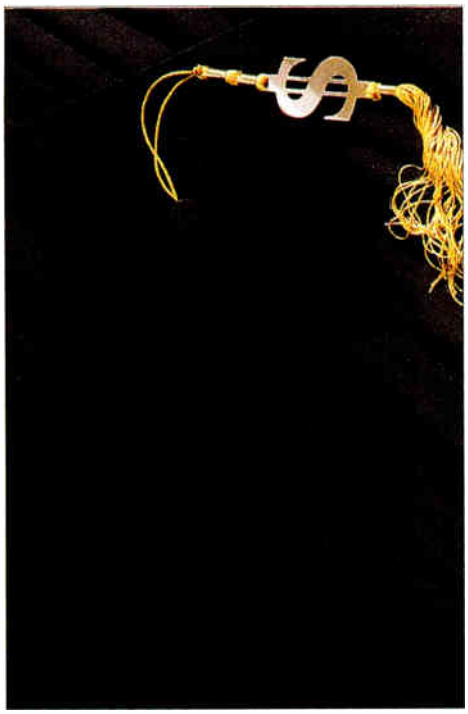

Photo by Seman Design Group, The Stock Market

28 Multimedia distance learning networks

By Bob Beaury and Tom Donahue, Broadband Networks Inc.

For many operators, the provision of distance learning services is now on the front burner, either because of mandatory franchise renewal requirements, or for the opportunity to generate new revenues. The cover story details some real-world projects, including the TEEN (Technology Excellence in Education Network) system.

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Features

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By Rob Koslowsky and Drew Martino, Nortel Broadband Networks, a division of Northern Telecom Inc.

The introduction of fiber optics has revolutionized the telecommunications industry. Though the recognition of fiber's capacity as a carrier goes all the way back to the ancient Greeks, it is only in the last two or three decades that the development of the technology has matured.

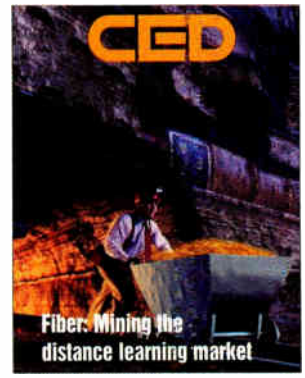

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Photo by Ron Lowery, The Stock Market

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By S.W. Merritt, G.J. McBrien and E.R. Yates, Uniphase Telecommunications Products

This article details integrated optic modulators, which meet the needs of hybrid fiber/coax system architectures, and the design criteria and performance data for both the devices and externally modulated systems.

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By Frank La Barbera, General Instrument Corp.

Taking into account the relatively high cost of 1550 nm equipment for broadband communications, it's critical that service providers have the right information to select the equipment best-suited to their performance needs. This article provides an analysis of 1550 link components.

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While telling technicians that a laser will blow a hole through their head is probably not an effective safety training method, a little fear goes a long way in preventing laser-related injuries.

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By Roger Brown and Leslie Ellis

The christening of Jones Intercable's John Brouse as this year's Polaris Award winner for fiber optic innovation was one of the highlights of the SCTE's Conference on Emerging Technologies. The conference also featured updates on critical network performance data.

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By Michael Lafferty

The number of Direct Broadcast Satellite (DBS) systems is doubling from two to four this year. DBS prices are expected to fall, and cable may face increased pressure.

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By Fred Dawson

Engineering executives continue to gather data on the performance parameters of HFC networks to help them evaluate the cost/benefit equation for digital communications.

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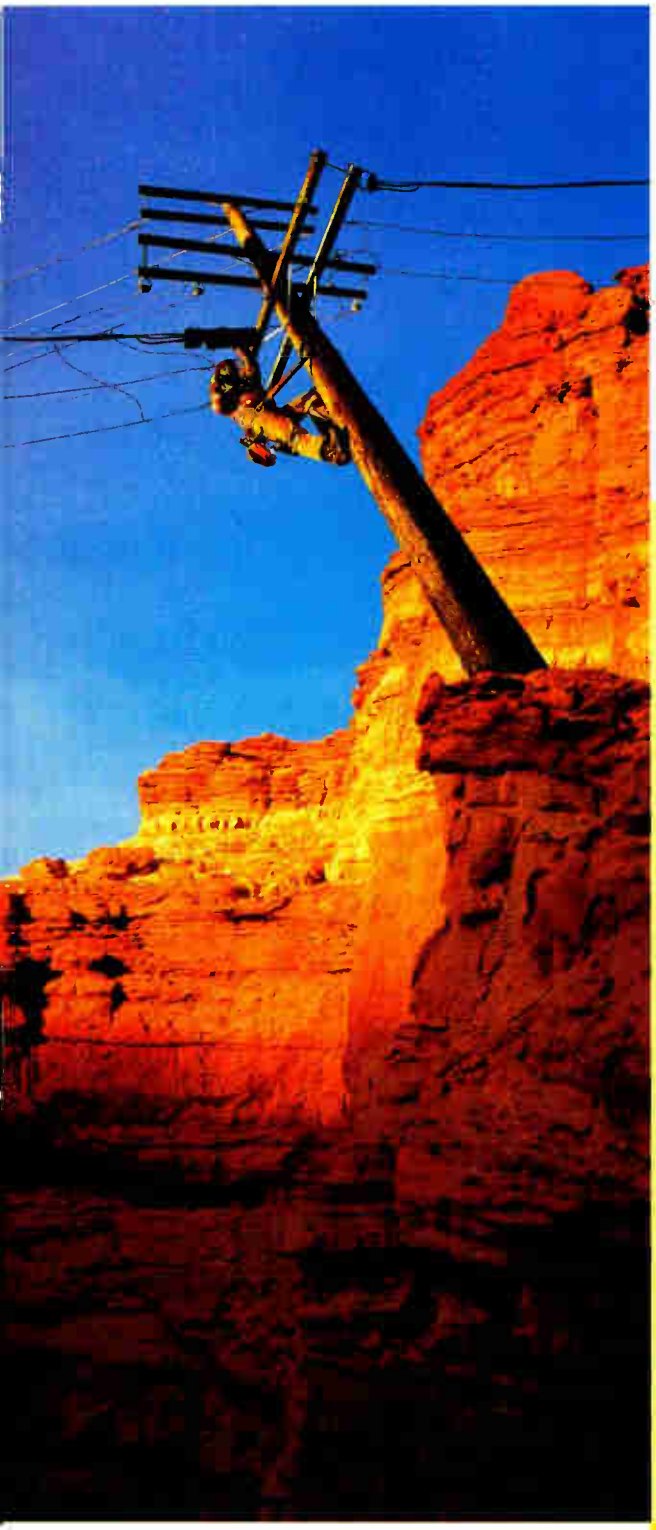

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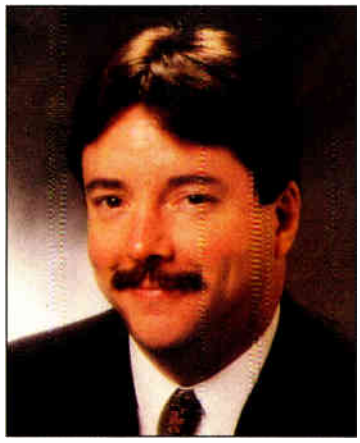

Seems like deja vu all over again

While Congress was busy last December shooting holes in new telecom legislation, the cable industry apparently dodged another bullet when the Federal Communications Commission put off a decision on a potentially troublesome issue related to the ownership of drop cable in multiple dwelling units. To make a long story short, private cable operators like Liberty Cable in New York City are hoping to have those drops–installed at great expense by cable operators like Time Warner–considered part of the building, making them available to all video competitors free of charge.

This isn't the first time that in-home cabling issues have risen to the top of the priority list. For years, the industry has been trying to deal with substandard in-home wiring and connectors that are typically installed by do-it-yourselfers. Often, the equipment used comes from retail hardware and electronics stores and is of poor quality, with little or no shielding.

While cable operators understand homeowners' motivation to perform in-home wiring themselves, substandard components lead to poor picture quality and noise, and could induce other problems higher in the network.

A few years ago, the NCTA Engineering Committee attempted to tackle the issue by establishing an in-home wiring subcommittee. That group's task was to evaluate the extent of network problems associated with in-home cabling and suggest solutions. Also, the SCTE organized a committee and asked it to write a series of recommended practices aimed at making the entire drop system better.

Others took a different tack and attempted to open a dialogue between the cable industry and organizations such as the homebuilders association, among others. The intent was simple: educate homebuilders about the issue and press them to use high-quality coax and connectors when prewiring new homes for cable service. Square D, an electrical equipment manufacturer, developed the Elan home network, which was a compilation of high-quality components aimed at distributing high performance signals throughout the house.

Lately, however, action has been lacking. The NCTA subcommittee has been largely inactive, and other initiatives seem to have lost their momentum. This is problematic, because the issue has actually become more important as the industry stands ready to deploy digital networks. Substandard in-home wiring could very well make digital service delivery impossible.

Oddly enough, the consumer electronics industry might come to the rescue. Through a group called Wire America, the CE industry intends to spend millions of dollars educating the public on the benefits of using high-quality wire and components in the home. Why? Because electronics equipment manufacturers are currently focused on two issues that scream for high-quality premise wiring: home theaters and home automation.

The cable industry shouldn't be caught unaware by this new initiative. It behooves everyone to quickly convene a meeting between EIA and cable TV interests to determine the scope and message of this education effort so that all parties can benefit. Having already been down this path, MSOs could approach the meeting proleptically and help make the effort fruitful.

Roger Brown
Editor

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See your network in a new light

S-A licenses RSA's encryption for new PowerKEY system

Scientific-Atlanta Inc. announced that it has licensed advanced encryption technology from RSA Data Security Inc. to be included in its PowerKEY digital conditional access system, which is being developed for use in set-top terminals, headend components, cable modems and network element management software.

The system will combine public key and secret key cryptographic methods in physically secure implementations to provide a high-performance security solution for broadband networks.

Sophisticated conditional access systems allow cable and other broadband network operators to be more flexible in implementing new services that employ easy-to-use security. For example, both content providers and network operators can have their own secure way to protect content and communicate interactively with subscribers. Theft of services, falsified orders and vandalism of software and databases can be curtailed. Sensitive information, such as credit card numbers, can be encrypted and exchanged. In addition, the identity of the sender and the message content can be authenticated–an important capability for multi-provider authorization environments and for validation of orders from subscribers.

The PowerKEY system, which is designed to be a licensable access control and security system, will combine robust security and encryption techniques with physically secure implementation and sophisticated control systems. The PowerKEY system will be available on a variety of interactive and broadcast networks. Its key functions will include: message authentication to reject altered content and prevent downloading computer viruses to digital terminals; unambiguous confirmation of sender's identity; public key encryption for secure transfer of entitlements, authorizations and consumer orders; high-speed secret key encryption to protect against theft of services; physically secure logic with renewable and replaceable security modules to thwart pirate tampering; seamless operation in support of both analog and digital services; multi-provider authenticated key management; forward and reverse path protection; and messaging with guaranteed non-repudiation without need for trusted third parties.

RSA's products are considered a de facto standard for data encryption and authentication. The license to Scientific-Atlanta is the first that RSA has granted to a set-top terminal manufacturer of its widely adopted, patented technique for private messaging and digital signature authentication. The agreement provides for the licensing of RSA technology, including the algorithms that enable RSA's public key-private key cryptography. No other terms of the agreement were disclosed.

S-A plans to use RSA cryptography algorithms in its end-to-end digital systems–set-top terminals, headend equipment and control systems–to improve communications security for digital pay-per-view, cable modems and other broadcast and interactive applications.

The widespread deployment of RSA encryption methods supports the move to open standards of interactivity. The system's implementation of RSA algorithms and Cylink Corporation's "Stanford patents" (licensing of which was also announced) is designed to be compatible with global open standards, such as MPEG, DVB and DAVIC.

RSA developed and patented a method of exchanging authenticated secret messages without exchanging secret keys. Most encryption systems rely on the sender of a message or document to know the receiver's "secret key." The more parties a secret key is distributed to, the more vulnerable it becomes to unauthorized use. With RSA's "public key" approach, a person's public key can be made available to any interested party to send that person a private message. There is no need to privately exchange secret keys. For other parts of the electronic network services application, such as digital video transmission, the PowerKEY system will employ proven private key algorithms that provide high-speed operation and excellent signal security.

DAVIC issues specs; turns to data protocols

The Digital Audio-Visual Council (DAVIC) met its self-imposed deadline and released version 1.0 of its technical specification for an interoperable, end-to-end digital communications network during its mid-December Berlin meeting, but already has plans to broaden the scope of the work to include high-speed data modems.

So, even while the group's first document is shipped off to the International Standards Organization for approval as a global standard, development of a similar set of protocols for data networks "has become the priority issue," according to Bob Luff, chief technical officer at Scientific-Atlanta and a key member of the DAVIC management committee.

In fact, to meet an aggressive deadline that cable operators believe is paramount in their rush to capitalize on the popularity of on-line services, DAVIC has scheduled a May meeting so that it can develop Release 1.1 by June of this year. That deadline, though aggressive, would dovetail well with a similar effort spearheaded by Cable Television Laboratories, which is trying to lay down interoperable standards by the middle of April 1996.

According to Luff, development of modem standards could only help spur the development of interactive TV and encourage others to embrace the DAVIC 1.0 standard.

DAVIC Release 1.0 covers a wide range of interface protocols, including modulation methods, forward error correction, set-top/network interfaces, interfaces between servers and set-tops and a host of others considered to be essential for a digital interactive TV network. Included in Release 1.0 are specs for hybrid fiber/coax networks, fiber-to-the-curb networks and satellite links.

As it turns its attention to data transfer, Luff said DAVIC leaders have already agreed that compliant systems should be able to at least browse the Internet through a set-top device, while PC users should be able to access DAVIC servers, which should spur renewed interest in interactive TV, Luff noted.

Finally, Luff said other DAVIC goals that were originally supposed to be addressed in Release 1.1 will instead be pushed back into Release 1.2, scheduled for completion at the end of 1996. This was done to give the group more time to concentrate on data transfer issues.

TWC, Shaw announce cable modem deals

Time Warner Cable (TWC) and Canadian cable operator Shaw Communications both recently announced agreements to purchase and deploy high-speed data modems.

TWC will purchase 50,000 modems from Toshiba Corporation of Japan and deploy them in as many as three systems–starting with the San Diego cable operation. Each of the systems will be upgraded to HFC (hybrid fiber/coaxial cable), allowing for broadband communications of up to 750 MHz.

Toshiba will begin shipment to TWC early this summer. The order includes the sale of the modems, as well as equipment for the headends and distribution hubs.

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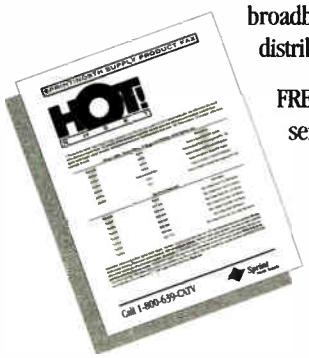

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Toshiba and TWC have been jointly developing this high-speed cable data system in the United States, and recently performed technical trials of this new system.

Toshiba officials said the company aims to be a major player in this emerging service area and is positioning itself as both an equipment supplier and system integrator. In doing so, Toshiba is able to draw from its integrated capabilities and expertise in computers, semiconductors, telecommunications and consumer products. The company is also aiming to extend this technology to countries outside the U.S., including Japan.

Meanwhile, Shaw Communications announced a multi-year agreement in principle to purchase 100,000 CyberSURFR cable modems and Cable Router infrastructure products from Motorola Inc.-Multimedia Group.

Motorola will provide 100,000 modems plus associated infrastructure, beginning in late 1996. Shaw will deploy the equipment to serve both its commercial and residential customers.

The CyberSURFR modem connects subscriber personal computers to the HFC system via a standard 10Base-T 802.3 LAN connection specifically designed for data communications for on-line services, Internet access, telecommuting and other emerging services for home and business PC users. The modem offers throughput speeds of up to 10 Mbps in the downstream path and upstream path throughput of 768 Kbps. The Cable Router is installed in the network headend where it interfaces the hybrid fiber/coax distribution network to local or remote IP networks.

GI, Fore Systems to work together

General Instrument last month announced plans to work with Fore Systems to jointly develop a high-speed, ATM-based telecommunications network system that will allow broadband network operators to deploy services over hybrid fiber/coax (HFC) networks.

Fore Systems designs and manufactures networking products based on ATM technology, including switches, adapter cards, LAN access products and system software.

The system envisioned by GI and Fore will be able to deliver full-motion video in real time to the PC, along with Internet and on-line service access. Also, a multimedia library of CD-ROM titles will be made available on demand.

The system will be designed to provide computer connections at speeds up to 25 megabits per second. Servers and content gateways at the headend would be connected to Fore Systems switching products to a processor that will be jointly developed by the two companies. This process will send traffic downstream over an HFC network to a high-speed cable data modem. The modem is connected to a home personal computer outfitted with a standard network interface card.

General Instrument is already developing a specialized network navigator for use with the system.

The two companies view ATM as offering several advantages over other proposed cable data systems, including: scalability, billing flexibility, adherence to standard interfaces and high quality service delivery of multimedia.

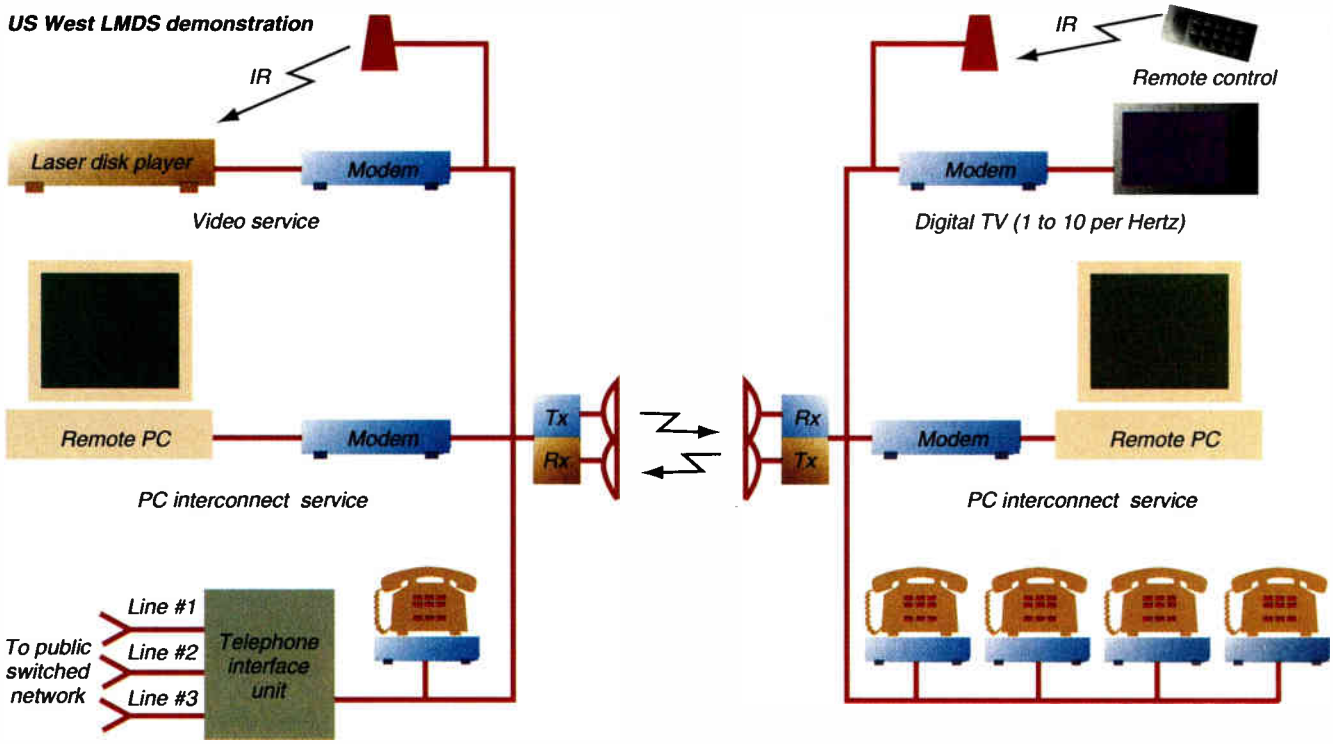
US West demos LMDS technology

Add LMDS to the list of technologies the telephone companies plan to use to compete with established cable operators.

US West Communications successfully demonstrated Local Multipoint Distribution Service technology at its Advanced Technologies laboratory in Boulder, Colo. last month, sending a host of video and data applications over a short, indoor link.

Specifically, the demo featured transmitters and receivers developed by Endgate Technologies sending entertainment video, data from both Unix- and Macintosh-based local area networks and four lines of telephone traffic across the expansive indoor lobby.

LMDS technology involves sending data at 28 GHz–which makes it a line-of-sight technology limited to serving areas about 3 kilometers in radius, according to Earl Langenberg, executive director of the Growth Division at US West and the person who lead the demonstration team. However, signal prop-



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agation tests performed by US West show that signals can be sent through glass and even through trees, if the gain is turned up enough.

Although many technologists are skeptical, companies such as Texas Instruments, Hewlett Packard and Philips are all working on developing transceivers for LMDS applications.

In addition to US West, which is exploring a wide range of technology options that would leverage its extensive base of twisted pair wires, Bell Atlantic is known to be interested in LMDS options. In fact, Bell Atlantic is an investor in CellularVision of New York, which has a single transmitter providing service to residents of Brighton Beach. CellularVision hopes to take advantage of a recent FCC decision and expand its service area to include Manhattan, Brooklyn, Queens and the Bronx over the next few months.

In its demo, US West showed how the system could be used to simultaneously deliver entertainment video, data and telephony services. A laser disk player sent video over the network, while internal Unix and Appletalk LANs were tied into the transmitter via Zenith 4 Mbps modems. Finally, modems from First Pacific Networks were used to demonstrate the telephony service.

ADC, PCS Wireless form strategic alliance

ADC Telecommunications Inc. announced that it will form a strategic alliance with PCS Wireless Inc. of Vancouver, B.C., Canada. The formation of the alliance was conditional upon due diligence and the execution of formal documentation by January 31, 1996.

The first component of the agreement between the companies is ADC's commitment to purchase 5 million shares, or 15 percent, of PCS Wireless at approximately market value. The second component is the establishment of a joint venture to operate a worldwide Remote Antenna Driver/Remote Antenna Signal Processor (RAD/RASP) business.

The JV will be initially capitalized at U.S.$5 million. PCS Wireless will transfer product development employees to the JV, and ADC will provide the JV with access to its manufacturing, sales and marketing resources.

The third component of the alliance is a non-exclusive original equipment manufacturing and licensing agreement for PCS Wireless to supply ADC with Frequency Division Duplex (FDD) cellular and PCS Microcell EXtender/Base station EXtender (MEX/BEX) products. ADC will integrate these technologies and products into its current wireless products and market them globally.

"ADC's alliance with PCS Wireless solidifies our developing position as a systems supplier in the wireless local loop market," said William J. Cadogan, ADC's chairman, president and chief executive officer. "In addition, the agreement immediately adds to ADC's in-building RF distribution capability," added Cadogan.

PCS Wireless designs distributed antenna arrays (DAAs) for cellular and PCS telecommunications systems. The company's product offerings consist primarily of dedicated coax-based DAAs which include the MEX/BEX products targeted for indoor use, and wide area network-based DAAs, which include the RAD/RASP products targeted for outdoor use.

Stellar One set-top nominated for award

Stellar One Corp.'s Stellar 1000 digital set-top has received the Chairman's Nomination for the 1996 Computerworld Smithsonian Award. The Stellar One product has been nominated in the category of Environment, Energy and Agriculture. As a nominee, the Stellar 1000 has already been approved for inclusion in the permanent research collection of the Smithsonian Institution and will become part of the Smithsonian's on-line information resource on the Internet World Wide Web.

Through the use of Novell's NEST and new power line technology, The Stellar 1000 interactive digital video set-top box will send high quality digital video, voice and data across electrical power lines, enabling consumers to use menus and other displays on their television sets to manage home energy use and control intelligent appliances from their home, office, hotel or other remote sites.

The Stellar 1000 will also allow electrical utility power companies to better deal with power management on the power grid. Applications include the interactive playback and control of stored or real-time video on a network, live video transmission from a camera in the home with remote camera control, remote operation of home systems including lights and VCR, intelligent home security systems and time-shifted broadcast video.

The Stellar 1000 was one of the first interactive digital video set-top boxes and the most widely deployed in ADSL (Asymmetric Digital Subscriber Line) worldwide market trials.

The Computerworld Smithsonian Award Program was founded seven years ago to honor the creativity and inspiration of those who use modern information technology to improve the course of human life. The awards are recorded in a permanent research collection at the Smithsonian's National Museum of American History to provide future generations with an understanding of the information technology revolution. Previous award recipients include the Boeing 777 Aircraft, America Online, the Internet and the New York Stock Exchange.

Jottings

Continental Cablevision has filed an application for certification as a competitive access provider in the state of New Hampshire. The company has been experimenting with high-speed data transfer between a local hospital and doctors' offices in the Exeter, N.H. area and envisions a similar commercial service rollout if certification is granted . . . **Primestar** and **LodgeNet Entertainment Corp.** will create a joint venture to provide digital television and other guest room services to the lodging industry. The agreement will help LodgeNet bring advanced television services to owners of hotels and motels–even those with fewer than 100 guest rooms. LodgeNet already provides premium services to 245,000 U.S. hotel rooms . . . **Cincinnati Bell Information Systems** has installed its CableMaster 2000 subscriber management and billing solution in Time Warner Cable's Austin, Texas system. The cable CSRs will be provided with more account information, and the system will be able to use the data to a greater extent, officials say . . . **Digital Equipment Corp.** and **SkyConnect** have allied to provide a national on-line system that automatically distributes and inserts local spot advertising. Under the agreement, SkyConnect will begin selling and installing Digital's ad insertion system and will modify its software to operate as a front-end to Digital's Mediaplex servers . . . **CableLabs'** 1996 $14 million budget will consist of $10 million for operations, $3.7 million for the research funding pool and almost $500,000 for capital equipment. Key projects in 1996 will be developing cable data modem interface standards, helping its members deploy digital transmission and compression technology and helping operators obtain technology to enter the telecommunications business . . . **AT&T Network Systems** and **Hewlett-Packard** will jointly design and build broadband networks using a common network architecture to form worldwide intelligent networks. In addition, the two companies will develop networks as platforms for high-speed Internet access, wireless network broadband service delivery and broadband enterprise networks. They are also co-developing operational support systems and business support systems . . . . CED

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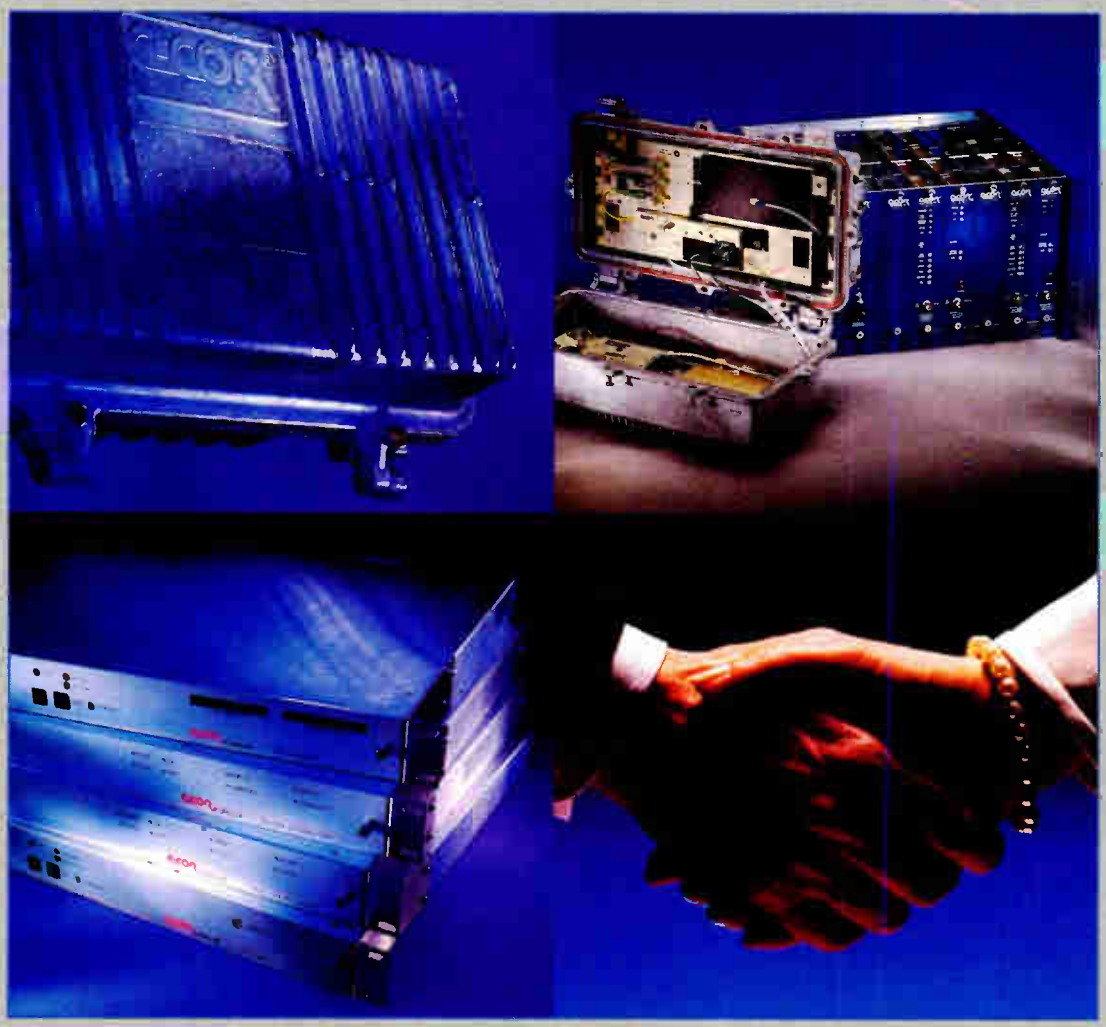

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Circle Reader Service No. 9

Pushing fiber to the limit for Jones

John Brouse

Jones Intercable's John Brouse, winner of this year's Polaris Award for fiber optic innovation, has been involved with enough professional disciplines to fill at least two lifetimes. After enlisting in the U.S. Navy in 1968, he signed up for its nuclear power program, obtained his bachelor's degree in meteorology, went to naval flight school and ended up specializing in electronic warfare, obtained a master's degree in telecommunications systems management, and was in on the initial staff up of Naval Space Command.

His time spent in small, entrepreneurial types of units within the military left him well-prepared to enter the cable industry—Brouse knows how to be competitive, and he knows how to gather intelligence. The common element throughout his career has been experience with the very latest in high-tech electronics equipment. "I go all the way back to my electronic warfare days in managing spectrum," notes Brouse. "A lot of people say, 'I need more and more bandwidth.' And in fact, we don't. What we need is fewer people competing for available bandwidth."

One program he worked on for the Navy had the mission of mapping the entire surface of the ocean, pulling out the effects of the weather, and allowing for the impact of structures like sea mounds and the Marianas Trench. Why would the military spend its time mapping the surface of the ocean? To ensure better targeting accuracy for missiles launched from submarines, or, as Brouse explains, "as they break the surface of the water, they know which way is up."

Broward County sows seeds of Alexandria

His time in the military came to a close in 1988, when Brouse, on a fluke, got into the cable industry. During the course of a job interview with a former military colleague, his friend casually mentioned that he had bumped into an executive with Jones Intercable on a ski lift, and that exec just happened to be looking for someone with Brouse's qualifications. The Jones' executive turned out to be Bob Luff, now chief technical officer? with Scientific-Atlanta, Broadband Division, whom Brouse credits with having the guts to pull in someone from outside the cable industry.

"Bob certainly put a lot on the line," he recalls. "Here's this guy who has no idea what cable is, other than you pay the bill every month."

Brouse entered the cable industry as system engineering manager for Jones Intercable's Broward County, Fla. system, where he and his mentor, Hugh Bramble, implemented the Cable Area Network (CAN), which centers around high reliability. The Broward County system was the testbed for an economical, first-generation status monitoring system, and the project also laid the groundwork for Jones' "headend of the future" in Alexandria, Va., which Brouse helped to design.

A financial manager of technology

The challenge of Alexandria was not only to ensure that the network met high standards of reliability, but also, to ensure that the design of the system was financially competitive. To that end, Brouse mulled over ways to economize the use of expensive technologies like DFB lasers by utilizing switchable optical couplers, which allow the use of lower-powered lasers on smaller rings in Alexandria.

Jones' use of switchable optical couplers has another fringe benefit: "free" fiber surveillance. Engineers can send 90 percent of the light down the primary route, and 10 percent down the backup route; thus, by monitoring the voltage on the optical receiver, they have a fiber optic surveillance system.

In addition to his work with maximizing the potential of fiber, Brouse is also throwing his energies into ways to utilize new technologies like spread spectrum, as well as an evaluation of distributed vs. centralized networks.

While engineering systems like Alexandria, Brouse has worn a number of hats at Jones.

✔ In 1991, as special projects engineer for the operator, he was instrumental in securing three experimental PCS licenses.

✔ After moving into a position that managed advanced applications and network design, he focused on evaluating new technologies.

✔ As director of network development, he threw his efforts into the rebuild and upgrade of Jones' systems.

✔ Most recently, he moved over to become engineering director for about one-quarter of the company's systems, responsible for those in the Midwest.

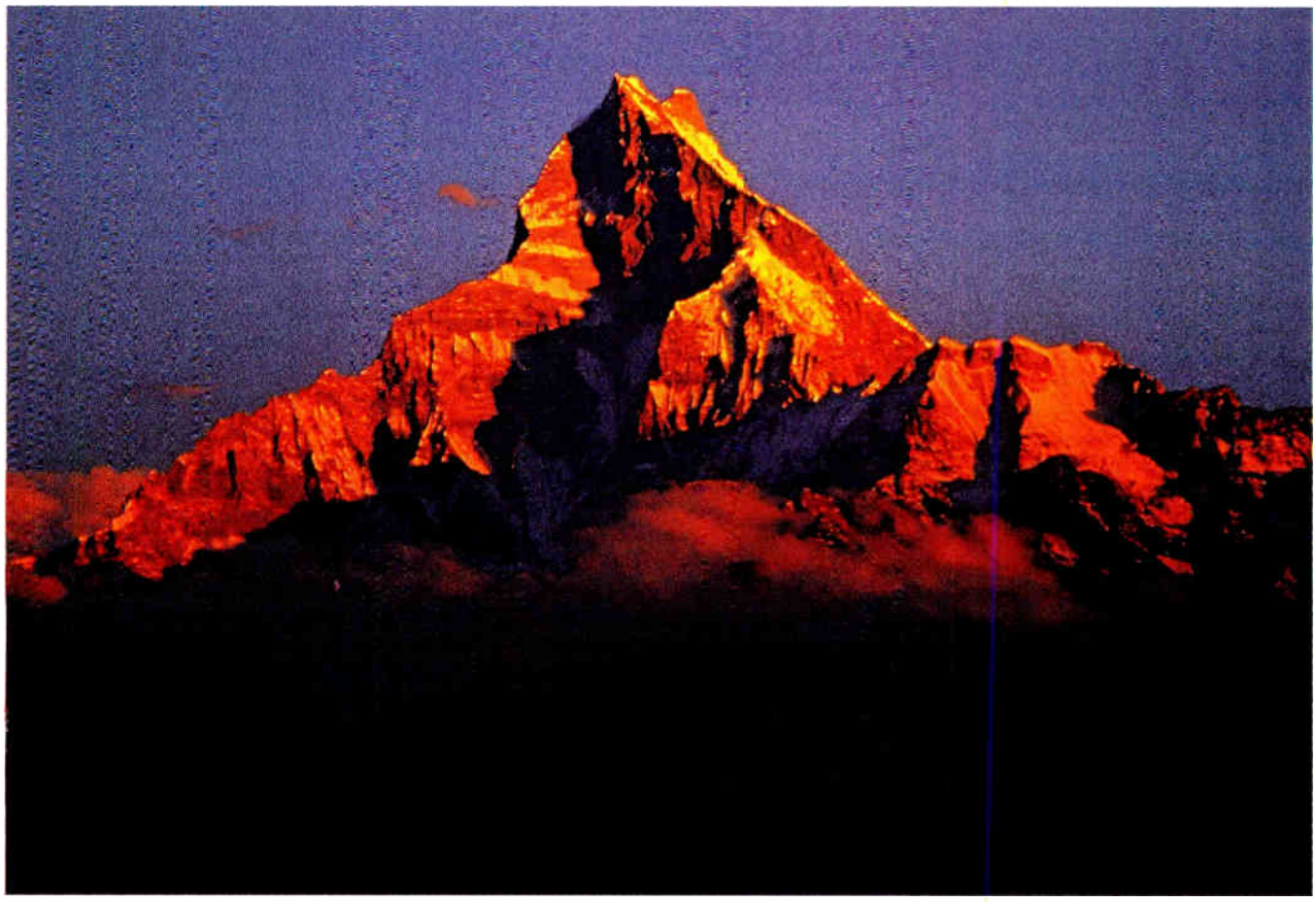
But that's about what you would expect for a man whose master's thesis was entitled, "The modern analog and digital communications channel from a manager's perspective," eventually used as a textbook for a master's course in electrical engineering.

Ski bum

Though his employer is based in Colorado, Brouse scoffs at the notion that he is lucky to be near such prime skiing country. "This is nothing compared to Utah snow," he declares. You can't really blame him, though, because skiing has been a favorite hobby since his days as a student at the University of Utah, when it was 30 minutes "from the time I closed my backdoor until I was sitting on the lift," recalls Brouse.

His time for such pursuits is somewhat limited these days, given his professional responsibilities, but Brouse seems to be happy with his latest career. "If we can become as competitive as I think we can," he notes, "...we, as an industry, are going to make life better."

–Dana Cervenka



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Circle Reader Service No. 10

Blizzard of '96 was a blessing for cable

By Wendell Bailey, VP of Science and Technology, NCTA

Wow! Snow, snow, and more snow. All of the snow that you would ever want to see (except for certain skiing operations) was, and actually still is, available for your pleasure all over the East Coast of the United States. Just so that you don't feel too sorry for me, I should mention that for the first part of the "Blizzard of '96," I was holed up in an airport hotel in Denver waiting for a flight to the East Coast. But I'm sure that all of your friends and colleagues from this part of the world have already regaled you with tales of missed flights and lonely hotel rooms, so I will relent and get on with this essay.

One of the things that I noticed as I struggled to get into and out of the District of Columbia during this period was the number of customer service personnel who I saw on the streets of both my home community and the areas around my office in downtown. I was pleased to notice that local cable television trucks and service personnel were well represented in this admittedly unscientific sample.

Having once been an outside construction type of person myself, I know the feeling of going out into the teeth of a storm to do a job when every part of the body cries for just a few more minutes in front of the fire or TV. But there they were, slogging through snow and icy wind, while their customers snuggled up to their TVs and VCRs.

And just to prove that every cloud has some sort of silver lining, the reports from several cable systems in this area of huge increases in PPV buy rates made me think of what it might take for the viewing public to realize what a great service cable systems and their programmers offer.

Neither snow, nor more snow...

It has been suggested by one wag that cable engineers need to come up with a viable technique for cloud seeding. An interesting idea, but I think that I'll pass. The sight of those service people hiking over snow-clogged streets, past block after block of closed store fronts, made me think that in spite of improved buy rates for certain services, there had to be an enormous amount of plant damage from the storms.

The people going into customers' homes to check out snowy pictures had to have it better than the cable engineer I saw hanging on to a strand with one hand, an amp cover with the other, and the pole with his third hand! Well, it seemed like he had three, but the snow was whipping, and a working man was doing his job. It made me glad that I don't have to climb poles anymore, and equally glad that the people who *do* don't offer excuses when something needs to be fixed.

It may not seem that this type of effort is necessary under those circumstances, but I also had a chance to talk to friends and neighbors who could not get through the first three sentences without mentioning the fact that they were staying glued to their cable TV. I heard about reports on CNN, The Weather Channel and local news Channel 8; I heard about movies, sports and all kinds of things that most of us take for granted.

Suddenly, everyone was glad that they had cable television, and not a single person complained (within my hearing range) that the service was overpriced or the programming was poor. It would seem that those types of comments are saved for the cocktail parties when the weather is more pleasant. There probably is a deep, societal explanation for the fact that we would notice such a thing, but I don't have a clue as to what it would be.

Hibernation breeds appreciation

All of the experiences that I have had during this storm have left me with several observations. What would make a person slog through snow and climb a pole in this kind of weather? It can't just be the paycheck. I believe that it's the desire to do the job that needs doing, even if it is inconvenient and difficult. Our industry is full of these kinds of people.

What would make subscribers notice the value of a ubiquitous service like cable, after spending so much time knocking it to friends and neighbors? It could just be that when you really need information and are forced to submit to being entertained, it's hard to look someone in the eye and say that it's "just that boring old cable system," without feeling just a tad cynical.

So, after all is said and done, the East Coaster who reads this may smile and tell a few tales of how he handled the "Blizzard of '96," but I wonder what those of you who live and work in places where this kind of weather is an everyday occurrence think about all of this. Do your techs continue to provide service, even as the wind blows the snow into their face? Do the subscribers who are constantly faced with this level of hibernation appreciate the offerings of the cable system more than most? Do those of you in the more rigorous climes have better PPV rates than those in temperate areas of the country? How does the cable plant hold up to repeated poundings of this sort, as opposed to the once or twice a year deal that we have here? See, I told you that there was a need for deep societal thinking after an experience like this.

The cable companies all did their best in a tough situation, but I am reminded of a comment that the CEO of a cable system on a tropical isle once made to me: "The worst days for my business are when the sun shines and the sky is absolutely blue and perfect, because that's when all of my subscribers go to the beach, and while sitting at ease, they begin to think that maybe they don't need my service." It seems that bad weather, in any guise, shows cable at its best. CED

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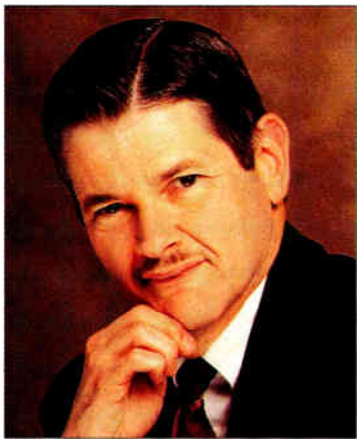
Circle Reader Service No. 11

Brunswick stews over spectrum analyzers



By Jim Farmer, Chief Technical Officer, Antec Technology Center

I have a friend who works for a small cable operator, whose name is being withheld to protect the guilty. Though not his real name, we call him Brunswick, because he is always getting into a stew about something. (If you don't know about Brunswick Stew, you have missed the second biggest treat in my part of the country.) Here's a letter I got from him recently.

Hi Jim:

Late one morning, I was sitting in my office going over some trouble reports and working on my long-range plan (where to eat lunch). I heard this screaming and pounding coming from the headend. Coverdale, my headend tech, was yelling and beating his head on the desk. I like to let my guys express themselves, but I'm not sure how much more that foot prop will take.

"Easy there, Covers," I said. "Nothing could be so bad as to make you wreck that old desk."

"Brunswick, the levels of all channels are unstable. I tested levels with that new spectrum analyzer you bought. You said it would tell me a lot about our signals, but it can't even read a level right. It's not working."

Considering what I'd paid for the thing, I really got in a stew when he said that. I walked over to the analyzer, still displaying the output of our channel 8 modulator. Sure enough, there was the picture carrier, bouncing up and down as the picture changed. I hit a few buttons and the signal level jumped up and stayed steady.

"Gee, how did you get it to do that, Brunswick?"

"Well, it's a deep secret known only to bosses and smart people, but if you drive to lunch, I'll let you in on it," I said.

A fancy signal level meter

A few minutes later, we were seated on plastic seats at a plastic table, using plastic plates and forks to eat, well, I don't want to know: it probably had plastic in it. I had to confess to Covers that he made the same mistake *I* made the first time I fired up an analyzer.

"A spectrum analyzer is little more than a fancy signal level meter, with the readout replaced with a graph of signal level versus frequency," I explained. "You could do much the same thing it does if you tune a signal level meter to a frequency, record the signal level, move to a slightly higher frequency and record the signal level there, and so on. If you plot the readings versus frequency on a graph, you would get about the same display as the analyzer gives you.

"The analyzer lets you get yourself into a bunch of trouble by giving you lots of adjustments to set incorrectly. Not only does the manufacturer let you mess up, but they also program the silly thing to mess up your readings automatically, if you don't override some of the settings. One of the adjustments the analyzer folks let you mess up is the resolution, or IF bandwidth.

"The TV signal is amplitude modulated. That is, we transmit picture information by changing the amplitude, or strength, of the carrier. So how can we talk about a signal strength measurement when we are changing the strength of that signal all the time?"

I could see by Covers' interest in his last french fry that he didn't remember how "signal level" was defined and measured for video, so I continued.

"The modulated TV signal consists of video and sync. The sync is transmitted at the highest amplitude of the carrier, and the level during sync is what we call the 'signal level.' But we can't measure the amplitude unless we have enough bandwidth to let the sync tip come through in some semblance of its shape, so that we can measure its amplitude. Remember that the narrower a pulse (such as sync tip), the wider the bandwidth we need in order to reproduce it. We don't have to reproduce the sync tip perfectly to read its amplitude, but we do need enough bandwidth to let the sync tip reach its maximum amplitude.

"You were letting the analyzer automatically set the resolution bandwidth for you. Because it didn't know that you were measuring a television signal, it set itself to measure narrower band signals. It was measuring with a resolution bandwidth so low that the sync tip wasn't getting through to the CRT. When that happens, you tend to measure something closer to the average signal level. That's why the amplitude kept bouncing around like your kid after I manage to fill him full of chocolate, before giving him back to you. That average signal level depends on picture content. The high level you saw floating through the display was the vertical sync. Because vertical sync is longer than horizontal sync, you can see its peak level even with the lower bandwidth. However, it doesn't constantly occur in the display because of the way the analyzer sweep is triggered."

Covers couldn't stretch out that last fry any longer, so we headed back to the office. On the way back, I told him about the video, or baseband bandwidth, which also has to be set right. As a rule of thumb, both IF and baseband bandwidths should be set to at least 300 kHz in order to measure video signal level.

I hope Covers is out there right now, experimenting with the spectrum analyzer, while I write to you. Think you could do something on spectrum analyzers and how to use them?

Best,
Brunswick

OK, anyone else out there interested in a bit more on spectrum analyzers? Let me know. CED

Have a comment?
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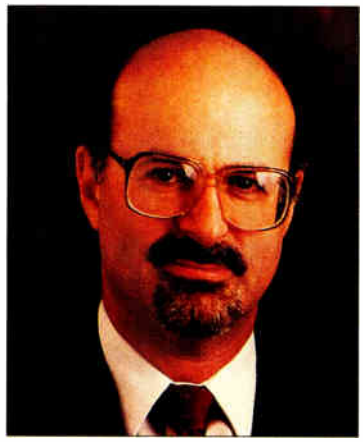
Access charges for the Internet



By Jeffrey Krauss, access charge wonk and President of Telecommunications and Technology Policy

Have a comment?
Contact Jeff via e-mail at:
jkrauss@cpcug.org

Would you like to have a 5-cents-per-minute tax slapped onto your use of the Internet that would subsidize local exchange telephone companies? That's the latest proposal being floated by the FCC, as part of its upcoming revisions to telephone access charges.

The last time the FCC wanted to impose access charges on "enhanced service vendors" like packet data networks and data retrieval services, it encountered a firestorm of grassroots opposition and threats from Congress. The FCC backed down. Now, an FCC staffer has been quoted as saying that this time, Internet users could be hit with this tax.

Back in the days of AT&T's monopoly, long distance calls cost a lot more than today, and a substantial portion of the long distance revenues were siphoned off by AT&T and used to cover the cost of the local telephone network. Economists might say this was not a subsidy, because the local network was needed to originate and complete long distance calls. But by AT&T's bookkeeping, for every minute the local network was used, long distance calls were charged three times the amount that local calls were charged.

MCI became successful partly because its customers did not have to pay the same subsidy to the local network that AT&T customers paid. But in 1983, after the divestiture of the Bell Operating Companies, the FCC replaced the AT&T subsidies with a system of access charges paid by all competing long distance carriers.

It's these access charges paid by long distance carriers that might be imposed on Internet service providers. If you recall, before access charges, you would make an MCI long distance call by keying in a local phone number, logging in to MCI by keying in an account number, then keying the number of the called party. MCI paid ordinary local phone rates for that local number you dialed, covering the path from the local telephone company switch to the MCI switch.

Today, MCI pays "carrier common line charges" which are much higher than ordinary local phone rates for the path from the telco switch to the MCI switch. As a result, MCI pays local phone companies like Nynex as much as 5 to 6 cents for every minute those local lines are used. This adds a significant amount to MCI's long distance charges.

Of course, MCI received some benefits from this conversion to access charges, because there were modifications to local telco switches as well. Everyone then was "pre-subscribed" to AT&T; to use any other long distance service, you had to key or dial many more digits. Today, you can pre-subscribe to MCI, or you can dial into its network using the access code 10222. There's no need to dial a local phone number. You don't need to key in an account number. These improvements are known as "equal access."

Today, you send Internet e-mail by keying in a local phone number, logging in and then keying in the e-mail address of the recipient. Your Internet service provider pays local phone rates for the path from the telco switch to its Internet server/switch. It's exactly the same as using MCI before the days of access charges. But Internet users would not benefit at all from these access charges.

Wait a minute. Maybe the FCC will do something rational and require that the new access charges be used to subsidize local ISDN data services rather than voice services. Naahhh!

The last time around

In 1987, the FCC proposed to apply these carrier common line charges to "enhanced service vendors." ("Enhanced service vendor" is the term the FCC uses to designate anyone that offers a service in which telecommunications and computer processing elements are combined; it includes packet switching networks, e-mail networks, database retrieval services, burglar alarm monitoring, etc.) The FCC received formal comments from 129 parties, and many informal comments and letters, mostly opposing the idea. Not surprisingly, the local telcos loved it.

There was no public use of the Internet then, but there were packet switched networks such as Telenet and Tymnet, and many companies were just starting to set up corporate e-mail networks on these packet networks. The banks were doing electronic funds transfer over enhanced service networks. CompuServe existed then, and so did Quantum Computer Services, which later changed its name to America Online. In addition, even then, there were thousands of electronic bulletin boards which had begun to exchange messages across the country. They all opposed the FCC's plan.

In October 1987, Congressman Ed Markey convened a hearing in Boston on the issue. Not surprisingly, he had no problem rounding up witnesses who opposed the FCC's plan. The FCC Chairman at that time, Dennis Patrick, tried to defend the FCC's proposal. It is fair to say that he did not enjoy that hearing.

Future of access charges

As local telephone service is opened to competition, the FCC recognizes that it will be forced to revise the access charge policies. Today, local monopoly telcos reap a windfall from access charge taxes imposed on long distance carriers. It isn't fair to continue these subsidies to the established local telcos while requiring new competitive local phone carriers (like cable companies and PCS operators) to operate without them. Access charge taxes should be eliminated over time, so that competing phone companies have a level playing field. Get rid of 'em, don't create new ones! CED

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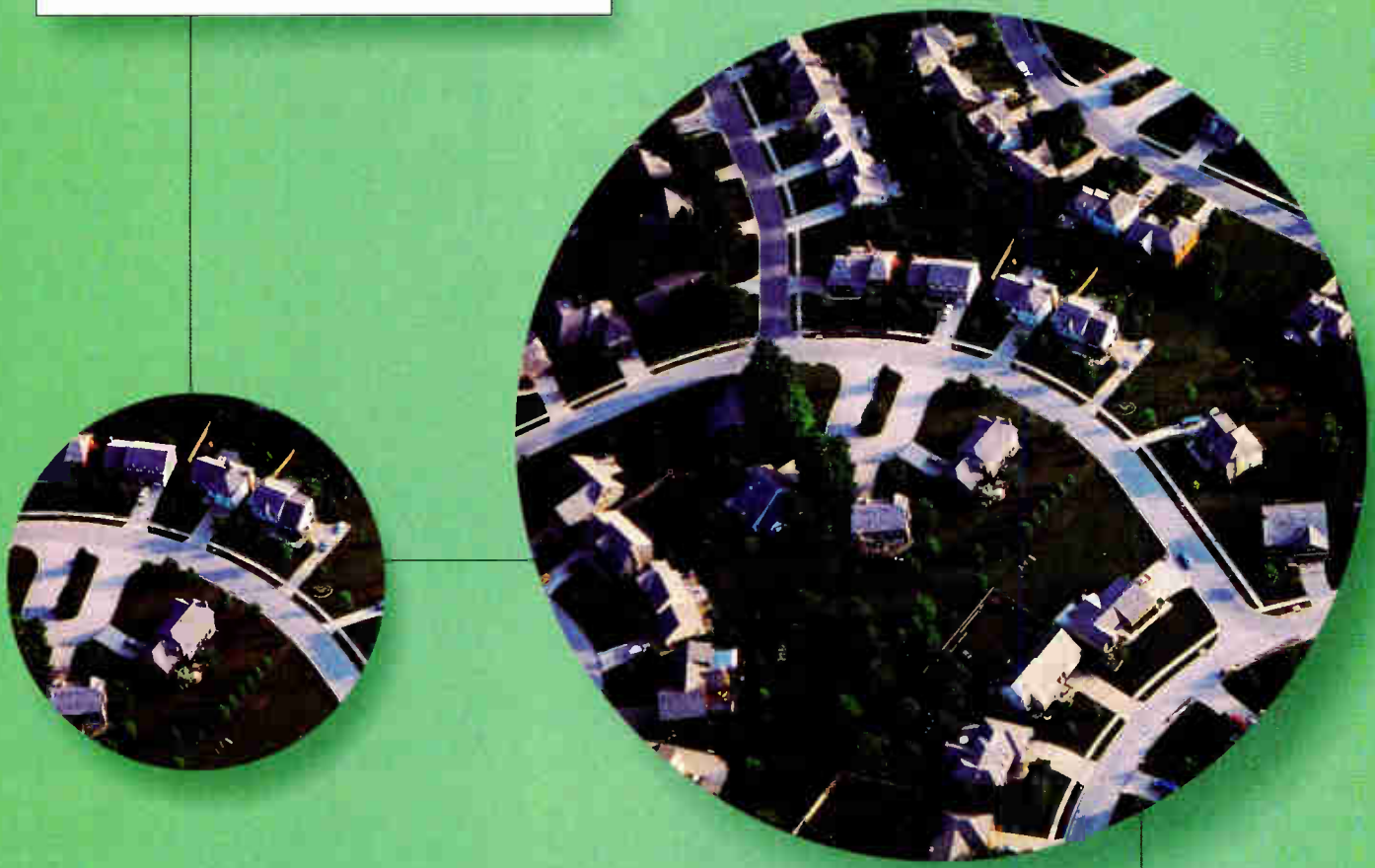

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Hazards of retail set-top sales

By Walter S. Ciciora, Ph.D.

The Telecommunications Bill keeps promising to be passed, but things keep getting in the way. It is not possible at this point to know for sure whether the Bill will succeed. However, there are some parts of it that deserve serious consideration because of the problems they will cause.

The topic covered here is the hazards of retail sale of set-top boxes. Congressman Bliley has put forth an amendment requiring the sale of set-top boxes from consumer electronics retailers such as Circuit City, one of his constituents. As I mentioned in a previous column, the consumer electronics industry has positioned set-top boxes as evil things, the work of the devil. These nasty things get in the way of all of those wonderful TV and VCR features and functions (whether you want those attributes or not!). The only reason folks don't use those features and functions is not because nobody cares, but because the evil set-top box gets in the way.

A mixed bag

Sometime in 1995, there was an apparition from heaven that told the consumer electronics guys they were not seeing things clearly. The set-top box is in fact a wonderful thing that can be sold at retail! Rather than trying to kill off set-top boxes, the consumer electronics guys now want to make and sell them! We've entered a new era!

Very little in life is all bad or all good. Most things have advantages and disadvantages. From a cable operator's perspective, the advantages to subscriber ownership of set-top boxes are primarily economic and potentially customer satisfaction. Certainly, getting the subscriber to pay for the hardware and its maintenance is a real blessing. Also, there is the potential that the subscriber who owns the set-top box will see it as a benefit, rather than as something that gets in the way of TV and VCR features and functions. There is something about a pride of ownership that brings a "halo" effect. As I mentioned in a previous column, the VCR is in almost every way a "set-top box" which has as much interference with the features and functions of a TV as does a cable set-top box. Yet you never hear any complaints about VCR interference with TV features!

Serious hazards arise from subscriber set-top box ownership. Perhaps the first issue is that of resolution of in-home problems. Most subscribers do not realize that the leasing of a set-top box brings with it in-home pre-paid service. This service is generously provided and covers not only technical difficulties, but even assistance in usage and user errors such as not checking to see if the set-top box is plugged in. It will be important to advise subscribers who purchase their set-top boxes that this assistance must come from the retailer, the manufacturer, or will be an extra charge when provided by the cable operator.

Signal security is a major concern. When the cable operator provides the set-top box, it can decide when signal security has been breached and replace the boxes. Subscribers will not lose an "investment" in in-home hardware. When subscribers own set-top boxes, they will be faced with replacing them if they wish to continue service.

When a service fails

A serious drawback to subscriber ownership of set-top boxes comes from the hurdle this creates to taking new services. If the set-top box owned by the subscriber does not have the technology to provide access to a new service, the subscriber will have to choose between a) not taking the service, b) adding a second set-top box to provide access to the service, and c) replacing the existing set-top box with a new one that combines the old capability with the new. Clearly, this presents financial, convenience and "just doing it" hurdles to subscribers who might otherwise try a new service.

Another aspect of this problem is that a new service needs to attract subscribers quickly. If the cable operator provides the set-top box, it will be installed in a large number of homes simultaneously. The service provider quickly adds subscriptions. When the service provider has to rely on consumers purchasing set-top boxes, there will be a significant reduction in the speed of penetration. Many service providers will not be able to survive long enough under these conditions. This raises yet another concern: what happens when a service fails? Under current conditions, a service which fails and leaves hardware useless does not directly impact subscribers. If the subscriber purchases a set-top box for the new service and it then fails, the subscriber will bear the loss. Not only will this cause unhappiness, but it will further reduce the willingness to try new services in the future.

Subscriber education

While these problems are not yet upon us, the potential is high that they will be in the near future. It is worthwhile giving them some serious thought now. Probably the most important action to be taken by cable operators is subscriber education. The issue here is "management of expectations." If the consumer is well aware of the advantages and disadvantages of his purchase decision and proceeds with an informed decision, the likelihood of later problems is reduced.

Another way of minimizing the problem is to require all set-top boxes sold at retail to comply with FCC requirements for "cable ready" TVs and VCRs. This includes the Decoder Interface. A modular set-top box minimizes many of the problems described above. CED

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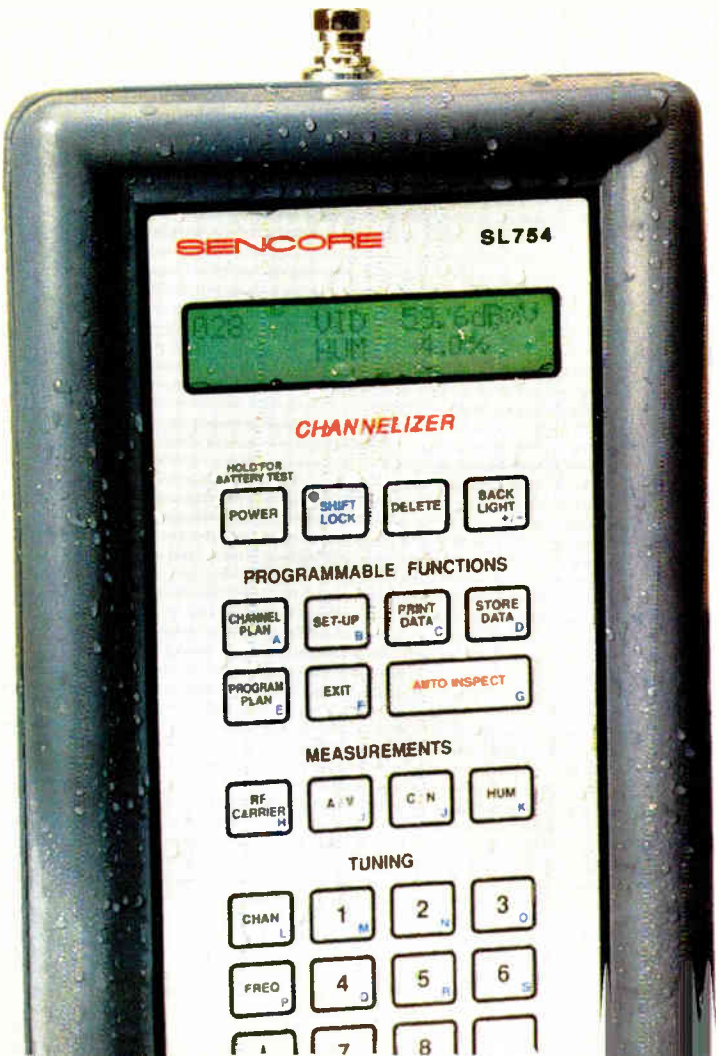

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Multimedia distance learning networks

Cable's design approaches and business opps

By Bob Beaury, President, and Tom Donahue, VP Sales and Product Development, Broadband Networks Inc.

Cable television operators have a long history of providing service to institutional customers such as schools, businesses and government users. In the past 18 months, the combined factors of increased competition and demanding franchise renewals have made the provision of distance learning service mandatory for many operators, and for some, an opportunity to generate new revenues.

This article reviews the history of fiber optic distance learning system design. The focus is on the current state-of-the art, which is a dedicated fiber optic network that can deliver a comprehensive set of interactive video and data services. Also discussed are some real-life experiences related to bidding and building multimedia distance learning networks.

The early days–FM rings

In the second half of the 1980s, FM fiber optics became a commercially viable solution for headend interconnects and other applications such as distance learning. These first networks were either directly owned and operated by the school district or supplied by a telephone or alternate access company. In both cases, the parties involved, including the design consultants, had no desire to deal with a coax/amplifier-based system and wholeheartedly embraced a fiber optic solution.

The first systems were designed in a "ring" topology with a maximum capacity of 16 simultaneous channels on the ring. Each location was capable of transmitting one channel and receiving three. This channel configuration stemmed from the conventional wisdom that the maximum number of remote sites an instructor could manage during one session was three, therefore, three receive channels.

In general, these systems met the needs of the first users, but the limitations of the basic design approach made it difficult and expensive to add new sites, increase channel capacity and troubleshoot problems. It was a good solution for its time, but it never provided the functionality and cost to allow for the wide-scale deployment of distance learning networks.

AM fiber optics

In 1990 the cable TV industry embraced AM fiber optic solutions for trunking applications. Acceptance of AM technology in the world of distance learning did not occur for several more years and can be attributed to two factors. Distance learning projects often have a 12- to 36-month cycle, beginning with a consulting

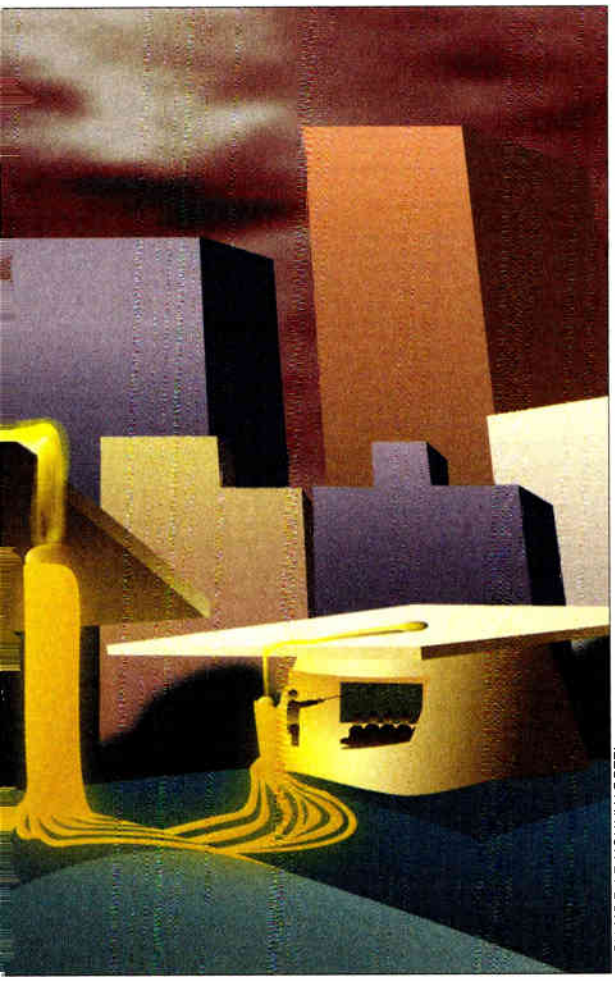


ILLUSTRATION BY DON RUTH

engineer defining a bid specification. Many projects in the early '90s were built based upon bid specifications that were written prior to the introduction of AM transmission electronics.

The second factor relates to the type of people who were doing the design of distance learning systems–they were not cable television engineers! It took a number of years, more time than you would reasonably expect, for the majority of the engineering community outside of the cable industry to understand the advantages of AM systems.

One of the notable exceptions was Ameritech. In 1991, the company built a large distance learning network in Indianapolis that connected 90 schools for interactive multichannel video and 10 MB data using AM electronics in a star architecture. It is still today one of the largest interactive distance learning networks in the country.

AM/FM hybrid designs–TEEN network

By 1993, AM fiber optics was becoming more commonly understood, and in that year, some of the first "AM/FM hybrid" networks were designed and built. The TEEN (Technology Excellence in Education Network) was one of those systems and was an extremely interesting project because of how the network was designed, and because of the people involved.

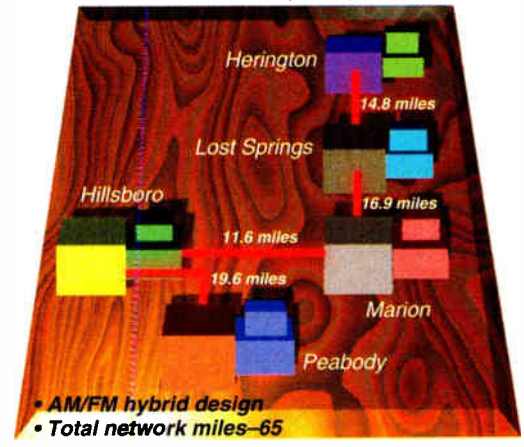
The TEEN Network represents the efforts of a group of dedicated educators and administrators to provide a modern curriculum to students at five rural schools in Kansas (Figure 1). Working with engineering consultant Tele-Systems, the group first considered the classic FM ring approach but determined it was too limiting in terms of channel capacity and site expansion.

The conclusion was a design approach that used both AM and FM transmission electronics in a star architecture. For the inbound portion of the network, the remote sites were configured the same as in a classic FM design. Each site used an individual FM modulator and FM transmitter to deliver one channel to the next site, and eventually to the system headend, which was located at Marion.

At Marion, all of the signals were received and FM demodulated to baseband. The signal package was then AM modulated and fed to AM transmitters for delivery outbound. Cost considerations dictated a minimal fiber count and the need to share fibers between sites. To address the situation, the outbound portion of the system was designed with cascaded AM links. The output of high-power DFB transmitters delivers the entire channel package to each site. AM receivers detect the signal package at each site, and the receiver output is simply fed to a cable-ready TV set for channel selection and viewing.

Using AM electronics reduced the total cost of the network, while providing expanded channel capacity

Figure 1: Technology Excellence in Education Network (TEEN)



The AM/FM hybrid approach provided the best advantages of both transmission techniques. The robust nature of FM inbound transmission allowed for the received signals at the headend to be of broadcast quality, even though most of the sites were located many miles away. The high quality of the inbound signals at this point allows them to be either retransmitted outbound to the TEEN locations or to another network. In either case, the system is designed so that the roundtrip signal performance meets or exceeds what the students are watching in their own home.

Using AM electronics reduced the total cost of the network while providing expanded channel capacity. The TEEN outbound transmitters were built for 450 MHz of usable bandwidth, which will meet the needs of the users for many years to come. It also made the classroom relatively simple to install, because the end user interface device is a standard cable-ready TV with a handheld remote control.

In the years that have passed, the TEEN users have consistently expanded the service capability of the system. Today, the network includes Ethernet data service, as well as a codec for long distance conferencing with other networks. The next challenge for the TEEN group is Internet access, which it hopes to have up and running sometime in 1996.

AM/FM hybrid design–today

The basic concepts of the AM/FM hybrid design approach are still being used today. The most significant differences between the TEEN design and the design work done today have to be considered refinements, more than real changes.

Today's outbound design (Figure 2, page 32) looks just like a cable TV trunking application in that optical splitting is used to allow one DFB transmitter to serve multiple sites.

The inbound portion uses the same design approach but more cost-effective FM transmission equipment.

The TEEN design used frequency agile FM modulators and demodulators with separate transmitters and receivers. This allowed the network to be easily configured for a full 16 inbound channels. Today, it is generally recognized that most schools will never need to transmit more than four simultaneous video channels, and the majority of sites will only require one channel. This has led to the use of lower cost fixed frequency modulation and demodulation equipment, that in the case of the single channel requirement, is all integrated into one small package (Figure 3, page 34).

The service package today

What has changed significantly in the past three years is the set of services most end users expect to be provided by a modern distance learning network, including:

✔ Outbound video–550 MHz is a minimum requirement, and many users want 750 MHz. The actual number of channels to be delivered outbound upon system turn-up varies depending on available funds but is rarely less than 40 channels. The bottom line is that users want as many channels and as much usable bandwidth as possible for broadcast-only service, interactive videoconferencing and media retrieval.

✔ Fax–Any capability of the network that reduces the end user's existing cost helps pay for the network. Most users expect the network to provide the capability for fax service between sites. This capability is relatively simple and inexpensive to implement, and in fact, was provided as part of the functionality of the TEEN Network.

✔ Data–10 MB Ethernet & Internet Access. This is the must-have service. For many educators it is more important than the video service. The 10 MB Ethernet capability can be used for administrative functions, such as attendance, payroll, record keeping, etc. Schools see this as a means to centralize their data processing functions and to reduce MIS expenditures. Internet is almost self-explanatory. Does anyone want their children to attend schools that aren't connected to the Internet? It is the 1990s' version of the encyclopedia.

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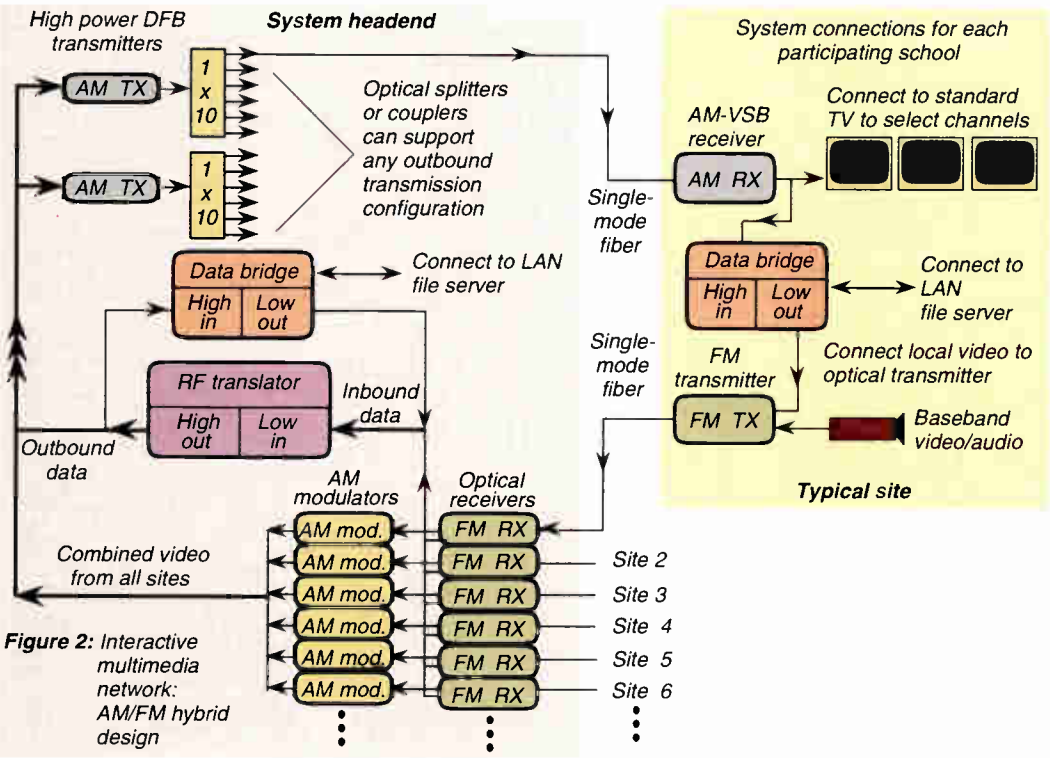
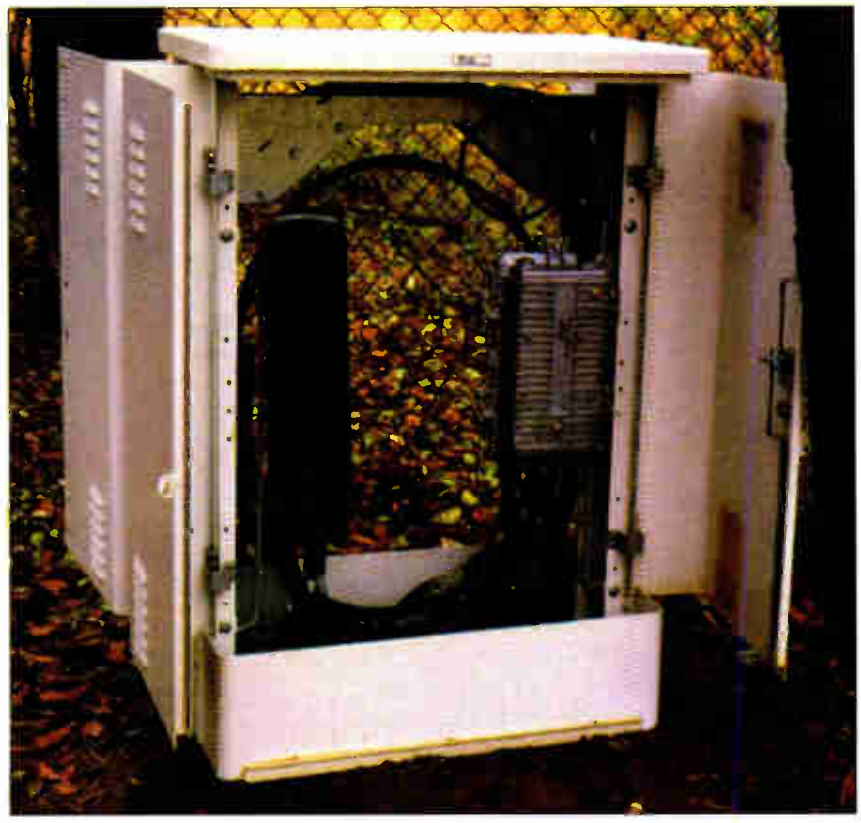


Figure 2: Interactive multimedia network: AM/FM hybrid design

ous transmission of 10 MB Ethernet, Internet and multiple full motion video services. RF bridges connect each remote Local Area Network (LAN) into a multi-site Wide Area Network (WAN). The WAN can approach a 200-mile service radius and be fully symmetrical with full 10 MB throughput. The bridges connect to the WAN via standard cable TV video RF frequencies to allow data carriers to be combined and transmitted with the video channels (Figure 2).

A central headend collects the inbound data carrier from each LAN and uses a frequency translator to convert the data package to a high frequency outbound carrier returned to each site's bridge. The headend equalizer or "pacer" router synchronizes the data flow and network authorization between LANs (Figure 4, page 35).

Fiber Optic Management Systems



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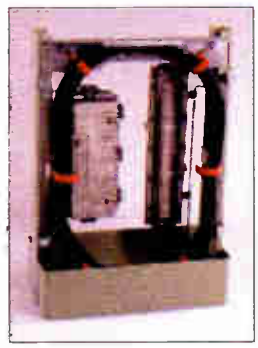

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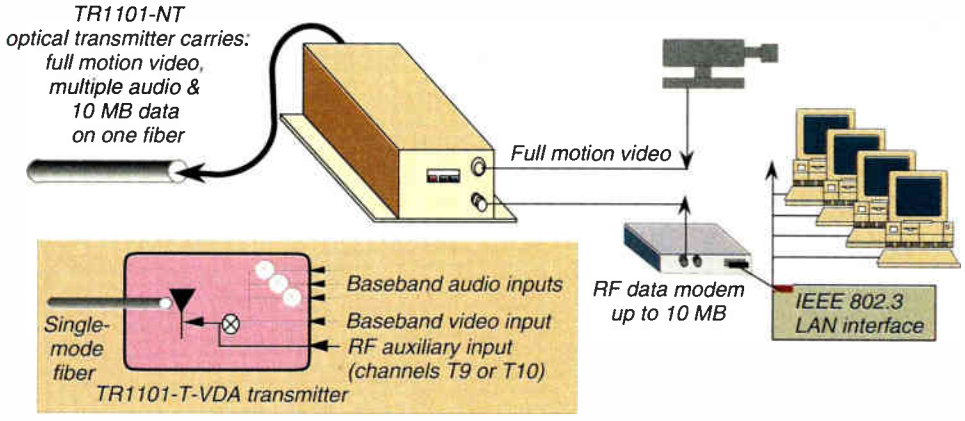
Figure 3: *Integrated FM transmission*



Internet Protocol (IP) access is connected from the local Internet provider or "gateway" and connected to the WAN using an IP router. The IP router allows simultaneous Internet and Ethernet service over the WAN Ethernet bridge/translator network. The IP router directs Internet access to LAN users via their IP address, while other protocols are directed by the Ethernet pacer.

The network management software allocates data bandwidth and access between sources and users.

Any network that provides all of these capabilities has to include system switching or be designed so that system switching can easily be added in the future. Many of the early distance learning networks were complicated to use and discouraged rather than encouraged teachers and students to use the system.

The technology can't interfere with the learning process, and this is best accomplished by giving the teacher very simple tools to set-up and control conferences.

Based upon the feedback received, the following are some of the user capabilities that need to be provided by a modern distance learning network:

✔ End users can schedule their own conference and receive immediate feedback upon their request.

✔ If the conference can't be scheduled as requested, the network provides alternate conference times and dates.

✔ The classroom environment provides the teacher and students with a full-motion, continuous view of

all participants.

✔ The teacher can control and switch the video images being viewed.

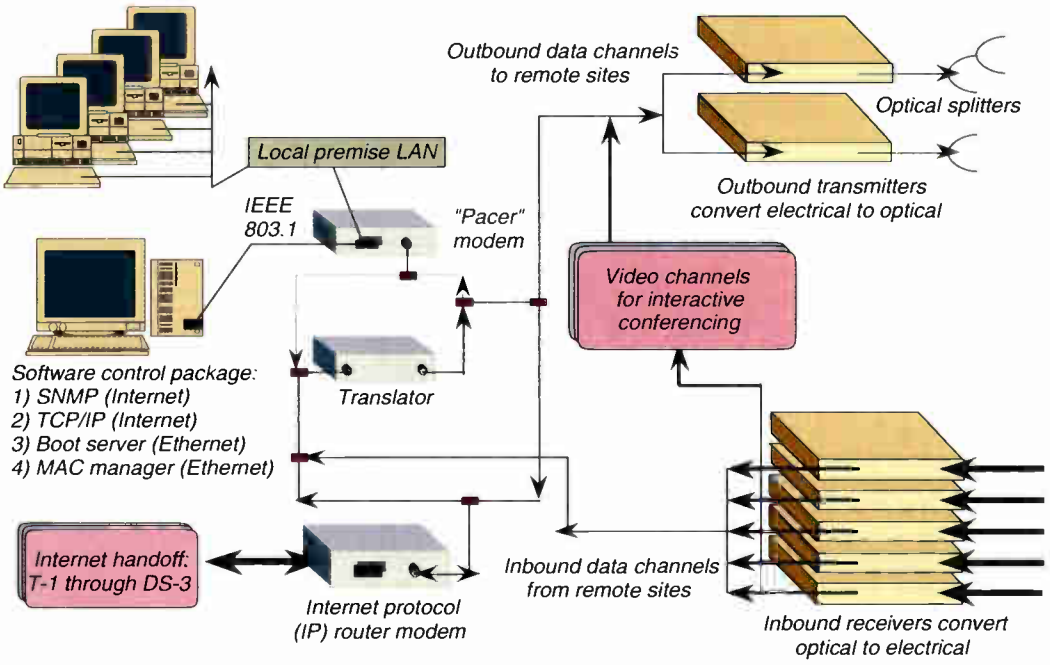
✔ The teacher has access to multiple views of any one location.

✔ The teacher can remotely control source devices, such as VCRs, cameras and microphones.

✔ The control functions are all through a handheld remote control, like the one teachers use in their own home.

The classic approach to setting up a video switch is to establish a centralized baseband matrix switch at the system headend. This approach can be very expensive both in terms of the penalty it places on the transmission electronics and the cost of growing the switch in the future. To avoid these problems, the focus has moved to distributed switching solutions using simple programmable demodulators at the school controlled by the EDCOMM

Figure 4: *Headend configuration for concurrent Ethernet/Internet connection*



network management system.

The advantages of this approach, beyond reduced cost, include the capability to designate any site on the network as a gateway and the ability to grow the switching capability of the network in an incremental manner based upon the needs of each site.

A growing number of cable operators are exploring the possibility of providing distance learning solutions. The common perception is that this growth is resulting from a need to satisfy franchise requirements. This is partly true, but ignores the fact that cable operators see the opportunity to generate new revenues and enhance their public image. It also does not recognize the reaction of many cable operators to imminent competition for video service in their franchise areas.

Distance learning–the business case

This multi-purpose strategy is the case for Comcast in New Jersey and Marcus in Wisconsin. End users are capable and willing to pay for both video and data services, if they are delivered with cost-performance tradeoffs that are of real value. The authors' company has worked very closely with Comcast and Marcus to put together cost-effective solutions that include simultaneous full-motion videoconferencing, 10 MB Ethernet service and full Internet access.

This combined set of services and the guaranteed capability for future expansion to more sites and other systems gave Comcast and Marcus dramatic advantages (and the winning bids) versus the competition.

These systems provide the infrastructure and demonstrate the capability to reach a new customer base with an expanding number of site and service requirements. Most importantly, both systems use current, cost-effective technology in designs suitable for wider scale business plans.

Areas up to 70 square miles are serviced with expansion capability provided for 30, 60 or more fully interactive sites. These sites can include government institutions, medical facilities, colleges and schools to provide multiple market opportunities all supported by one network.

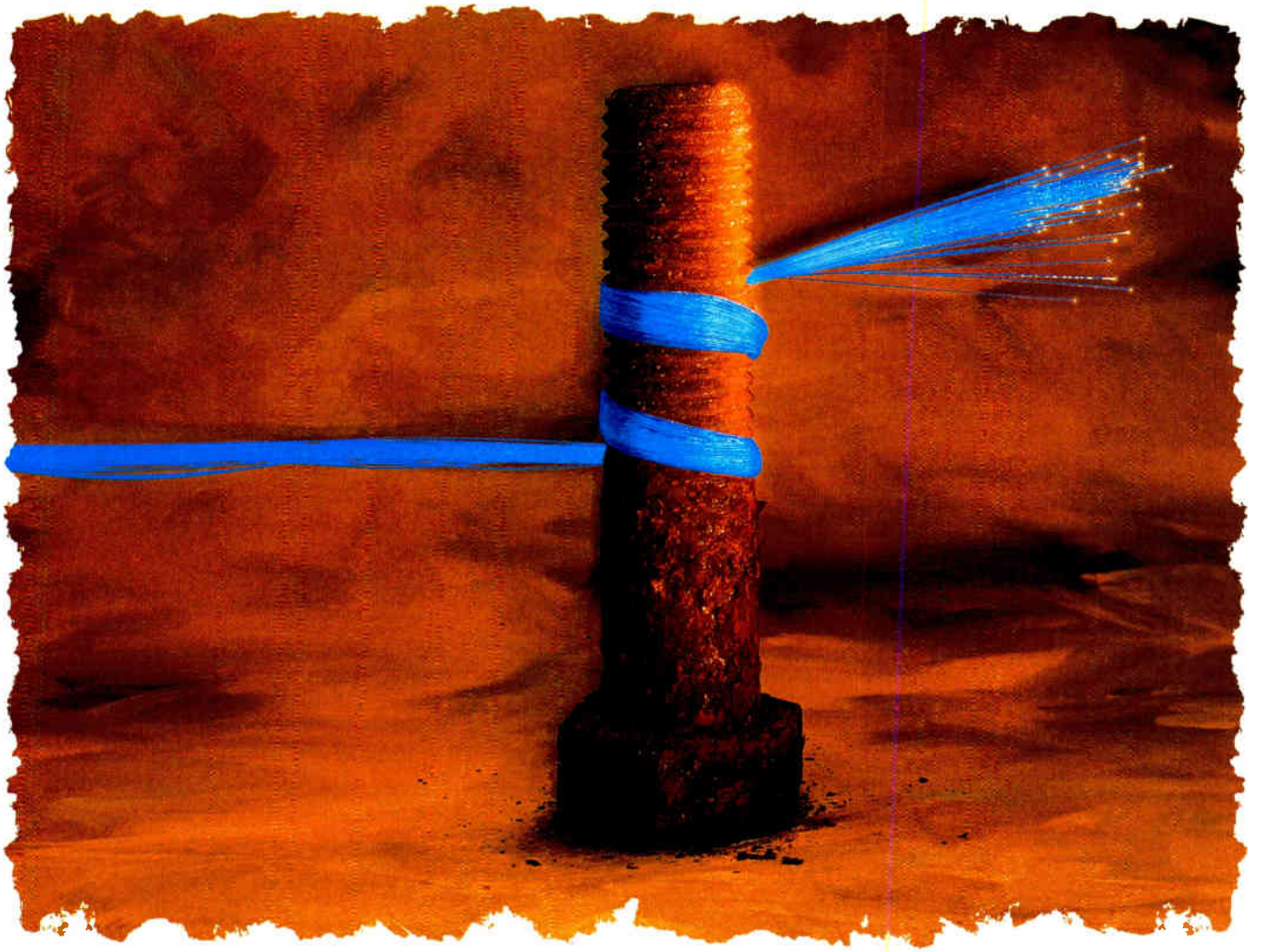
The building of infrastructure and the delivery of service today at a realistic price positions Marcus and Comcast extremely well for future growth. Their competition has been pushed back, their networks have expanded their reach and service capability, and as corporate citizens, they are viewed as providing an innovative, important service to their communities.

It isn't hard to understand that this is a winning strategy for these two operators and others who share the vision.

In conclusion

Distance learning–defined as providing interactive video, audio and data services to schools, businesses and government–is a real business that is of strategic importance to the cable industry.

The existing franchise, when combined with the use of a comprehensive multimedia design solution, provides the cable operator with enormous advantages over the competition. CED



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Fiber optic evolution

From the fall of Troy to present day extends capacity, reach

By Rob Koslowsky, Director of Transport Marketing, and Drew Martino, Marketing Support Specialist, Nortel Broadband Networks, Atlanta, a division of Northern Telecom Inc.

The past decade has ushered in a dramatic increase in bandwidth-hungry applications. Many predict that by the end of this decade, traffic will be almost 10 times today's volume, due to the emergence of multimedia applications.

The transformation of electronic communications to an Information Highway is being realized by fiber optic cables. With a bandwidth capacity thousands of times greater than copper and coax lines, fiber cables provide a transmission medium that is quickly leading communications onto the "high performance highway." The appeal of fiber is that compared to copper and coaxial cable, it can carry thousands of more bits per second, and it has a bit error rate a thousand times less.

In the beginning . . .

Optical communications pre-dates both electrical and radio communications. Queen Clytemnestra received news of the fall of Troy in 1184 B.C. by way of optical communications. A series of bonfires, on line-of-sight hilltop locations, relayed this information a total distance of 900 km. This was one of the first long distance networks.

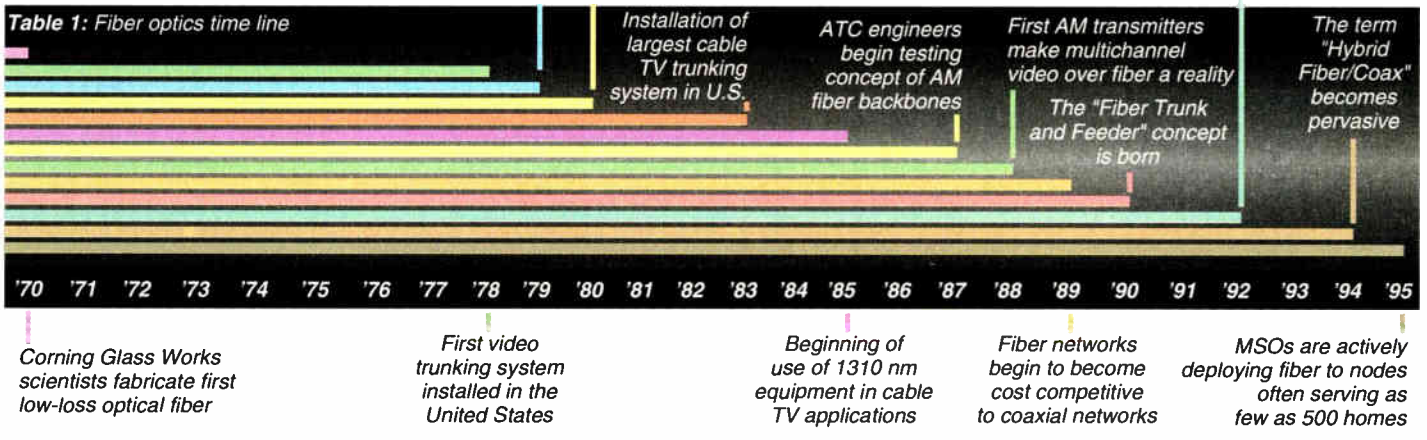
The ancient Greeks observed that light could be guided by a piece of glass. And it wasn't until 1966, when Kao and Hockham (U.K.) suggested optical fiber for long distance transmission, that fiber optics development mushroomed. The 1970s brought fiber optic technology to service providers. A basic fiber optic link features a digital bit-stream, obtained from data, video or telephony sources, driving a laser transmitter to produce light pulses. At the receiver, these impulses appear attenuated and widened due to the fiber characteristics. A photodiode receiver converts the impulses back to the original bit-stream. Both telephony and cable TV providers deployed systems with up to 10 km reach, carrying a few voice circuits or video channels. During the early 1980s, fiber's loss characteristics and pulse narrowing advantages were improved. This improvement allowed service providers to extend the reach and increase capacity of their fiber optic systems by an order of magnitude. Figure 1a [1] illustrates the bit rate capabilities for several types of transmission media, including fiber (see page 42). Clearly, there is still plenty of room for higher bit rate electronics to fully exploit the bandwidth carrying capability of optical fibers.

Fiber–the early years

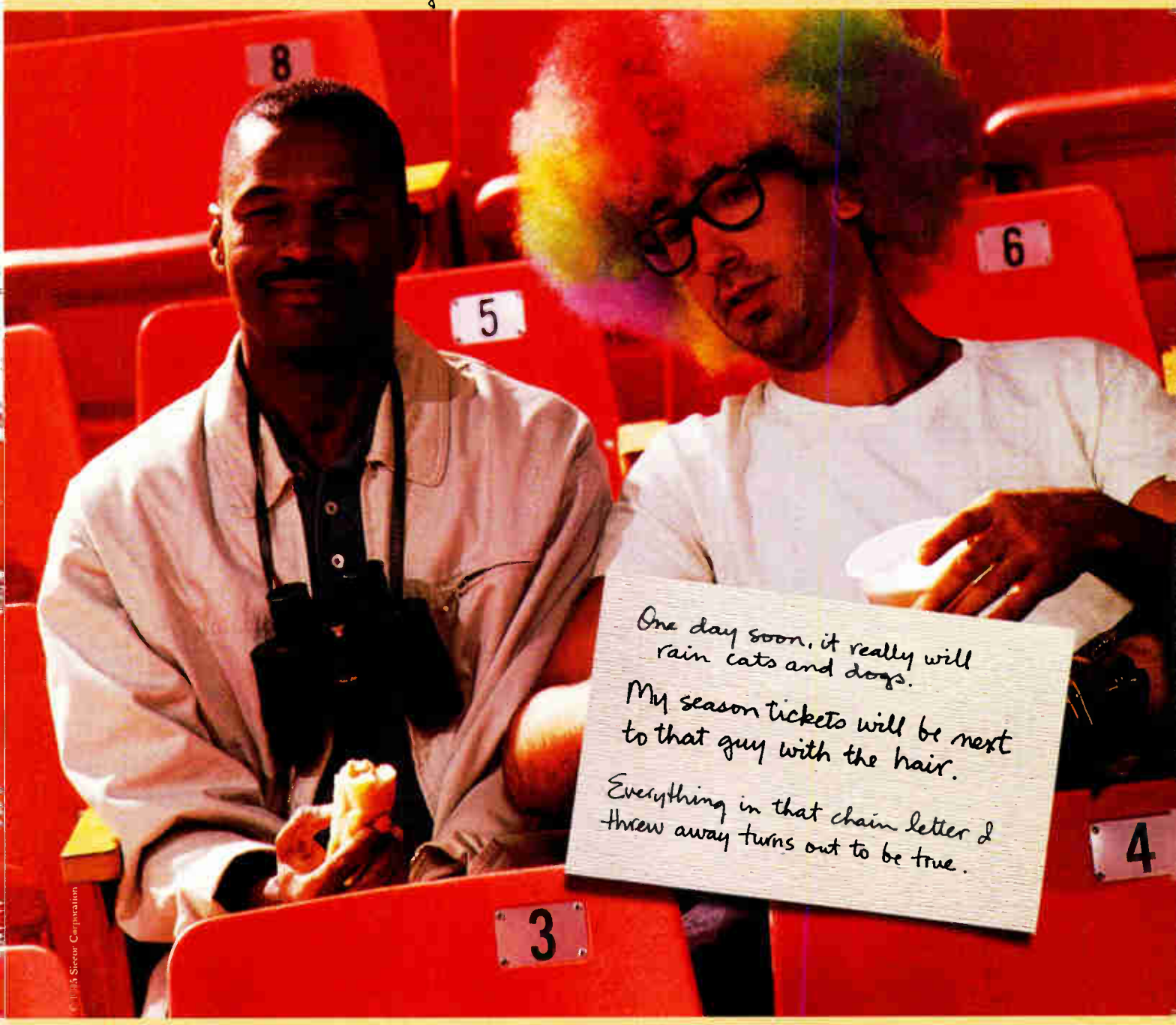
Moving information from point A to point B is therefore not a new challenge–telecom managers have been addressing this issue for a number of years, and usually responded by packing transport pipelines to capacity or by increasing the size of the pipeline itself. This was accomplished by removing the copper bottleneck and replacing it with digital microwave radio technology and optical fiber systems throughout the 1980s. By the close of the decade, fiber transport was the delivery vehicle of choice for high bandwidth transport. Figure 1b illustrates the industry's experience with asynchronous fiber technology, the precursor to Sonet technology (page 44).

Various types of asynchronous technologies were developed during the 1980s, all with vendor-specific protocols. During that time, manufacturers developed extensive experience with service providers. From this experience, it was learned that fiber technology reduces burst-errors, an important requirement for data and video transmission. Field operation of fiber electronics confirmed the reliability of laser device technology and the reduction in maintenance routines, which is so important to operations personnel.

It was also discovered that available bandwidth attracts use, resulting in development of



THE FEARS OF Roger Wallace, CATV NETWORK TECHNICIAN



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higher-speed optics. Fiber cables required no upgrades. Capacity and reach were extended by deploying new fiber electronics. It was also learned that "cable cut" survivability was a definite requirement. Outages were not acceptable for fiber cables simultaneously carrying 8,064 voice channels.

At the same time, Sonet and SDH signaling standards were in development [2], as service providers and manufacturers alike realized that the expansion of the communications infrastructure and the "shrinking globe" required common terms and standards so that messaging could change routes and travel on other highways with equal ease. Product compatibility among vendors would allow efficient "packing" of circuits and access with add-drop multiplexing (ADM) and virtual tributary bandwidth management (VTBM).

During the 1990s, one supplier alone has shipped more than 20,000 Sonet network elements (as of December 1, 1995). This translates into an additional field capacity of over 16 million DS-1s supporting the longest Sonet routes in both Canada and the United States.

Outages have been reduced to barely minutes per DS-3 annually, and network survivability within rings and between rings is now available, allowing a damaged central office to be bypassed by uninterrupted traffic.

The industry has pushed the performance pedal-to-the-metal, from a bit error rate of 1 x $10E^{-9}$ to 1 x $10E^{-12}$, an improvement of three orders of magnitude. In fact, the new OC-192 technology includes forward error correction (FEC) so that bit errors can be detected and corrected–further improving the quality of the digital signal. Manufacturing environments today subscribe to an ISO 9001 level, to ensure quality processes, procurement and production. And the traffic keeps building on the highways as fast as they're constructed–available fiber bandwidth continues to attract use.

Managing the high performance highway

Manufacturers have managed the complexity of the electronics for the high performance highway so that network providers can do the job of delivering high-end services. To facilitate the service demand, fiber optic terminal evolution has seen the industry triple or

Sonet for video transport

Unlike analog technology, digital signals retain strength and clarity when transmitted over great distances. Only digital technology can handle high-speed data and graphics/video transport as well as voice. Sonet delivers a standard-based fiber platform that is finding industry acceptance for delivering video.

Cable TV operators and local exchange carriers are minimizing capital, operations and maintenance expenses by establishing Sonet rings for super headends that efficiently connect with mini-headends across a city or across a region.

Interexchange carriers are providing a service for terrestrial delivery of video signals. Governments are increasingly funding integrated community networks for deploying educational programs to rural schools, for sharing resources across agencies, or for enabling town hall meetings.

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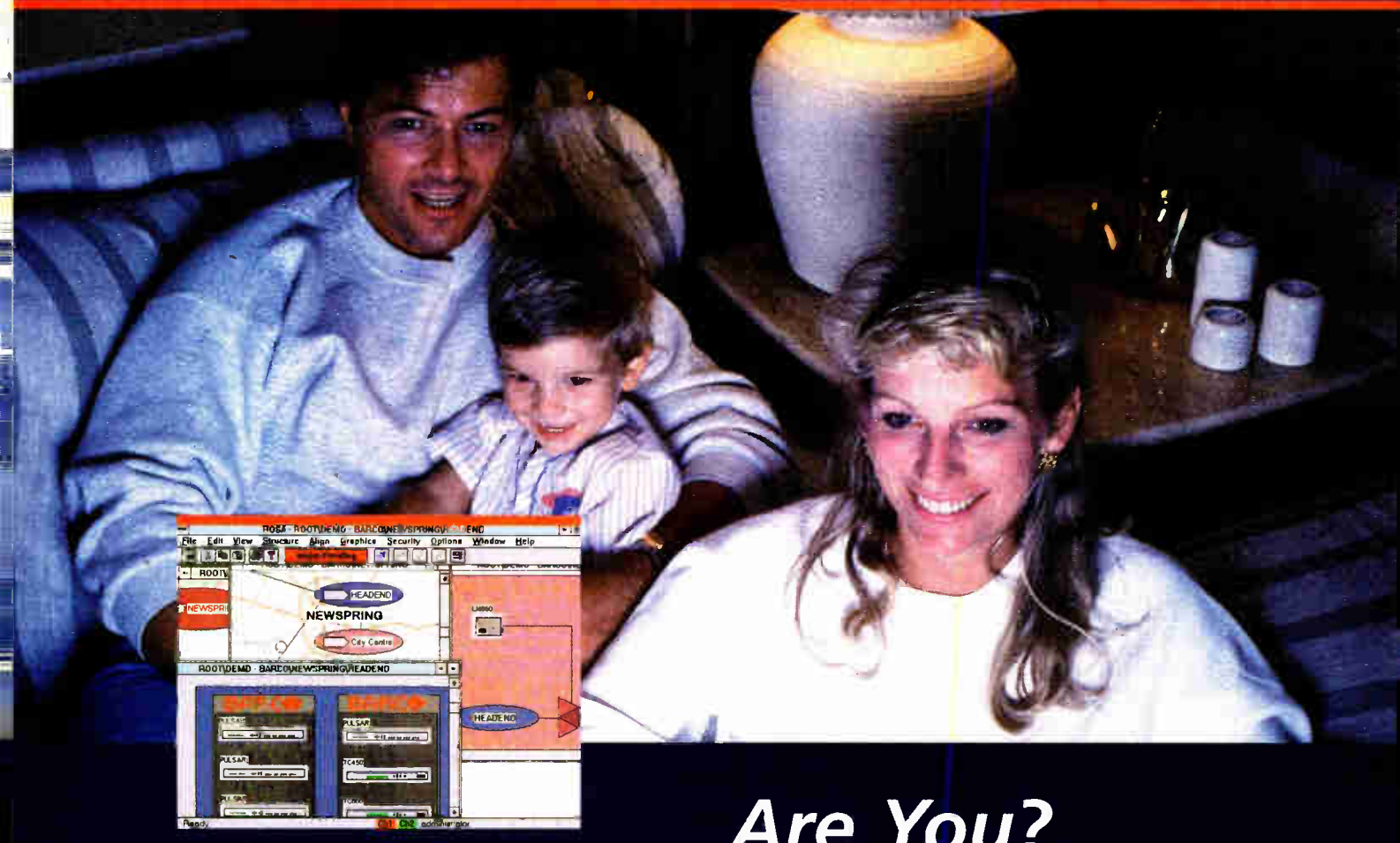

- **Complete Headend Monitoring and Control**
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- **Reduce Maintenance/ Troubleshooting Costs**

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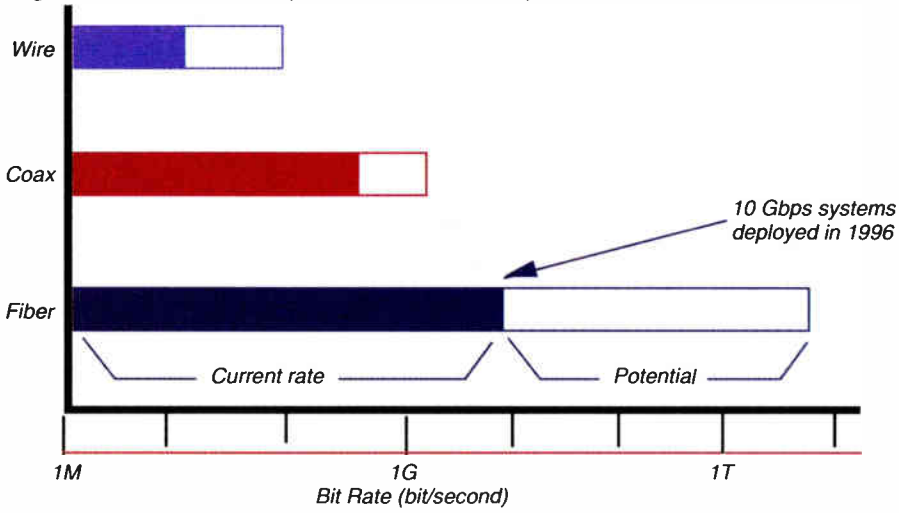
Figure 1a: Maximum bit rate possible for various transport media



quadruple fiber bit rate capacity every four years. This is shown in Figure 2a.

Another perspective is that from 1980 (four DS-1 fiber systems) to 1996 (5,376 DS-1 systems), the following occurred with fiber:

✔ Capacity is 1,554 times more on the same two fibers;

✔ Flexibility is five times greater with point-to-point terminals, regenerators, rings, ADM and hubbing;

✔ Size is the same: about 1/2 of a 7-foot rack, 23-inches wide;

✔ Power consumption is the same: a few hundred watts.

Incorporation of microprocessors, microcontrollers and software into fiber electronics has significantly increased functionality and rendered external monitoring devices obsolete. Monitoring of the network is centralized and instantaneous, enabling the identification and resolution of potential problems before they can impact service. This is critically important, because it guarantees uninterrupted service to many who can realize huge losses from just minutes of downtime. Although transparent to the customer, simplified maintenance and problem reporting add a degree of reliability to the network and ensure prompt action in the event of a problem. In fact, a number of service providers have back-up monitoring centers. This proactive approach to correcting problems improves customer satisfaction.

Enabled by the construction of these high performance highways, all service providers are now seeking a share of the growing access market by delivering voice, information and entertainment to businesses and residences. CableLabs is considering gigabit Sonet rings for video distribution; Bellcore is examining Sonet rings for telco new service deliveries; competitive access providers are looking at gigabit Sonet rings for service delivery for ATM; utility operators are deploying Sonet rings for power grid management; and corporate America is eyeing gigabit Sonet rings for high-speed data transfer.

By the year 2000, 50 Mbps services may be activated within hours after customer request

With the prevalence of fiber plant and standards based optoelectronics, service providers can deliver DS-1 and DS-3 private line services in days, instead of weeks or months. Figure 2b illustrates the improved responsiveness service providers have achieved. It is predicted that by the year 2000, 50 Mbps services will be activated within hours after customer request.

The capacity of networks to meet demand has been a challenge for service providers over the past 10 years. What seemed like adequate bandwidth at the beginning of the "service revolution" has barely kept pace with emerging technologies. Trends such as simplification of today's voice networks, continued growth of domestic and toll traffic, increasing emphasis

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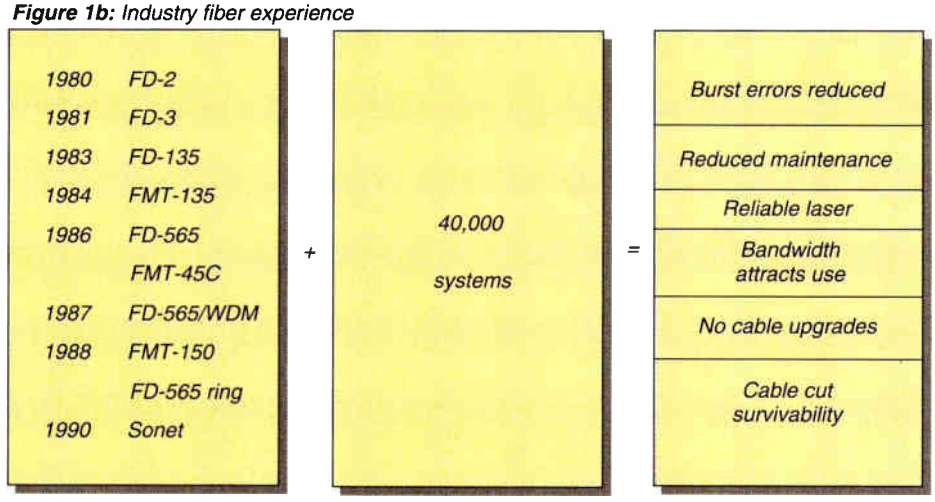
on reducing downtime, interconnection of servers at native speeds and wide area networking are driving the bandwidths. The existing bandwidth available is only due to the foresight and major capital investment of service providers who have been challenged to provide adequate transmission capability within cost constraints.

Figure 1b: *Industry fiber experience*



So, a solid Sonet infrastructure allows significant growth and service flexibility. Sonet technology ensures that a service provider can rapidly deploy services. Figure 3a illustrates this "service ready" concept.

The requirements for a service ready Sonet infrastructure are as follows:

✔ ensure high capacity OC-48 and OC-192 solutions are available;
✔ ensure access networks are flexible to accommodate both OC-3 and OC-12 levels of traffic;
✔ deliver both "cable cut" ring and "node failure" ring (matched nodes) survivability;
✔provide STS bandwidth management across the OC-48 or OC-192 "pipeline" and VT bandwidth management across the OC-3 or OC-12 "spigot;"
✔ensure both traditional and emerging (concatenated OC/STS-3c or OC/STS-12c) services are supported among multiple ring structures;
✔ simplify network upgrades with software-based evolution; and
✔ conduct network planning reviews to eliminate network bottlenecks and maximize fiber utilization.

The high performance highway infrastructure today is weaving a complex web of high-capacity traffic pipes across the country, and an interesting mix of services off the highway to those who wish to tap in from the communities it supports. But what does the roadmap of the future look like from a service provider's perspective?

As more traffic is added to the infrastructure with larger chunks of bandwidth, both fiber exhaust and fiber electronics bit rates will need review by the service provider. They will also need to look at the long-haul or interoffice equation. Such route analysis and subsequent planning are driven by dollars per bit economics. "How far and how fast can I propel this traffic?" will be the question for the network manager.

Many service providers are now looking for innovative ways to increase the traffic-handling capacity of existing fiber routes without incurring the expense of laying additional fiber cable. This trend will accelerate in the future as new and emerging services dramatically increase the demand for additional network bandwidth and for enabling technologies such as Asynchronous Transfer Mode (ATM). The network infrastructure to address these emerging needs is synchronous optical networks (Sonet) configured to protect against electronic, cable and node failure, while at the same time, supporting new service. Ramping up for the information superhighways of the future will require innovative

Figure 2a: *Fiber optic terminal evolution*

	Lightwave transport bit rate (Mbps)		
Timeline	Interoffice	Feeder	Distribution
1980	45	N/A	N/A
1984	135	45	N/A
1988	565	150	N/A
1992	2400	600	150
1996	9600	2400	600
2000	38400	9600	2400

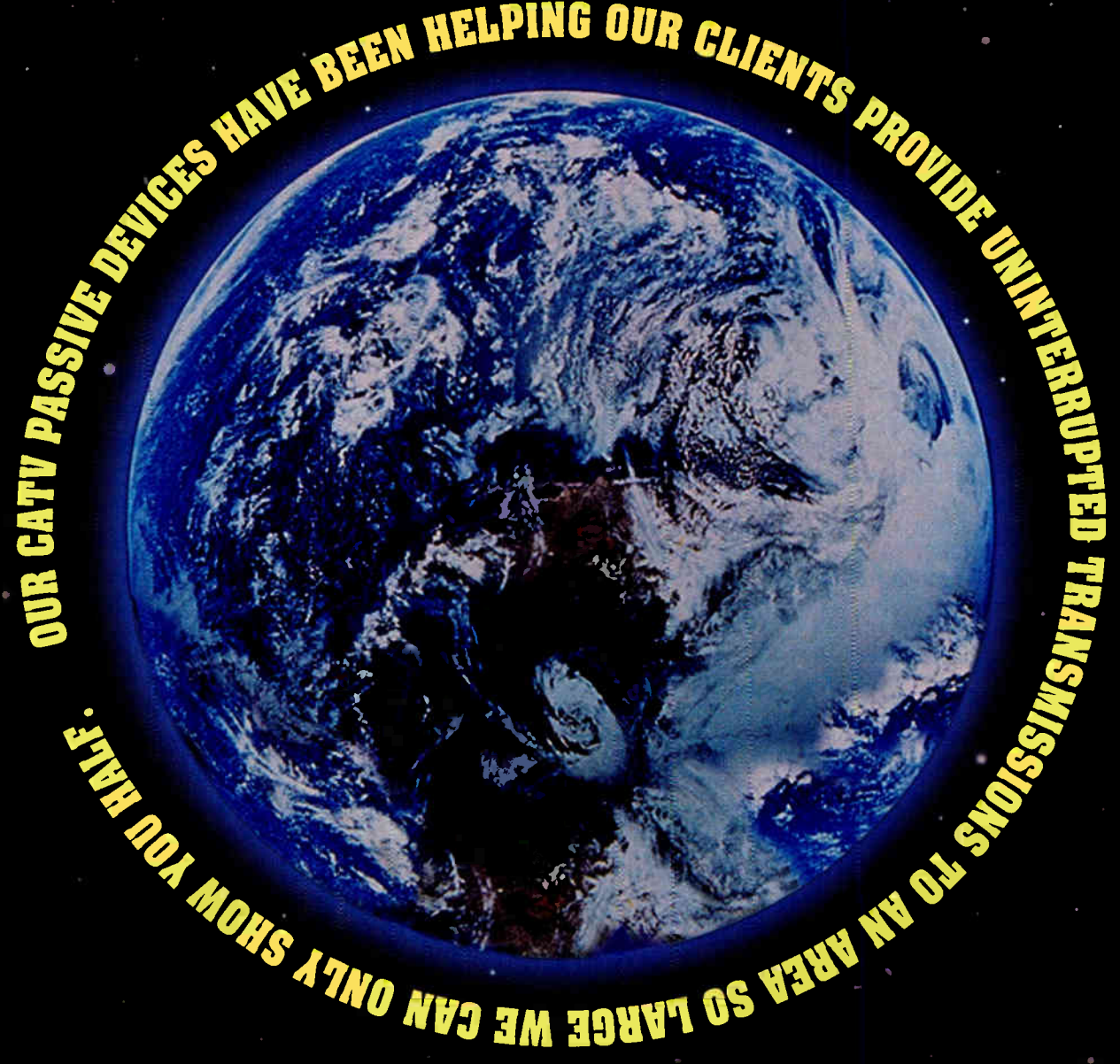


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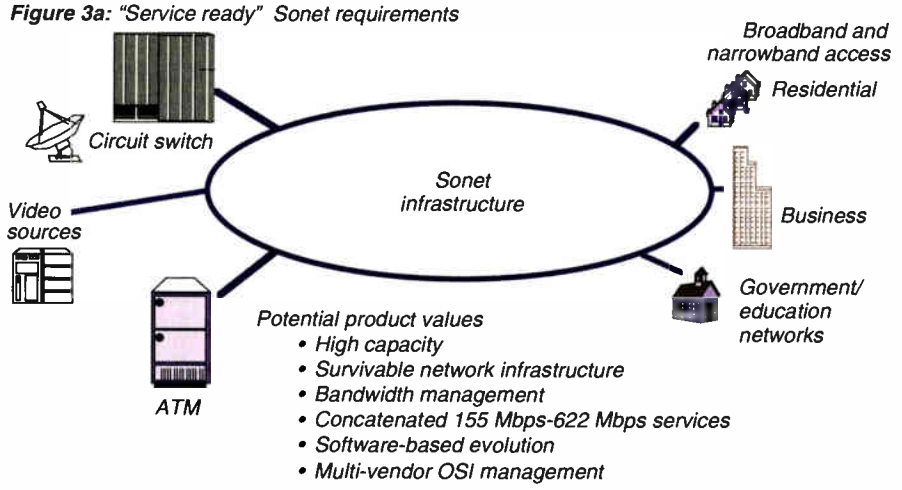
Figure 3a: "Service ready" Sonet requirements



tems. If an operator's fiber is enclosed in a pipeline, installed in a tunnel, buried under a street or strung along a high voltage transmission line, then upgrade plans do not call for more deployment of fiber. Service providers are maximizing the fiber resources that are already there. Upgrading OC-48 electronics to OC-192 provides a 4:1 fiber utilization, a 4:1 network element reduction and bandwidth management across the "pipeline."

Constructing the access ramps

During the past year, the importance of having a flexible access plant to service end users has become evident. Large clusters of bandwidth-hungry businesses require OC-12 capacity, while a number of more widely distributed DS-1 users can be served with OC-3 capacity. Survivable Sonet rings are mandatory in this environment and must be able to be quickly reconfigured, delivering service adaptive access.

Sonet ring bandwidth management capabilities also provide flexibility and the responsiveness needed to position the network to carry new services. The synchronous nature of Sonet allows the ring terminal to be seen as a Sonet LAN which accommodates standard and non-standard interfaces.

Existing and future services can be dropped directly from this Sonet bus, allowing much greater flexibility in offering new or existing services anywhere in the access network, and increasing the service provider's responsiveness to its customers.

What is the next step? A service provider in the year 2000 will be considering deployment

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Figure 3b: *Optical amplifiers double system reach while maintaining the capacity gains of wave division multiplexing*

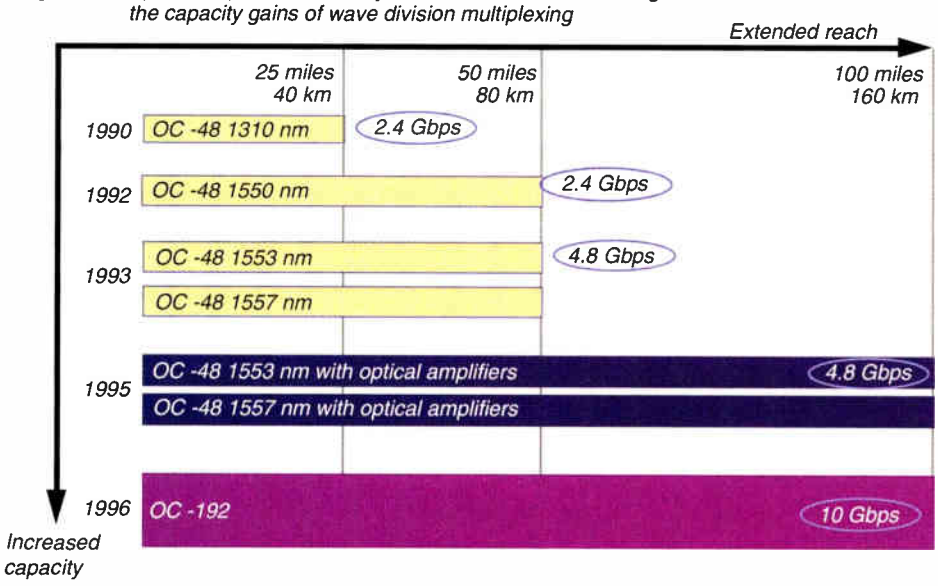
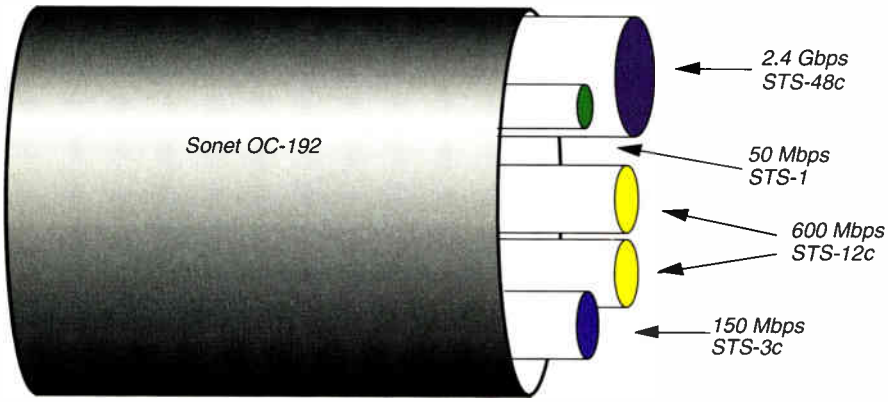


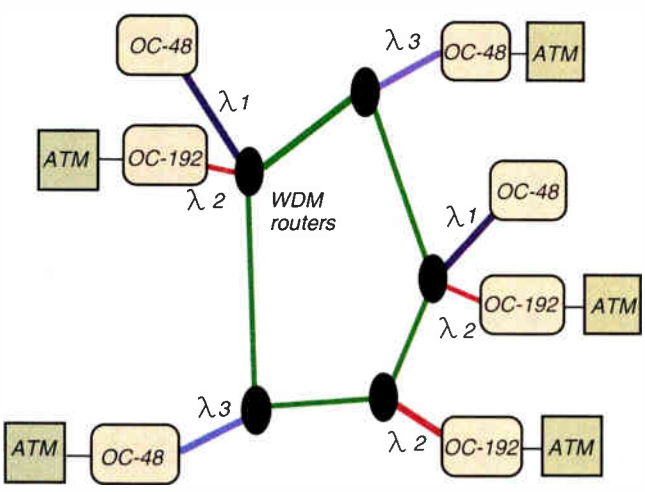
Figure 4: *OC-192 Sonet pipeline*



- *Optical hubbing with OC-48/OC-12 tributaries*
- *STS-3c, STS-12c, STS-48c broadband channels*
- *High capacity longhaul and ring networks*

No more DS-3 connections?

Figure 5: *Optical networks*



Natural evolution for Sonet/ATM backbone networks.

Higher utilization of fiber capacity and efficient very high-speed backbone networking.

Significant reduction in interface ports.

Requirements: Multi-wavelength technologies/WDM routing.

Operational visibility for all optical NEs.

of multi-wavelength technologies to implement advanced optical networks. Optical amplifiers will require flat gain across multiple wavelengths.

Another technical challenge will be the development of passive devices, which split and redirect a large number of wavelengths with high isolation between channels. Manufacturers need to fabricate new laser arrays with multiple wavelengths, separated by nanometers. Work is underway by many industry participants to ensure fiber capacity and reach continue to be maximized.

The network of the future will push network elements like Sonet terminals and ATM multiplexers into the end user environment. This is illustrated in Figure 5. The service provider will create an all-fiber network with higher utilization and capacity than possible today. Interface ports will no longer be electrical. Consequently, there will be fewer of them and the backbone will finally become "all fiber."

The technology challenges to be overcome include multi-wavelength WDM routing and operational visibility of optical network elements. With continued investment in the Sonet "pipelines" of today, optical backbones will become a reality in no time.

The challenges for manufacturers and service providers are to keep pace with fiber technology as it evolves and with the service provision demands in delivering the bandwidth, reliability, and capabilities that communities of the future will require. High-octane Sonet elements, comprising a solid high performance backbone, complete with flexible fiber access, planned in advance and expanded cost-effectively, will be the key requirements to future success. And, with fiber as the foundation, the communications path is clear. Welcome to the high performance highway. CED

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[3.] "S/DMS TransportNode, WDM Give Wiltel an Affordable Strategy for Growth," Nortel Applications Brief, February, 1994.

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[5.] "MRC Sees Sonet as the Smartest Route to the Information Superhighway," Nortel Applications Brief, May, 1994.

[6.] "LCI Builds Success and as Network for the Future," Nortel Applications Brief, May, 1994.

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Integrated optic modulators for 1 GHz HFC systems

Extended requirements

By S. W. Merritt, G. J. McBrien, and E. R. Yates, Uniphase Telecommunications Products

The use of fiber optic transmission in cable TV systems resulted from user demands for greater reliability, more bandwidth (channels), lower distortion, longer reach, and lower cost installations than was possible with all-coax systems. Fiber optic transmission for cable television became practical in the late 1980s, when optical links were demonstrated to meet the dynamic range and cost targets set by the industry.

Early installations supported 40 channels in a fiber-to-the-feeder architecture, where the optical links connected a headend with coaxial networks, each serving several thousand subscribers. The advantages of fiber-to-the-feeder over all-coaxial networks were achieved through the elimination of RF trunking amplifiers between the headend and the neighborhood to be served. As the amplifiers were eliminated, the system reliability improved dramatically. System reach was increased as the distortion contributions associated with the amplifiers along the transmission route were eliminated [1]. As a result, system upgrades to the increased bandwidths required for 60 and 80 channels were practical in systems using fiber-to-the-feeder.

Externally modulated transmitters for cable TV utilizing high power, low noise diode pumped YAG lasers operating at 1320 nm have been available for several years. The relatively high cost of the externally modulated transmitter is justified by the high optical output power attainable. The high power allows a larger number of subscribers to be served than can be accomplished with a directly modulated transmitter. Alternatively, a longer system reach can be achieved. New externally modulated transmitters operating at 1550 nm are being introduced at this time. External modulation allows dispersion-free operation at this wavelength, allowing the user to take advantage of lower optical attenuation in the fiber, and the use of optical amplifier technology. The result to the system user is longer reach than can be achieved with other link technologies.

As deregulation of the cable TV and telecommunications industries continues, hybrid fiber/coax network architectures are being deployed to deliver services in addition to analog broadcast video. These services include digital video, voice and data signals. Interactive services requiring two-way transmission are being introduced. The additional services require additional bandwidth. Further, system reliability becomes more critical, and headend/central office complexity and cost increases as the equipment required to provide interactive and video-on-demand services is added.

Figure 1a: *Dual ring-star signal distribution architecture for a hybrid fiber/coax system as proposed by cable companies and equipment suppliers [2].*

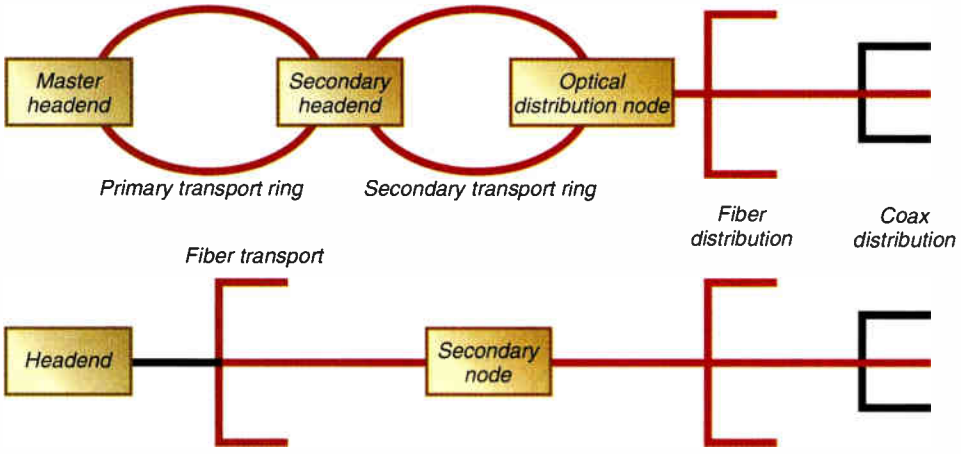


Figure 1b: *Star-star signal distribution architecture for cable TV and hybrid fiber/coax systems in use today [3].*

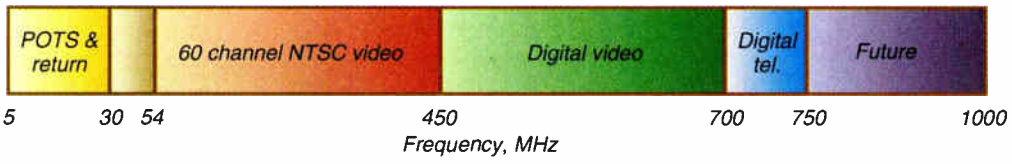
Redundant rings

Dual ring architectures are gaining favor for the distribution of services as an alternative to star-star plants. Both are shown in Figure 1. The redundant dual ring architecture is similar to Sonet rings deployed by the telcos, and offers enhanced reliability over the star-star. Both ring and star architectures utilize a primary transport network to distribute common signals to secondary nodes, where local programming may be added.

A primary ring is used to interconnect a master headend which receives satellite downlinks with widely spaced secondary headends. Because the primary ring links are for headend-to-headend communication, the modulation format used for signal transmission at this system level is at the discretion of the system operator.

The secondary headends distribute analog broadcast video, are the source for video-on-demand programming, and add local content to the programming. The modulation format used for transmission from the secondary headends must be compatible with end user equipment (NTSC televisions, set-top boxes). In addition, the secondary headends service the functions associated with the reception of upstream voice and data signals. A typical frequency plan for

Figure 2: *Frequency plan proposed by Scientific-Atlanta for HFC systems supports analog and digital video, data and voice signals [5].*



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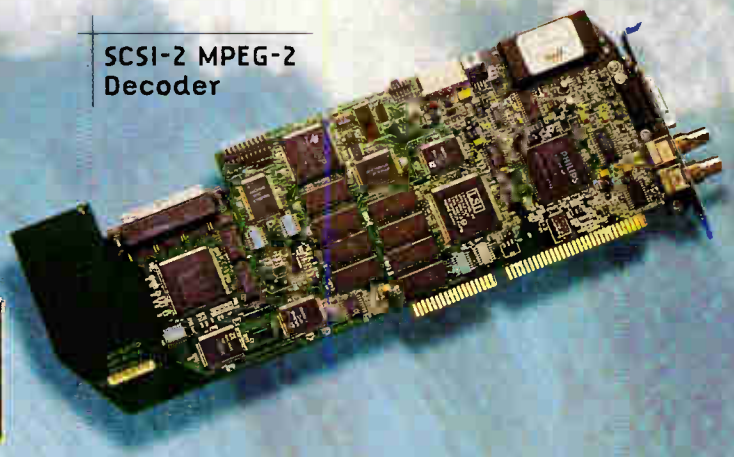

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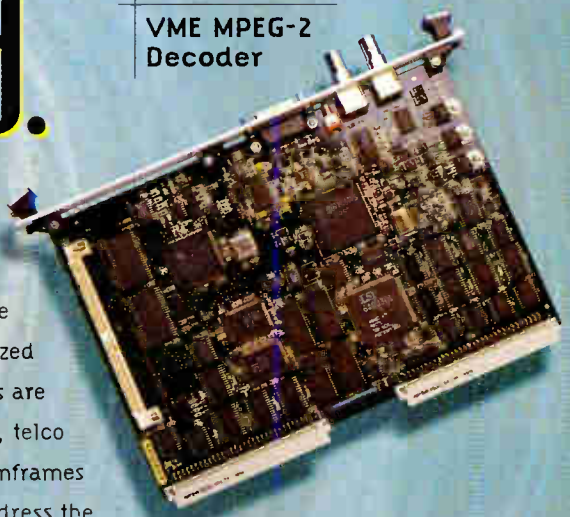

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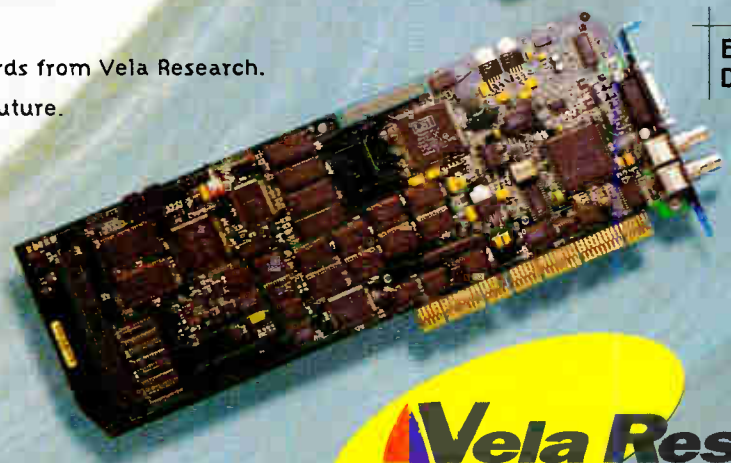

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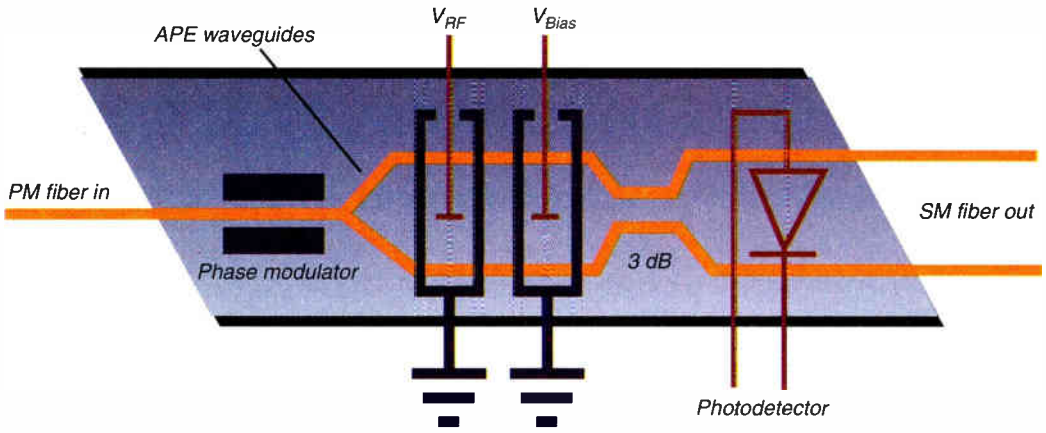

Figure 3: *Integrated optic chip for HFC applications includes a phase modulator for SBS suppression, a dual output intensity modulator to maximize overall optical throughput, and an integral photodiode for generating a signal for control circuitry.*

interactive hybrid fiber/coax distribution is shown in Figure 2. Modulation formats for the digital signals include spectrally efficient techniques such as n-QAM and n-VSB. These signals are analog-like in structure and, unlike 1/0 digital transmission formats, require high fidelity transmission systems.

The requirements of modern hybrid fiber/coax systems designed for the distribution of video, data and voice signals, therefore, increases the performance specifications and reach over what is required in a one-way, 550 MHz, 80-channel analog cable TV distribution system. Bandwidth to 750 MHz is required now, with bandwidth upgradeability to 1 GHz. System reach must be increased to accommodate the ring size, and additional optical power is required to drive widely spaced multiple nodes. Frequencies below 50 MHz must be useful for voice and data transmission, and means for suppressing nonlinear effects such as stimulated Brillouin scattering must be included in the system design.

The features of externally modulated transmitters, which are particularly favorable to the new systems, include operation at high optical power levels and the excellent suppression of second order distortion products. The unique distortion characteristics of externally modulated systems allow their cascade with directly modulated transmitters with little overall impact on the distortion budget of the system, thus increasing overall system reach [4].

The schematic of an integrated optic circuit with an external modulator designed for use in hybrid fiber/coax systems is shown in Figure 3. The circuit includes a phase modulator and an intensity modulator with a 3 dB coupler to generate complementary optical outputs. The annealed proton exchange optical waveguides provide for single polarization operation. The phase modulator can be used for line broadening, and the output coupler allows light normally lost in a single output Mach-Zehnder structure to be recovered and used in transmission.

In addition, the integral photodiode at the output provides a signal for control circuitry. The circuitry is used to monitor and fine tune the operating point of the modulator to minimize even order distortion products.

Modulator performance

Fundamental issues associated with modulator performance include achieving flat frequency and linear phase responses, maintaining constant input impedance over the frequency band, and meeting drive power requirements which are compatible with commercially available electronic amplifiers. These transfer function and impedance parameters are particularly important if the linearization electronics are to operate as required. Low optical insertion loss, minimal optical reflections, and stable operating characteristics are also required for optimal system performance. Figures 4-6 show the frequency response, deviation from linear phase and impedance characteristic of a modulator designed for HFC systems operating to 1 GHz. The nearly ideal characteristics are critical to successful lin-

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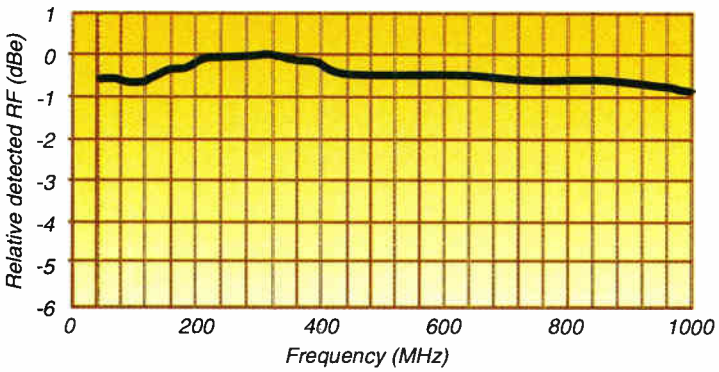
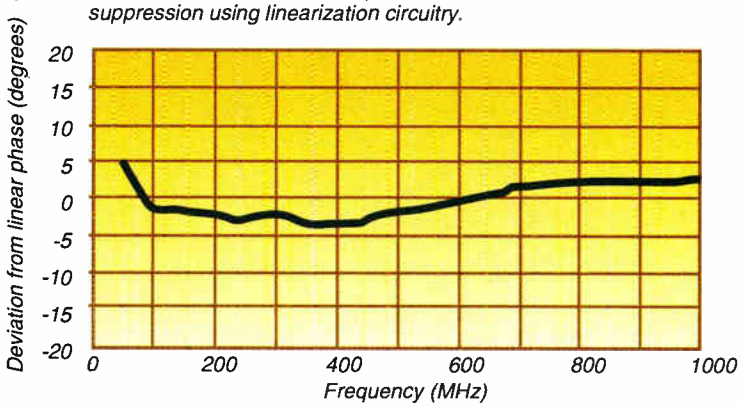
Figure 4: *Frequency response of modulator designed for HFC systems is flat to 1 GHz.*



earization as is required for transmission at high modulation indices. The typical third-order intercept point at the RF input port to a 1300 nm modulator is +27 dBm (+28.5 dBm at 1550 nm) and is compatible with commercially available preamplifiers used in cable TV transmission systems.

Figure 5: *Minimal deviation from linear phase allows for wideband harmonic suppression using linearization circuitry.*



The modulator illustrated in Figure 3 utilizes a directional output coupler to provide for two complementary optical signals. For these signals to be simultaneously linear, both must be simultaneously biased to the half intensity operating point. This is achieved by balancing the legs of the output coupler to within 0.3 dB. Then the zero voltage operating point of the modulator is set during the manufacturing process to within 100 mV of the ideal operating point. A small applied voltage is adequate to bring the even-order distortion products to -70 dBc under operating conditions. A photodiode incorporated into the modulator package provides a control current for use in fine tuning the bias point.

Optical reflections from the end faces of the integrated optic chip are suppressed by more than 60 dB to the incident light by angle polishing the endfaces of the chip. Reflected light falls outside the acceptance of the fiber, and is not guided back to the laser source.

Stable operating characteristics are achieved at optical powers of 200 mW over temperatures from -25 degrees C to 75 degrees C.

There are several advantages associated with the use of integrated optic modulators in conjunction with continuous wavelength sources. These include chirp-free signal transmission, allowing 1550 nm sources and optical amplifiers to be used in the networks. Because most of the fiber installed in the field is dispersive at 1550 nm, laser chirp must be eliminated if this wavelength is to be used for signal transmission. Optical loss in fiber decreases from 0.4 dB/km at 1300 nm to 0.2 dB/km at 1550 nm; longer distances/more subscribers can be reached in 1550 nm systems for a given transmitter output power.

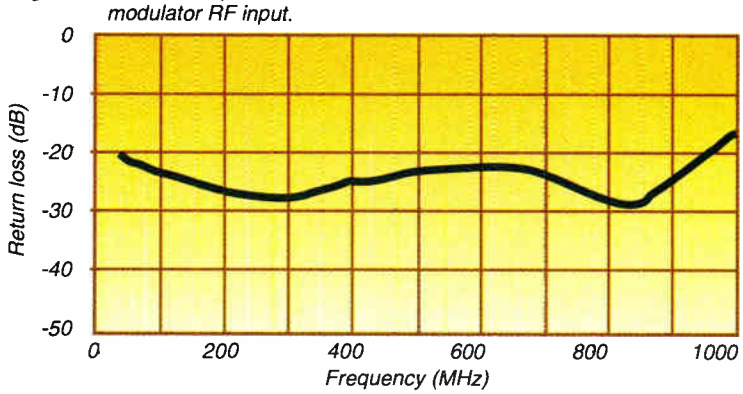
Long distance, high-power optical transmission systems using coherent sources are adversely affected by nonlinear effects including stimulated Brillouin scattering (SBS). These effects degrade the carrier-to-noise ratio of the link and limit the useful reach of a link to a distance substantially less than predicted by a link loss budget calculation.

Unless suppressed, SBS negates the advantages of high power transmission in long reach applications. Because SBS is a coherent effect, it can be suppressed by broadening the optical spectrum emitted from the transmitter. This can be achieved by phase modulating the optical carrier. This technique allows optical transmission over distances greater than 50 km with little degradation in carrier-to-noise ratio.

PHOTO BY JEFF CRANDALL

Ongoing fiber research promises additional support for HFC bandwidth requirements. Photo courtesy Uniphase Telecommunications Products.

Figure 6: *Constant impedance characteristic minimizes reflections at the modulator RF input.*



Performance of a linearized transmitter

Because the I(V) characteristic of an interferometric modulator is not linear, but sinusoidal, a transmitter using the component must include some means for canceling the odd order harmonics which are generated. Three techniques which have been demonstrated to provide suppression of the harmonics introduced by the modulator include predistortion of the electronic signal at the modulator input, feedforward cancellation, and harmonic cancellation in the optical domain.

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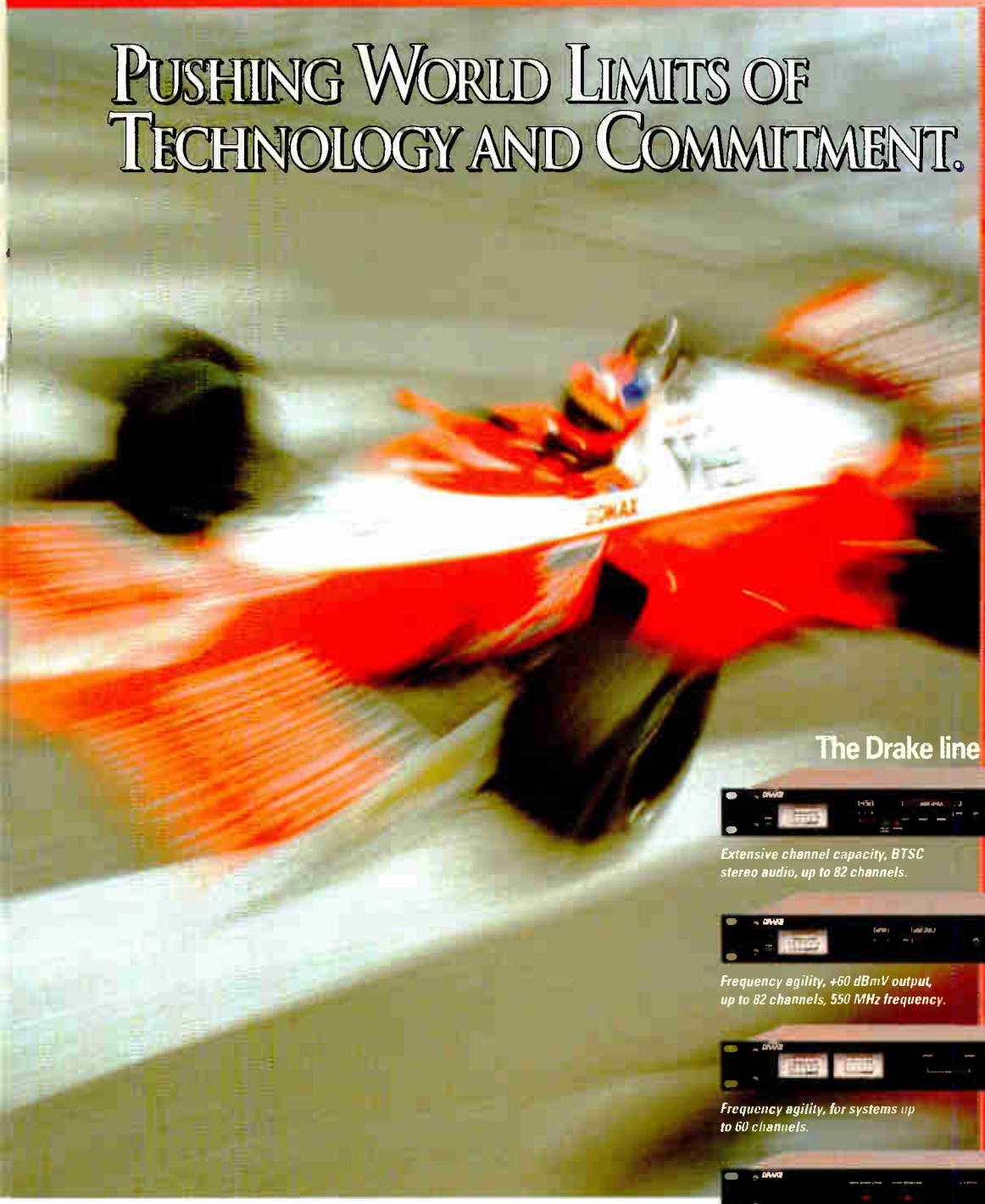

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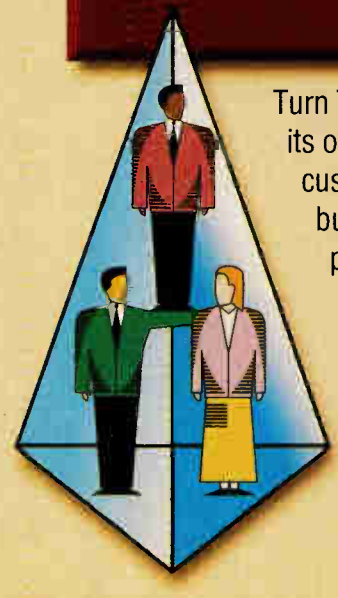

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Each of these techniques effectively generates third-order terms which are equal in magnitude to those generated by the modulator and subtracts the correction term from the signal to linearize the output. Linearization improves third order suppression by approximately 30 dB across the entire frequency band for the amplitude and phase characteristics shown in Figures 4-6.

The frequency response for a linearized transmitter using predistortion is shown in Figure 7.

For 80 channel loading at three percent optical modulation index per channel, the measured composite second order distortion is -67 dB below the optical carrier, and the composite triple beat terms are held to -66.5 dB. The level of second-order distortion products is determined by the accuracy to which the operating point can be set to quadrature. A carrier-to-noise ratio of 54 dB is achieved with a 1 mW optical power level at the detector.

SBS suppression

Nonlinear, coherent fiber effects arise in long distance, high-power optical links. SBS, in particular, can generate sufficient noise at the optical receiver to completely dominate the received signal. The onset of measurable SBS is a function of optical power, fiber length and laser coherence length (linewidth). It is commonly encountered in systems using optical amplifiers.

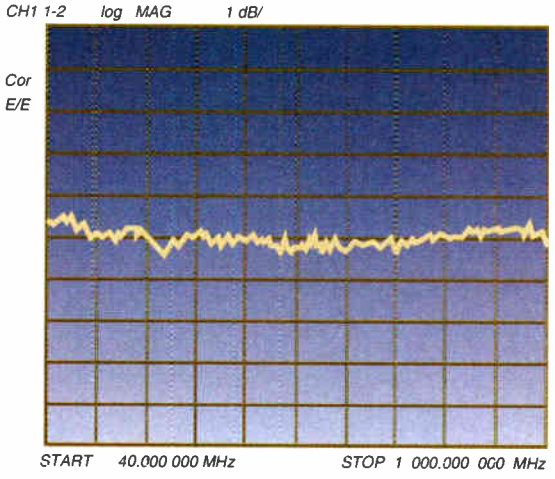
Even at relatively low optical power levels, SBS will add noise to the transmission and degrade the carrier-to-noise ratio at the receiver in systems using optical sources with narrow linewidths, unless the coherence length of the optical transmitter output is made short. Therefore, SBS suppression must be designed into the transmission system.

Because nonlinear fiber effects including SBS and self phase modulation are coherent, they can be suppressed by broadening the optical linewidth of the source. Two accepted techniques for source broadening include modulation of the current in diode lasers and phase modulation of the laser output.

If the phase modulator is included as part of the integrated optic modulator chip, no optical insertion loss penalty is incurred by including the phase modulation function in the system. Further, phase modulation does not add amplitude fluctuations to the output signal. Both phase modulation and laser current modulation introduce a frequency dither on the optical signal.

If dithering is accomplished without introducing intensity modulation, or if the resulting intensity modulation is outside the band of interest, the techniques will suppress the nonlinear effects without introducing artifacts onto the signal of interest.

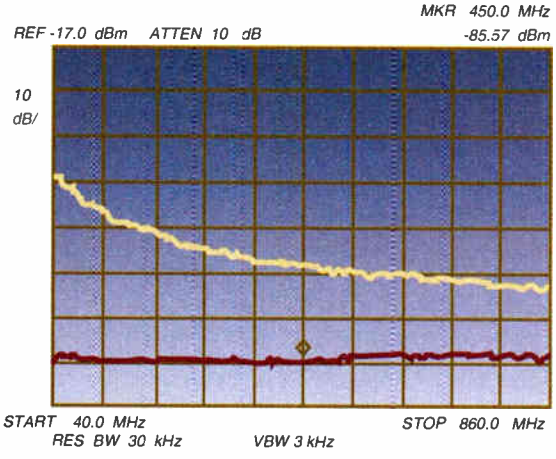
Figure 7: *Frequency response of an externally modulated transmitter linearized using predistortion is flat to 1 GHz.*



The upper trace in Figure 8 shows the noise spectrum measured through 50 km of fiber with +16 dBm optical input power and no line broadening. The optical input was generated using a 1550 nm DFB laser and an EDFA. The lower trace was measured when line broadening was employed and provided for up to 40 dB of noise suppression.

The noise floor at the fiber output (line broadening on) was equal to the noise floor at the EDFA, plus the noise added by the EDFA. Thus, by eliminating nonlinear fiber effects as sources of noise, a carrier-to-noise ratio of 51.5 dB is achieved in a 50 km link.

Figure 8: *Noise spectrum of cw, +16 dBm, 1550 nm DFB laser + EDFA output through 50 km of fiber with (lower) and without (upper) laser line broadening.*



Conclusion

Integrated optic modulator circuits have been designed which support the bandwidth requirements of hybrid fiber/coax systems for the transmission of video, data and voice. The devices provide the optical and electrical performance required to frequencies of 1 GHz.

Additionally, the circuits include a phase modulator for line broadening. Balanced complementary outputs maximize optical output power, and an integral photodiode generates an electrical current used to control the bias point of the modulator.

Because the phase and intensity responses, and the modulator impedance, are nearly ideal across the band, operation at high modulation indices is possible in transmitters using predistortion circuitry without introducing unwanted distortion products into the signal. Line broadening eliminates the noise contributions related to nonlinear fiber effects from the overall characteristics of the optic link.

Optical links using externally modulated transmitters provide for high power, long distance signal transmission, are compatible with the dispersion characteristic of singlemode fiber at 1550 nm, and can be used with optical amplifiers. The modulators and the transmitters meet the extended requirements encountered in the transport of broadband signals in modern cable TV and HFC systems. CED

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Making informed decisions about 1550 gear

Asking tough questions

By Frank La Barbera, Senior Systems Engineer, Cableoptics, Transmission Network Systems Business Unit, GI Communications Division, General Instrument Corp.

The advantages of sending broadband signals over fiber at 1550 nm have been well publicized. Standard singlemode fiber's low intrinsic attenuation at 1550 nm, in combination with the ability to amplify optical signals at this wavelength, have created exciting opportunities to consolidate headends and provide service to remote locations previously not within reach. However, a combination of fiber characteristics at the 1550 nm wavelength must be overcome before these opportunities can be realized.

As the market grows with new companies offering 1550 fiber optic products, understanding the advantages and disadvantages of these offerings will be vitally important in allowing the user to maximize system performance. Given the high cost of 1550 equipment for broadband applications, the wrong decision about its capabilities can impose a financial burden on broadband service providers. Possessing equipment that doesn't meet performance needs, or having to mix and match equipment to get desired performance, inevitably delays bringing subscribers online.

This article will dissect each component in a 1550 link to understand its contribution to the overall link performance in terms of three main figures of merit: carrier-to-noise ratio, (CNR), composite second-order (CSO) and composite triple-beat (CTB). This information will arm broadband operators with the right background to ask tough questions about 1550 solutions, so they can effectively select the best product offering.

Figure 1 illustrates a typical 1550 fiber optic link.

The various 1550 link components that will be analyzed are:

- ✔ Fiber
- ✔ Laser transmitters
- ✔ Optical amplifiers
- ✔ Optical receivers.

Figure 1: *A typical 1550 fiber link*

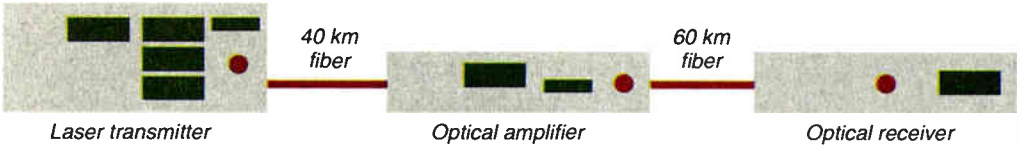
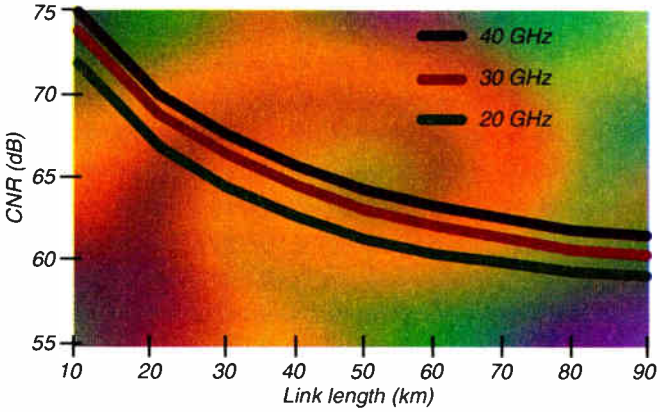


Figure 2: *C/IIN vs. link length*



Fiber

The first topic to review before making a comparison between 1550 systems is fiber. After all, it's fiber that is the backbone supporting these systems. It is the characteristics of fiber at the 1550 nm wavelength, specifically, dispersion and non-linearities, that force hardware complexity and costs. Ultimately, how well a supplier's 1550 products compensate for these characteristics will determine the end-use performance.

High-power, narrow linewidth lasers have revealed limitations in standard singlemode, non-dispersive fiber which conventional, directly modulated DFB sources never had to overcome.

When high-power optical signals are launched into the fiber, vibrations in the glass will be induced, which absorbs light energy. This phenomenon, known as Stimulated Brillouin Scattering (SBS), limits the threshold of power that can be launched directly into the fiber without significant degradation in CNR. If no attempts are made to reduce the effects of SBS, this threshold is between 8 and 10 dBm, making the 1550 solution unattractive for long-haul broadband cable TV applications.

To avoid SBS and thereby launch more power directly into the fiber, the source linewidth can be broadened, thus distributing the power over several optical wavelengths.

Interferometric intensity noise (IIN)

Structural irregularities within the fiber can cause multipath interference (MPI) resulting in interferometric intensity noise (IIN) and degrading system performance. The effects of IIN can be seen both at 1310 nm and 1550 nm wavelengths. Similar methods taken at the transmitter for reducing SBS can also reduce the effects of IIN in 1550 systems. Figure 2 shows that CNR degrades exponentially as the fiber length increases. It also shows that the CNR improves as a function of increasing laser linewidth.

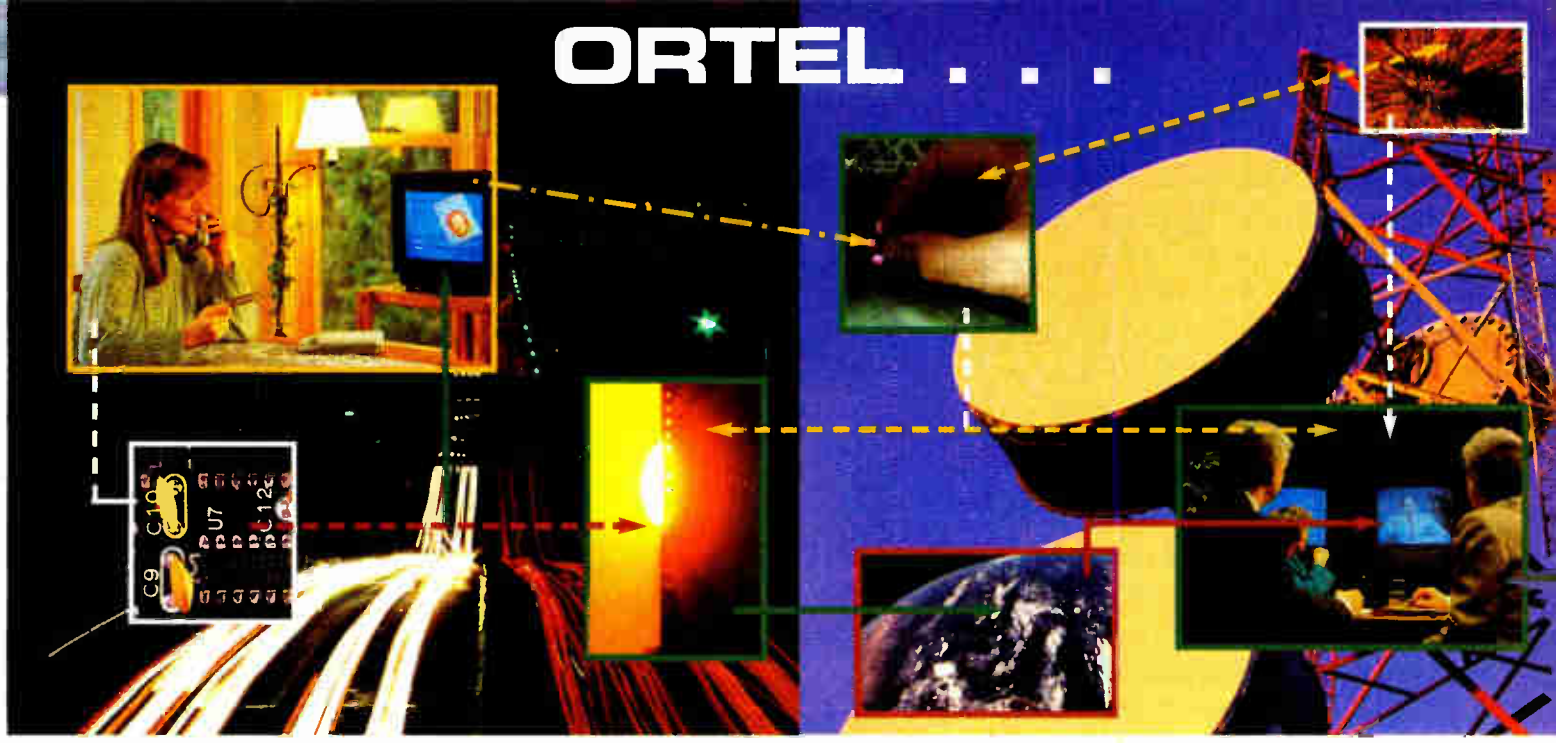
The CNR contribution from the fiber will add to the CNRs of other components in the link. Figure 3 shows link CNR curves, with and without the contribution from IIN. The link CNR performance with fiber will be 0.5 dB worse when using fiber between 40 and 60 km, versus when fiber is not used.

With lengths greater than 64 km, the receiver's optical input power drops below 0 dBm, and the link becomes receiver noise limited.

The following chart assumptions were made for Figure 3: Transmitter OMI–3 percent per channel; transmitter output power–16.5 dBm; channel loading–77; loss budget–all fiber plus 0.5 dB for connector loss.

Dispersion

Standard singlemode fiber has a zero dispersion wavelength centered around 1310 nm, while signals at 1550 nm can experience as much as 17 ps/(nm-km) of dispersion. If a transmitter generates signals whose waveforms are



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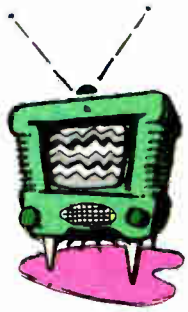

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comprised of different wavelengths centered around 1550 nm, they would propagate through the fiber medium at different speeds, causing the waveform to become distorted. This distortion is a second-order effect adding to the system's other second-order contributors and degrading the overall composite second-order (CSO).

Here are the key points to remember about fiber equipment:

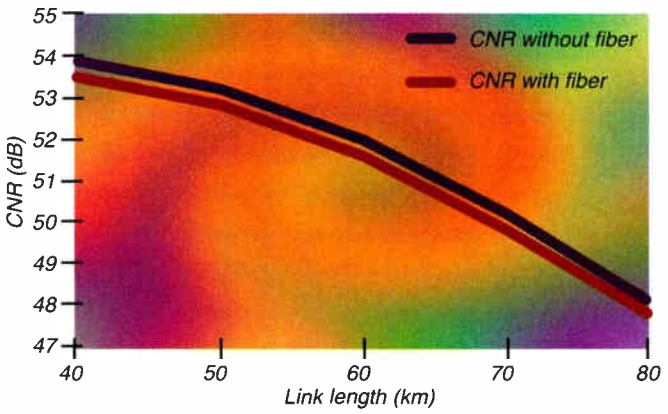
1. When a 1550 product supplier provides a link CNR specification, verify that this includes the CNR contribution from the fiber. It is also important that when comparing one supplier with another, the same amount of fiber is used to specify and test the CNR link performance.

2. Suppliers of 1550 transmitters with lower SBS threshold (lower maximum power launched directly into a fiber) cannot transmit signals as far, making their solution less attractive for long-haul broadband applications.

3. Some techniques used for reducing SBS and dispersion effects are valid only for a single fiber length. If your application requires feeds to multiple fibers of different lengths, these approaches may be incompatible.

4. When a supplier provides a CSO specification, verify it includes the contribution from all link components including fiber. Verify the length of fiber that this CSO specification is valid for. This is important because increasing fiber length increases dispersion-related distortions, which add to the other CSO contributions.

Figure 3: *CNR vs. link length*

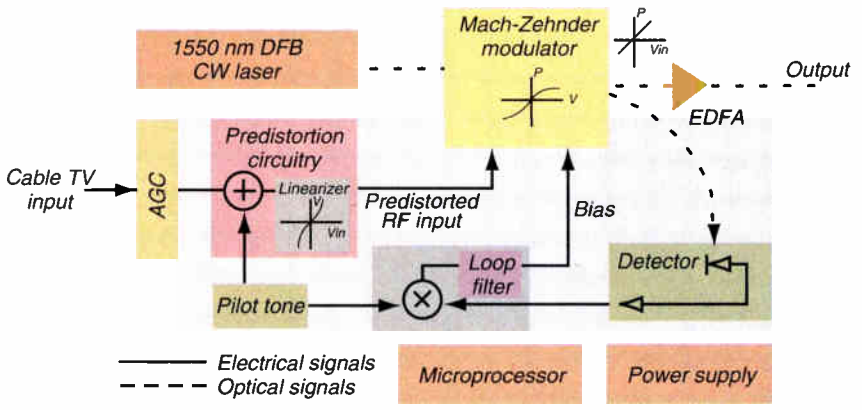


Transmitter

As described above, there are three main fiber characteristics at 1550 nm that a transmitter must overcome in order to effectively send signals down-line (e.g. dispersion, SBS, IIN). Ultimately, how well a transmitter counters these characteristics will determine its true value for a given application. The difficulty in making a comparison of one supplier's link performance with that of another stems in part from different suppliers' 1550 transmitters having varying degrees of success in overcoming these fiber effects.

This section of the article provides an overview of 1550 transmitters. The CNR contributions to the overall link performance are addressed, including under what conditions these contributions hold. The section concludes with a list of key transmitter points that should be considered before selecting a 1550 system provider. A typical transmitter architecture currently being used to counter these effects is shown in Figure 4.

Figure 4: *Typical 1550 architecture employing external modulation*



Overcoming dispersion

When a semiconductor laser is intensity modulated (direct modulation), its output optical frequency is also modulated (FM). This modulation technique is typically employed when using 1310 nm DFBs. If a 1550 nm DFB source is directly modulated with broadband signals in the same manner, the chirping of the laser light would make it practically unusable in systems employing standard non-dispersion shifted singlemode fiber, because of the severe dispersion these signals would experience.

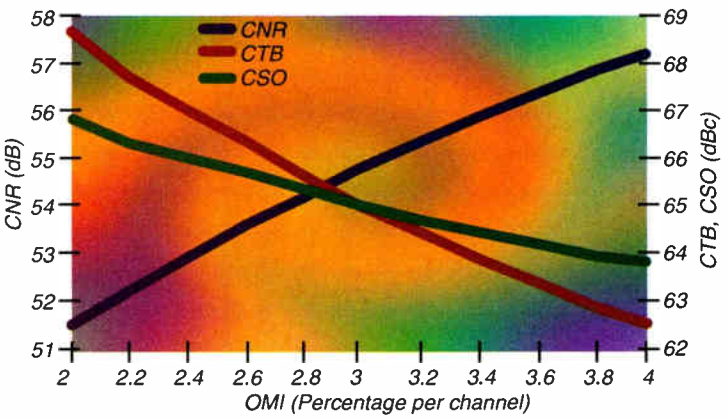
To overcome these shortcomings, 1550 transmitters have employed intensity modulation external to the laser sources, as shown in Figure 4. This method avoids linewidth chirping as experienced with direct modulating techniques, minimizing dispersion-related distortions.

Unfortunately, intensity modulators are inherently non-linear, causing third-order distortions. These distortions can be minimized by pre-distorting the broadband RF signals, linearizing the output signal. The diagram in Figure 4 shows the typical shape of the L-V transfer characteristic of the modulator before and after pre-distortion. Tightly controlling the bias point on the external modulator nearly eliminates the second-order distortion (< -70 dBc). The diagram shows a loop that is often employed to monitor and maintain the proper bias level.

Overcoming SBS and IIN

Several techniques are available to reduce the effects of SBS and IIN: external phase

Figure 5: *Transmitter CNR, CTB & CSO vs. OMI*



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modulation and direct dithering of the laser.

By phase modulating the laser, the power is spread over several optical carriers, increasing the effective linewidth, and therefore increasing the SBS threshold. This optical broadening also reduces the IIN contribution from the fiber. However, at this stage of phase modulator development, practical limitations make it difficult to obtain an SBS threshold much above 15 dBm.

Often a second method is used to suppress the noise generated from within the fiber. Directly modulating the laser source's bias current with a constant tone increases the effective linewidth of the laser. This approach limits the distance over which a signal can be sent without dispersion-related distortions; therefore, there must be a compromise between dispersion and SBS suppression. This dithering with a constant tone does not generate CSO in the same manner that would result from direct AM modulation.

Performance parameters

The main noise contributor from the transmitter is generated by fluctuations in the lasers' optical output power, known as relative intensity noise (RIN). For 1550 nm DFB lasers, RINs on the order of -160 dB/Hz are available. For a system with 77 channels and an optical modulation index (OMI) of 3 percent, the corresponding CNR limit imposed by the transmitter is 60 dB (not including any CNR contribution from an EDFA).

For every 1 dB increase in RF power per channel (OMI) into the laser, there is a 1 dB improvement in the CNR for the transmitter. This 1 dB increase in RF level, however, will correspond to an increase in the level of second-order terms by 1 dB relative to the carrier, and an increase in the level of third-order terms by 2 dB relative to the carrier. Figure 5 illustrates this relationship. This chart includes the CNR contribution from an EDFA.

The following are key points to remember when evaluating transmitters for 1550:

1. As previously emphasized, in order to verify that the transmitter effectively counteracted the effects of the fiber, fiber must be used in specifying and testing link performance.

2. Verify that the OMI value used by a 1550 transmitter supplier in specifying the CNR for the link is also the same OMI value used to specify the distortions for the transmitter. This is critical, because in a system, there is no option of selecting one OMI value for the best CNR value, and another for the best distortion performance. The level set for the OMI is a compromise between CNR and distortion.

3. It is important to determine if the link CNR performance a supplier provides is for video or CW signals. Generally, suppliers provide CW CNR values, because lab evaluations are done using a Matrix generator. There is about a 3 dB to 4 dB improvement in the CNR numbers quoted, if video signals are used.

4. Not all 1550 transmitter suppliers have the same amount of SBS suppression. The maximum SBS threshold currently available is around 17 dBm. Those transmitters with lower thresholds cannot launch as much optical power directly to any single fiber. This implies these system solutions cannot extend service as far, or they have to employ more optical amplifiers to obtain the same distances, driving up the cost of a 1550 long-haul solution.

Optical amplifiers

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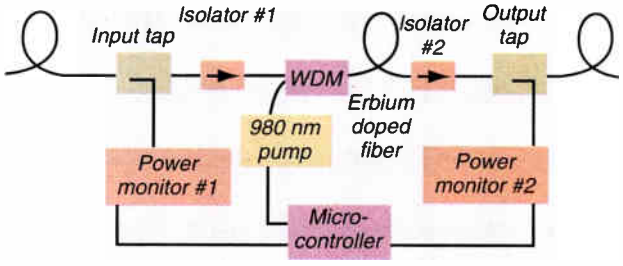
the number of nodes serviced. The location of the amplifier in the link dictates its input power, which in turn dictates its CNR contribution to the link. Often, suppliers specify the CNR of the optical amplifier independent of the link performance. A comparison between the performance of amplifiers from one supplier to that of another is straightforward, as long as the input conditions that both are specified under are the same.

This section of the article provides an overview of optical amplifiers. The CNR contributions to the overall link performance are addressed, including under what conditions these contributions hold. The section concludes with a list of key optical amplifier points that should be considered before selecting a 1550 system provider.

A typical architecture for an erbium doped fiber amplifier (EDFA) is shown in Figure 6.

There are three main elements that comprise an EDFA (i.e., wave division multiplexer [WDM], laser pumps and erbium doped fiber [EDF]). The WDMs serve to couple light from pump lasers within the amplifier into the EDF. The pumped light, of either 980 nm or 1480 nm, serves to excite the electrons associated with the erbium ions to a higher energy state. As the input 1550 nm light propagates through the EDF, optical energy is transferred from the electrons to the 1550 nm signal, amplifying the signal. Isolators within the system prevent degradation in performance due to reflections. The need for monitoring will dictate if taps are used.

Figure 6: Single pumped EDFA module



In broadband applications, the amplifiers are operated in saturation. As the input power to the amplifier is increased, the output power remains constant. The available pump power limits the saturated power level; therefore, the amplifier output power requirements will dictate whether there is a need for one or two pumps.

Performance parameters

To understand optical amplifier performance in a link, it is first helpful to realize there are two contributors within the optical amplifier itself that degrade the CNR of the link. The first contribution is from amplified spontaneous emissions (ASE). In ASE, some excited electrons can emit their energy spontaneously, without acting in conjunction with the input signal, and thereby increase the noise in the system. This noise contribution increases as the input power to the amplifier increases. The second contribution is from passive loss of the components prior to the gain stage of the amplifier. These components include WDMs and isolators, and may include taps. The two contributions combine to degrade the overall CNR of the link.

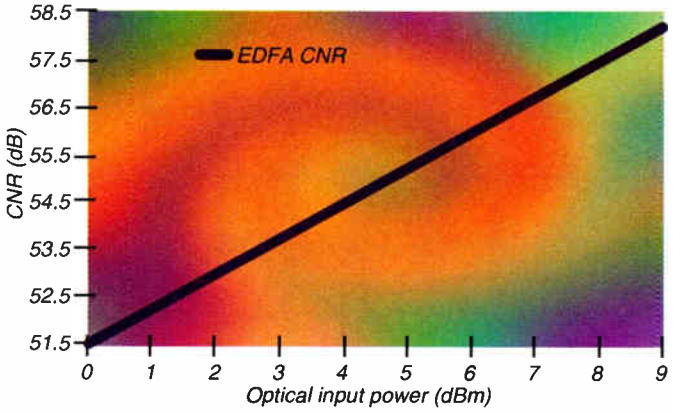
The optical amplifier's placement in a system dictates its input power. The greater the power into the amplifier, the less it degrades the CNR of the overall link. A plot of the CNR of an optical amplifier, as a function of input power, is shown in Figure 7.

As can be seen from Figure 7, the CNR of the optical amplifier does not improve one-for-one with increasing optical input power. As the input power increases, the noise generated in the amplifier increases, but at a slower rate. Figure 8 shows a plot of the EDFA CNR as a function of OMI per channel. This plot indicates that the OMI set at the transmitter will dictate the CNR contribution from the amplifier. Increasing the OMI will correspond to an improved amplifier CNR.

It is important to understand that no 1550 laser transmitter has a single defined wavelength. Generally, they will be specified to provide a wavelength that varies unit to unit over some range. Because an optical amplifier's CNR performance is a function of the input wavelength, this performance will vary as a function of the transmitter wavelength. In fact, some suppliers may place a filter at the output of the optical amplifier which may make it unusable at wavelengths outside the passband.

The following are key points to consider when evaluating amplifiers:

Figure 7: EDFA CNR vs. input power



1. Optical amplifiers' CNR varies with input power. When comparing the CNR of various suppliers' 1550 optical amplifiers, verify that both are specified using the same input.

2. If the plan is to mix optical amplifiers from one supplier with 1550 transmitters from another, verify the OMI used to specify CNR performance for the optical amplifier is the same as the OMI setting required to obtain the best transmitter performance.

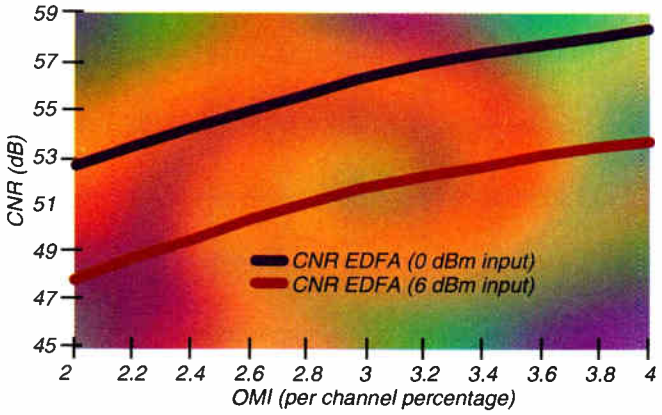
3. Also, if planning to mix 1550 optical amplifier products from one supplier with 1550 transmitters from another, be certain there is wavelength compatibility.

4. Because transmitter suppliers have different degrees of SBS suppression, verify that the optical amplifier output power can launch all of its power directly into the fiber.

Optical receivers

No two 1550 system suppliers use the same receiver when specifying the overall link CNR and distortion performance. This makes it extremely difficult when comparing the overall link performance of one supplier with that of another. A comparison is also made difficult because of the varying conditions under which suppliers operate their receivers in a link.

Figure 8: EDFA CNR vs. OMI



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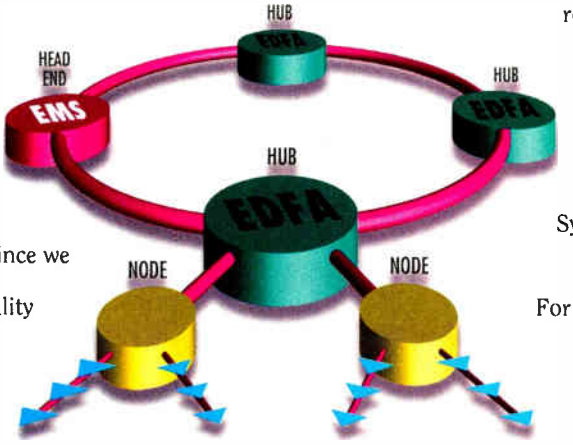

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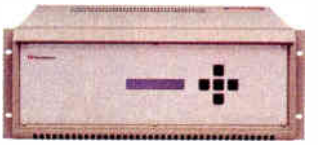

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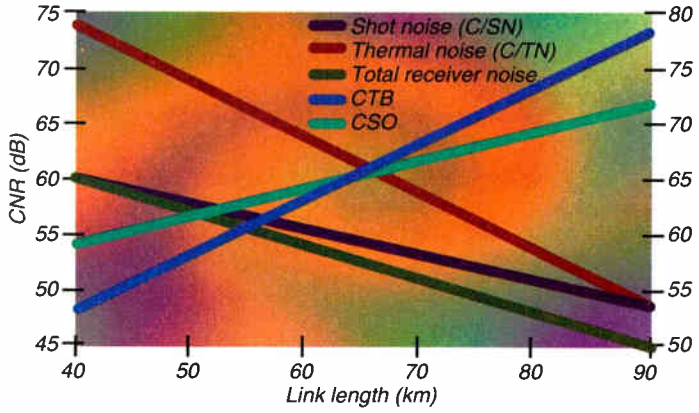
Figure 9: Receiver CNR, CTB & CSO vs. link length



This section of the article provides an overview of optical receiver contributions to the overall link performance, and under what conditions these contributions hold. The section concludes with a list of key receiver points that should be considered before selecting a 1550 system provider.

Most optical receivers used for 1310 nm applications will also work in 1550 applications. The only significant difference is the responsiveness of the photodetector is higher for 1550 nm wavelength light, typically around 0.9 mA/mW vs. 0.85 mA/mW. This difference yields a greater RF output power for the same received power.

Performance parameters

To understand the receiver performance in a link, it helps to realize two contributors from the receiver degrade the noise performance. The first contributor is shot noise, which is generated within the photodetector. The second major noise contributor is thermal noise, which is a function of the gain stages that follow the photodetector. Given the OMI of the transmitter, each of the above noise contributors can be represented in terms of CNR.

The greater the optical power into the receiver, the better the CNR performance. For every 1 dB of optical power increase into the receiver, the CNR contribution from shot noise improves 1 dB, and the thermal noise contribution improves by 2 dB. Figure 9 shows the relationship of CNR as a function of link length (input power). The assumptions for Figure 9 are as follows: Receiver 1: receiver gain–22.5 dB; receiver noise current–8 pA/Hz^0.5; transmitter OMI–3.0 percent; transmitter output–16.5 dBm; channel loading–77 NTSC; loss budget–all fiber loss plus 0.5 dB of connector loss; corresponding input power range– -6.5 to +6.0 dBm.

Despite the improved receiver CNR performance with increasing optical input power, the distortions degrade. As the optical input to the receiver photodetector increases, the RF output increases. The second-order terms (CSO) increase 1 dB relative to the carrier for every 1 dB increase in the RF output power, and the third-order terms (CTB) increase 2 dB relative to the carrier for every 1 dB increase in RF output power. (See Figure 9.)

Figure 10: Receiver CNR, CTB & CSO vs. OMI

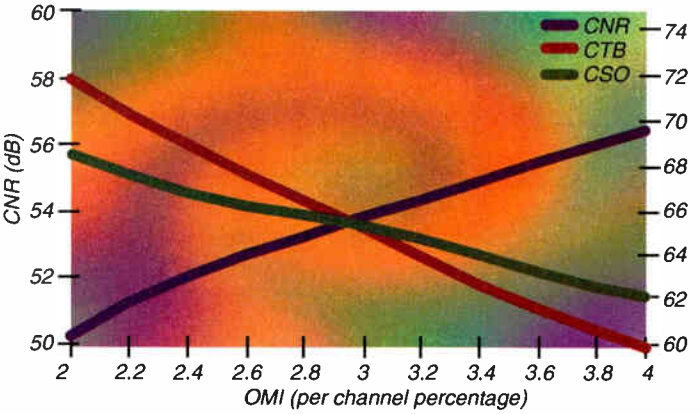


Figure 10 shows the relationship between OMI and CNR, CTB and CSO.

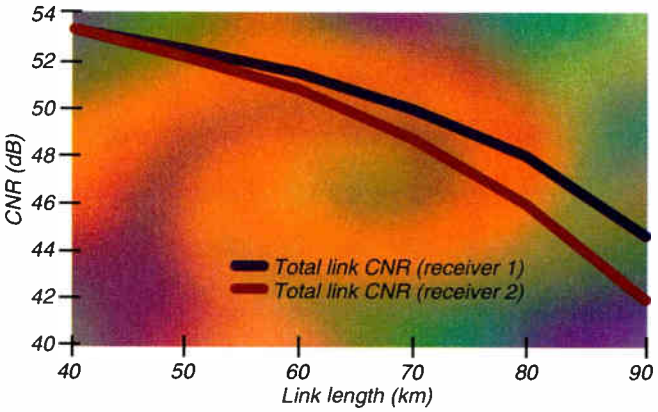
Comparing the CNR and distortion contributions of the receiver is a difficult task. No two receivers offered by the various suppliers have the same RF output power for a given optical input power. The differences result from different numbers of gain stages, different interstage padding, etc. This means that specified link CNR and distortion contributions with different receivers will be different. Figure 11 shows the CNR of two different receivers as a function of link length (input power).

The assumptions for Figure 11 are as follows: Receiver 2: receiver gain–22.5 dB; receiver noise current–8 pA/Hz^0.5; transmitter OMI–3 percent; transmitter output–16.5 dBm; loss budget–all fiber loss plus .5 dB of connector loss; corresponding input power range– -6.5 to +6 dBm.

If the receiver that a supplier uses for analyzing link performance has less gain, then the receiver's contribution to the overall CNR will be less, and the overall link performance specified will be better. However, if it requires that additional gain stages be added in order to provide enough power to downstream actives, then the real link performance in reality will be worse. What follows are the key points to remember about receivers and 1550 systems:

1. When comparing link performance of various suppliers, verify that the input optical power used for specifying the link CNR is the same for specifying link distortions. Also, when making a comparison of various suppliers' 1550 solutions, verify that the link specifications all use the same optical input power into the receiver.

Figure 11: Link CNR vs. link length



2. Verify that the receiver used in specifying the CNR and distortions for a 1550 link is the same receiver that would be offered for use in a real 1550 system.

Over the last year, the author's company has carried out a thorough survey of the different 1550 products that are available or are soon to be available. This effort has provided a good understanding of the advantages and disadvantages of these various offerings. For broadband service providers attempting to make informed decisions, this article will help to put the key evaluation points in focus. Some of these points are not unique to 1550 systems, but all must be considered to ensure that the product will maximize performance. The key message in this article is that 1550 transmission products are only a part of a delivery system; thus, the performance characteristics of this equipment must be evaluated in a total system context. CED

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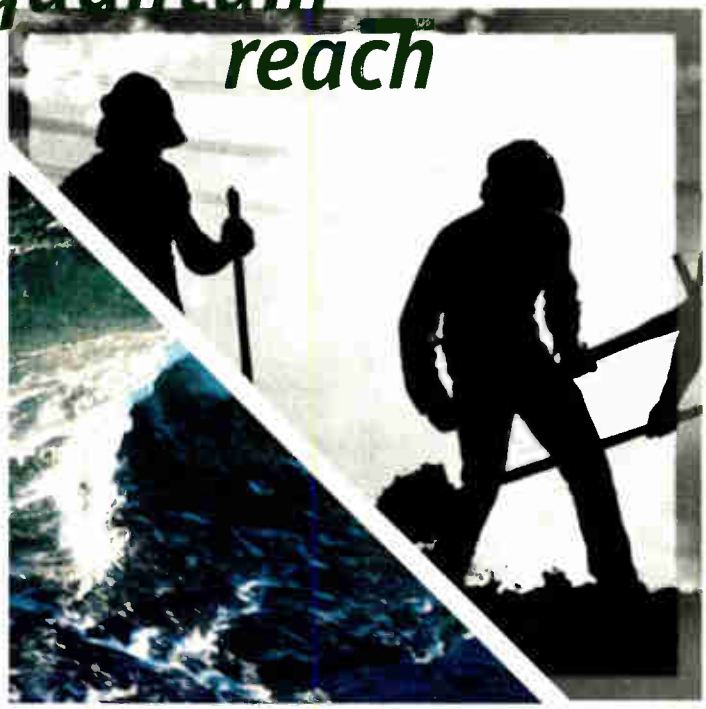

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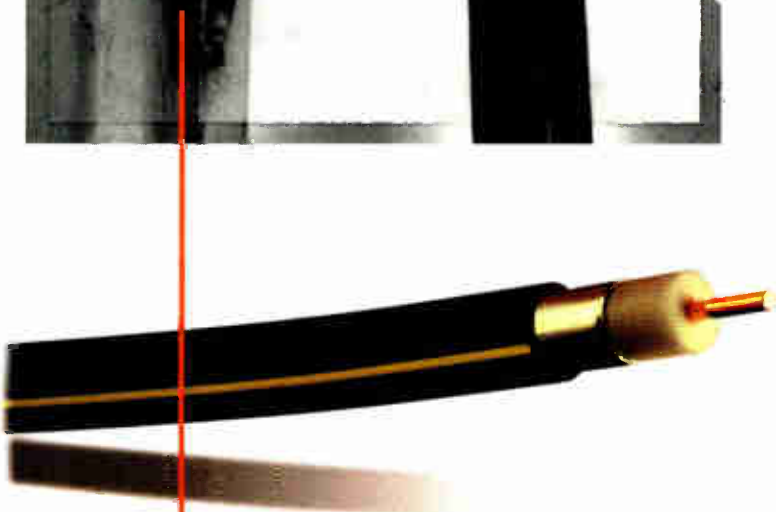

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The eyes have it: Complacency threatens fiber safety

"Manageable" fear a handy safety tool

By Michael Lafferty

As fiber optics continues to spread throughout broadband communication plants, and new fiber equipment is beginning to feature higher power outputs, many safety and training professionals in the industry are re-energizing their fiber optic training efforts.

Kevin Wilkes, director of field services for Integration Technologies, says that while fiber optic technology continues to change, fiber optic safety issues have not. In fact, he believes new technology only underscores the importance of long-term safety training that needs a healthy dose of fear to succeed.

"I think probably 99 percent of the concerns about safety involving fiber have not changed with technology," says Wilkes. "I think they've been amplified by higher launch powers and connectivity. But, the basis is still there for problems with the eyes.

"It's pretty straightforward.... Of course, there are other things to worry about. But they're pretty trivial compared to the eyes. You instill what I call 'manageable' fear. And, there's nothing wrong with that at all. Because too much comfort breeds carelessness."

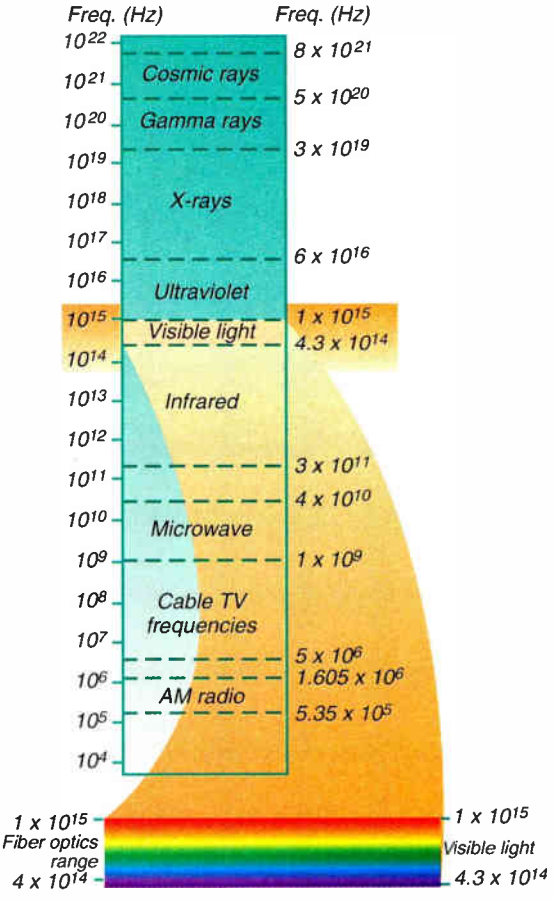
Laser dangers are real

The word "laser" is an acronym for Light Amplification by Stimulated Emission of Radiation. The light we see is just a small portion of the entire electromagnetic spectrum (see Figure 1).

When light is amplified or intensified, the atoms in a chosen laser material are electrically stimulated into an excited state of high energy. When the selected laser material absorbs enough energy, it's triggered to produce an enormous burst of light.

The laser material used depends on the task a laser is expected to perform. Higher power laser outputs use such things as gas molecules or crystals doped with a variety of lasing materials. Those used in optical fiber applications are made from semiconductor materials that feature low voltage, high-speed operation. Because some lasers have inherent physical dangers, they have been classified into four major categories (see Figure 2). Telecommunications lasers fall into category three, typically.

Figure 1: Fiber optic frequencies are in the middle portion of the electromagnetic spectrum.



Optical fiber lasers operate at 850, 1300 and 1550 nm wavelengths. They range from the lower part of the ultraviolet portion (1 x 10^{15} Hz) of the electromagnetic spectrum through the visible light section, to the upper part of the infrared portion (4.0 x 10^{14} Hz) of the spectrum.

Eye safety concerns are concentrated on those lasers that operate at the 850 and 1300 nm wavelengths. That's because these wavelengths are naturally focused by the eye onto the retina. The eye is opaque to the 1550 nm wavelength.

The problem occurs when lasers with either 850 or 1300 nm wavelengths pass through the cornea. As Wilkes notes, "If you give the eye the chance, it's going to try to make something out of the signal that's coming to it by amplifying it more and more." In fact, the cornea will amplify such beams approximately 100,000 times (10^5).

As a result, such beams, which are usually invisible, can burn retinal tissue. This damage, which usually results in permanent blind spots, is neither instantaneous, nor does it usually cause any immediate pain. The retinal damage occurs because the viewing time has exceeded the damage threshold. For wavelengths used in telecommunications, these threshold formulas are: 10 mW for 10 seconds and 5.6 mW for 100 seconds.

Tidy formulas breed carelessness

Engineers and technicians who work in telecommunications, by the very nature of the industry itself and the exacting sciences that define it, are usually very precise, tidy people. There are immutable laws and limits that, when broken or exceeded, will produce predictable results. And therein, says Wilkes, lies one of the biggest dangers in fiber optic safety.

"There are a tremendous (number) of misconceptions concerning fiber and light signals," remarks Wilkes. "A lot of systems you go into, there's some overkill on fiber safety, and then there are a lot who have no idea (about it). I've seen people stare right into the end of a fiber and say, 'Well, it's a class three laser; there's no worry.' It's really very scary."

Wilkes says in 1989, standard lasers had a launch power of about 2 mW. In those days, "We had a real 'heater' if we had maybe 5 or 6 dBm launch power, which is about 3 mW." Today, however, 10 mW has become the nominal standard. And Wilkes notes he's seen reports on units that will operate in the 200 mW range. Added to that, is the increased opportunity for danger because of the ever-increasing volume of fiber deployment.

"Now, we have a typical headend with maybe 100 termination points, maybe even 200," notes Wilkes. "So, there are a lot of places there that someone can go in and sim-

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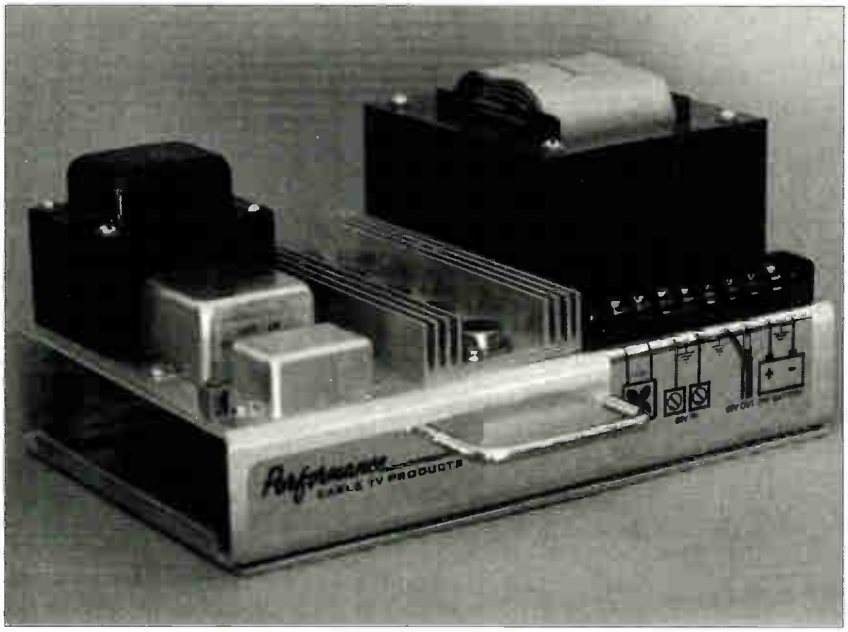

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Figure 2: *Laser classifications*

The four major laser classifications (1, 2 or 2a, 3a or 3b, or 4) are based on their accessible emission limits and their ability to cause injury. In the United States, laser product regulations and the classifications below are set by the Center for Devices and Radiological Health (CDRH), which is part of the Department of Health and Human Services in Washington, D.C.

Class 1	*Very low-power lasers, deemed inherently safe.*
Class 2	*Consists of lasers ranging in output from 400 to 700 nm which require only about 1mW of power to operate. The eye's blink reflex (which occurs within 0.25 seconds of exposure) is considered adequate to provide protection from these low-power lasers.*
Class 3	*These medium-power lasers (3a/visible; 3b/invisible) are typified by dangerous radiation levels that can cause eye damage (e.g., depending on the length of exposure and nearness of the laser beam to the eye, more likely to cause blind spots on the retina, as opposed to outright blindness). Damage can occur without optical instruments or possibly be intensified by improperly using microscopes, magnifying glasses or eye loupes.*
Class 4	*These high-power lasers are typically used in manufacturing environments for jobs like drilling and cutting and use potentially lethal, high-current, high-voltage power supplies. As such, they can injure the skin and ignite fires. Eye damage can be caused by either direct or reflected beams.*

ply take a connection and take it apart and look right into it."

According to Wilkes, when you combine the more powerful equipment, and the increased opportunities for danger, along with a fiber professional's unshakable belief in scientific formulas, a good dose of fear will go a long way in promoting fiber optic safety.

"With the magnification we're using to look at fibers and the launch powers we have now, it's a real danger," states Wilkes. "If you look at the formula, 10 mW for 10 seconds is the damage threshold. So, what is it at 80 mW? A half second?

"If you promote comfort...that there is a time factor, and a distance factor, and a launch power factor, and an eye-loop factor...you get comfort you don't want...but there is no middle ground. You don't need to tell your people it's going to burn a hole in the back of their head. But, you definitely want to instill a little bit of fear....

"It's like I've always said: I don't want to know the formula. Because I don't want to count 'one Mississippi, two Mississippi' and stop looking.... The worst thing you can do is to tell somebody that it's not dangerous until

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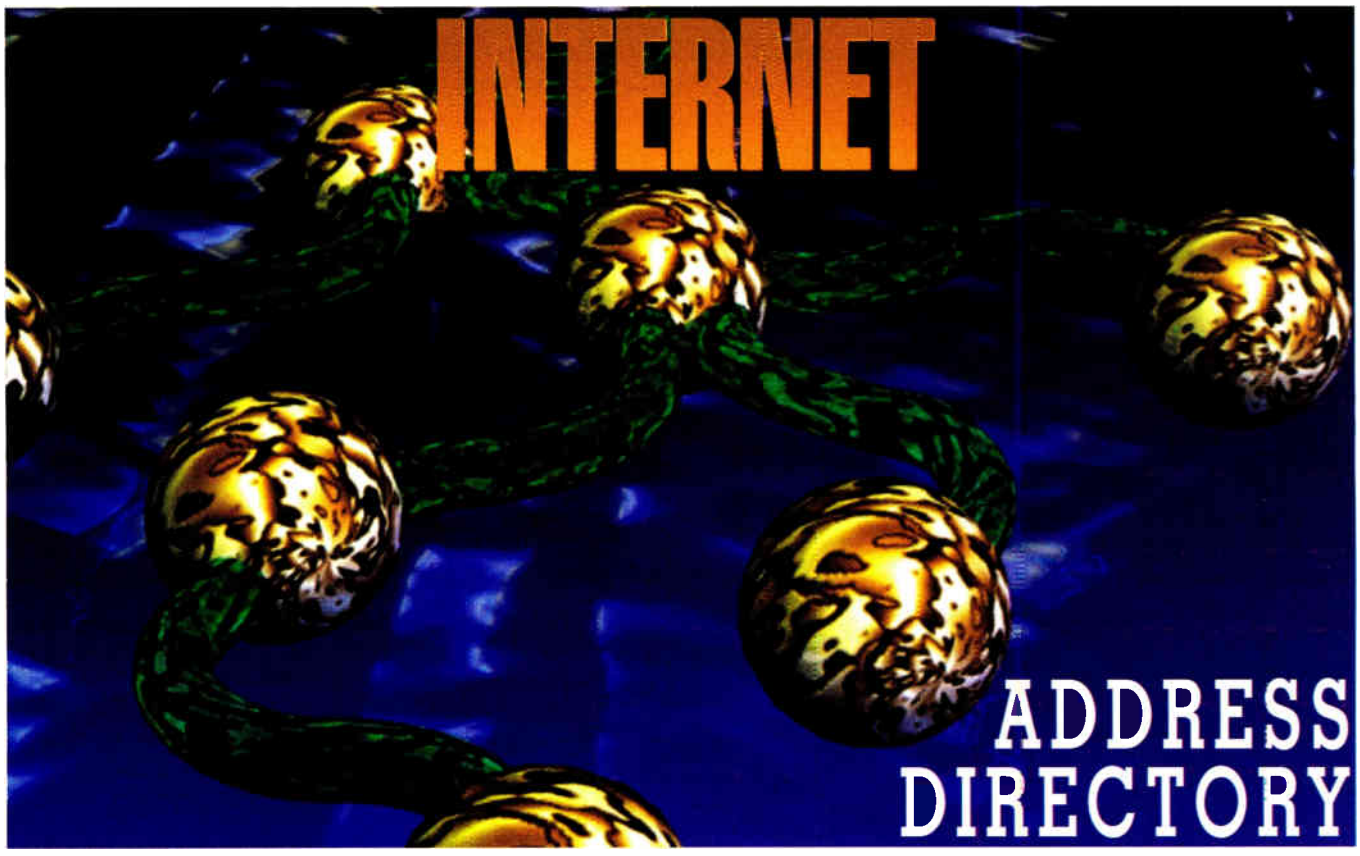

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you have looked at it a certain amount of time or at a certain amount of power, or whatever."

Damned if you do, damned if you don't

While the "don't look" rule is paramount, Wilkes is the first to admit handling fiber optics is not a job people do blindfolded just to be safe...now or in the past. "In the early days," says Wilkes, "when we did rotary mechanical (splices), I always worked with them active. But, I just never looked into it. I always looked at it from an angle, and I never had to worry...with that type of connection. But that's changing."

That change, he points out, can be seen in the increasing use of the metal-bodied twist and lock FC connectors and the plastic-bodied, push-in and click SC connectors. Both the FC and SC require someone to look into the connector and the fiber attached to it, "Otherwise, there's just no way of knowing whether it's cleaned or not," states Wilkes. "Cleaning in these connectors is incredibly critical, even if you get them right out of the box brand-new."

For that reason, Wilkes stresses a four-point plan, with a heavy emphasis on established procedures for handling fiber as far as viewing goes. First and foremost, says Wilkes, is for people to keep the "don't look" rule running through their minds like a mantra, from start to finish of every job. The second thing is to verify the equipment is turned off, locked out and/or tagged out "so no one can go into the headend or the CO and turn the laser on while you're out there working on it."

Next, he believes fiber workers should have a reliable power meter or finder's scope to confirm that the fiber is not transmitting. He notes that some fiber technicians have been using a cheap, over-the-counter device for testing home remote controls to accomplish this task. He strongly disagrees with this practice.

"I wouldn't dare use that as a tool to see if I'm dealing with an active fiber or not," declares Wilkes. "How exact can that device be, and do you want to trust your eyes to it? The answer is 'No, absolutely not,' especially with the higher launch powers and the greater number of connectors that folks are dealing with now."

He also recommends workers take advantage of protective lenses or goggles designed to attenuate (disperse) laser energy at key wavelengths. Lenses that block specific wavelengths usually offer better protection than broad spectrum glasses used to block a number of wavelengths.

Wilkes notes that while some companies are really gung-ho on protective lenses, others hesitate to enforce such a requirement. Their hesitancy is based on a fear that technicians will "become too comfortable," expecting the lenses "to fully protect them." But Wilkes prefers to err on the side of caution. "I don't think there's a lot of middle ground on protective eye wear," says Wilkes. "Ultimately, the best way is to use protective eye wear and keep hammering away at the policy of never, ever looking into the end of a fiber. It's double insurance."

The four-step plan, with its combination of using equipment and procedures, is of critical importance to Wilkes. "All these things should be used together, never one by itself," insists Wilkes. "My personal credo is 'Rely on the equipment for what it's supposed to do. But, back it up with no-fail procedures.'

"Procedures are a whole lot less likely to fail than equipment is, because you're responsible. You can't always be responsible for whether a particular piece of gear is going to work or not." CED

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Brouse wins 1996 Polaris Award

Committed to reliability

By Roger Brown and Leslie Ellis

John Brouse, director of network development at Jones Intercable, was named the 1996 Polaris Award winner at the SCTE Conference on Emerging Technologies in San Francisco last month. The Polaris Award is sponsored by the SCTE, Corning Inc. and *CED* magazine and was created to recognize the efforts of the "next generation" cable engineer who exemplifies an aggressive and innovative approach to fiber optics deployment. A reception was held in Brouse's honor, and he was bestowed with the "Rising Star," a piece of Stueben crystal.

Brouse has been instrumental in the design and deployment of Jones' innovative fiber optic architectures in both Broward County, Fla. and Alexandria, Va.

As system engineering manager in Broward back in the late 1980s, Brouse was responsible for getting the "Cable Area Network" fiber system installed. That unique design called for the addition of a route redundant fiber network running in parallel to the coax network, with a switch that connected the two. In the event of a laser failure, the switch would activate, and the coaxial network would seamlessly continue to provide service to customers.

After moving to Jones' corporate office in Denver, Brouse became part of a team that con-

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John Brouse holds the "Rising Star"

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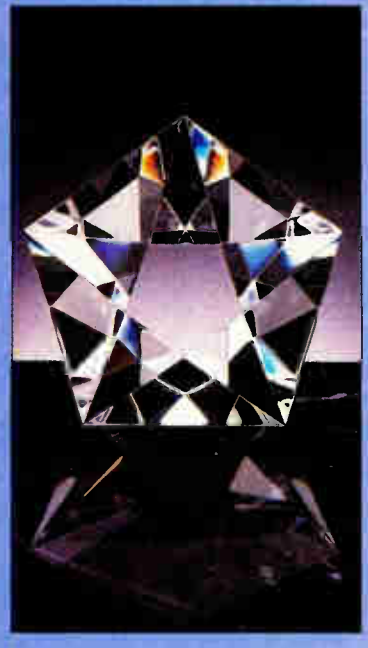
In cable television, the Polaris Award honors an engineering manager who has helped "light the way" towards a deeper industry understanding of the strategic benefits of optical fiber.

As established by Corning, the Society of Cable Telecommunications Engineers (SCTE) and CED Magazine, the award recognizes an emerging leader in the cable TV engineering community. An individual who has demonstrated a consistently high standard of performance and a customer-driven approach to fiber deployment.

John Brouse, Jr., Director of Network Development for Jones Intercable, Inc, embodies the principles of the Polaris Award. We're proud to recognize his exceptional vision, achievements and contributions to the cable television industry.

The winner of the Polaris award receives the handsome Steuben "Rising Star" crystal sculpture shown here. Corning also will donate $2,000 to the SCTE in the honoree's name to fund fiber-optic technology training.



CORNING

The SCTE's Bill Riker (left), Margot Botelho of Corning, and Rob Stuehrk (far right), publisher of CED, congratulate Brouse on winning the Polaris Award.

ceived and built a ring-based fiber architecture in Alexandria, Va. This network consists of 10 interconnected rings that provide complete network redundancy and route diversity. Its headend is recognized as a model for the future.

Brouse thanked his colleagues, including Hugh Bramble, John Linebarger and Bob Luff. "I particularly want to thank Bob for having the courage to hire someone who didn't know anything about cable TV," Brouse said.

Attendance high in spite of weather

More than 1,300 technology executives gathered in San Francisco for the conference, in spite of a major blizzard which hit the East coast. An estimated 200 Emerging Technologies attendees spent the first day of the conference stranded in their homes, though, with mountains of snow separating them from any plans for westward travel.

Those who made it to the conference were privy to the latest information on network availability, telecommunications and high-speed data. Several vendors, including Motorola Inc., Scientific-Atlanta Inc., General Instrument Corp. and others, stepped up to deliver their technological viewpoints.

Despite the apparent plethora of quantitative data which flooded this year's ET gathering, some executives scheduled to present papers at ET said there are still more questions than answers about telecommunications, high-speed data and digital video. But, they said, those questions have moved well into adolescence from last year's more elementary stance.

"I think, as an industry, we've moved ahead significantly, but I'd say without hesitation that there's a long way to go," noted Andy Paff, president of Integration Technologies, the joint venture company recently formed by Antec and Nortel.

Growing number of standards bodies

Significant progress is being made toward development of standards that will greatly impact the cable industry, but the growing number of interested bodies represents a "potential for conflict," according to a presentation by Curtis Siller Jr., a distinguished member of AT&T Bell Labs, and a representative from the IEEE 802.14 committee.

Siller's comments were made during a preconference tutorial session on standards activities, which reviewed the progress of DAVIC, IEEE 802.14 and the SCTE's own subcommittee structure. Furthermore, Siller said he'd like to see more participation from the cable and telephony industries in the 802.14 committee, which is attempting to create a standard protocol for cable TV-based networks. Although nearly 140 companies attended the last meeting (held last November), Siller called for more MSO representatives to attend future meetings.

Daljeet Singh of Harmonic Lightwaves detailed the progress made so far by DAVIC, which is attempting to forge a worldwide standard set of protocols for communications networks. The group's focus has been directed toward its Release 1.0 document, which was agreed upon following a week-long meeting last month in Berlin.

John!
Your award is well deserved.
From your proud colleagues at

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Just how will those two groups work out any differences between them, given that there is a plethora of other, informal standards consortia? That will be a key question, according to Siller. Already, the Broadband Link consortium announced last December, which includes AT&T, Hewlett-Packard and others, has different methods of accomplishing similar goals. Siller said these consortia shouldn't be viewed as a way to "go around" the standards-setting process. He did, however, acknowledge that cable system operators are on a fast track and felt that the IEEE process "needed to move more quickly" than it had been so far.

Singh agreed, and noted that because the DAVIC committee is run more like a company, it's focused on making significant progress over a short amount of time, much like the MPEG process. Siller noted that a number of steps have been taken to reduce the potential for conflict, including the addition of liaisons between groups and adoption of existing standards in whole.

Cryptography critical to security

As the explosive growth and popularity of the Internet and other on-line services and transactions continues, it will become increasingly important for both network providers and content developers to use ever-better security methods to control access to the content. That was the message delivered by Harvey Gates, Ph.D., of BDM International, during a pre-conference tutorial on digital cryptography.

In fact, these security systems will have to be both dynamic and rugged as high-powered computers make it possible to defeat sophisticated access control systems that had been considered robust.

Gates' presentation focused on both secret key and public key encryption systems and how they work. Gates explained that more than half of the 500 secret key systems are based on the Digital Encryption Standard (DES), while the public key system de facto standard was developed by RSA Data Security Inc.

DES was developed by IBM and became a government standard in 1977, Gates says. The standard is recertified every five years and is scheduled to be reviewed again next year, when some changes are anticipated. Presently, DES systems have 64-bit keys consisting of a 56-bit random key and 8 bits for error correction.

Furthermore, symmetric secret key systems are considered to be quite secure—brute computing force is the only known way to defeat them. These powerful computers would cost at least $1 million to beat a single DES system, Gates notes. These secret key systems require that the sender and receiver both have the same key, which requires that the keys be properly protected and managed.

Conversely, public key encryption systems are asymmetric, which requires two sets of keys—one "public key" published for the owner, and one "private key" held securely by the owner to decrypt the plain text. These "one-way" systems employ a variety of techniques, but the most popular is exponentiating prime numbers, Gates says. While these public key systems eliminate the need for a secure key distribution system, the process is slow—typically between 0.6 megabits per second and 1.0 Mbps.

Dramatic network improvements

The introduction of status monitoring devices and backup power throughout cable networks can make a "rather dramatic" difference in network availability and the number of perceived video outages, according to a detailed analysis undertaken by David Large, a principal with the Media Connections Group.

For example, simply by adding selective power improvements, a real-world network's downtime could be reduced by a factor of more than two, while video perceived outages can be reduced by a factor of six—all for a total cost increment of one percent over the cost of a network upgrade, or $2 per home, Large said. "This has to be the cheapest thing you can do to make your network work well," he concluded.

Of course, a major rap against using standby power is the cost, maintenance and disposal issues associated with lead-acid batteries and generators. But new technologies are being developed to overcome some of those shortcomings.

One development includes the flywheel energy storage method, which is being pioneered by companies such as SatCon Technology Corp. These devices often have a life of 20 years, need maintenance only every seven years and provide up to two hours of service, fully loaded. They can be recharged in five hours and provide 36V and 48V DC output, according to Richard Hockney of SatCon.

The company's new flywheels, designed for telecommunications use, will be field tested later this year and are scheduled to be in commercial production in 1997, Hockney said. CED

Congratulations

John Brouse

on receiving the
1996 Polaris Award.

Your innovative work
and expertise on the
Jones Alexandria
Virginia system
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commitment to
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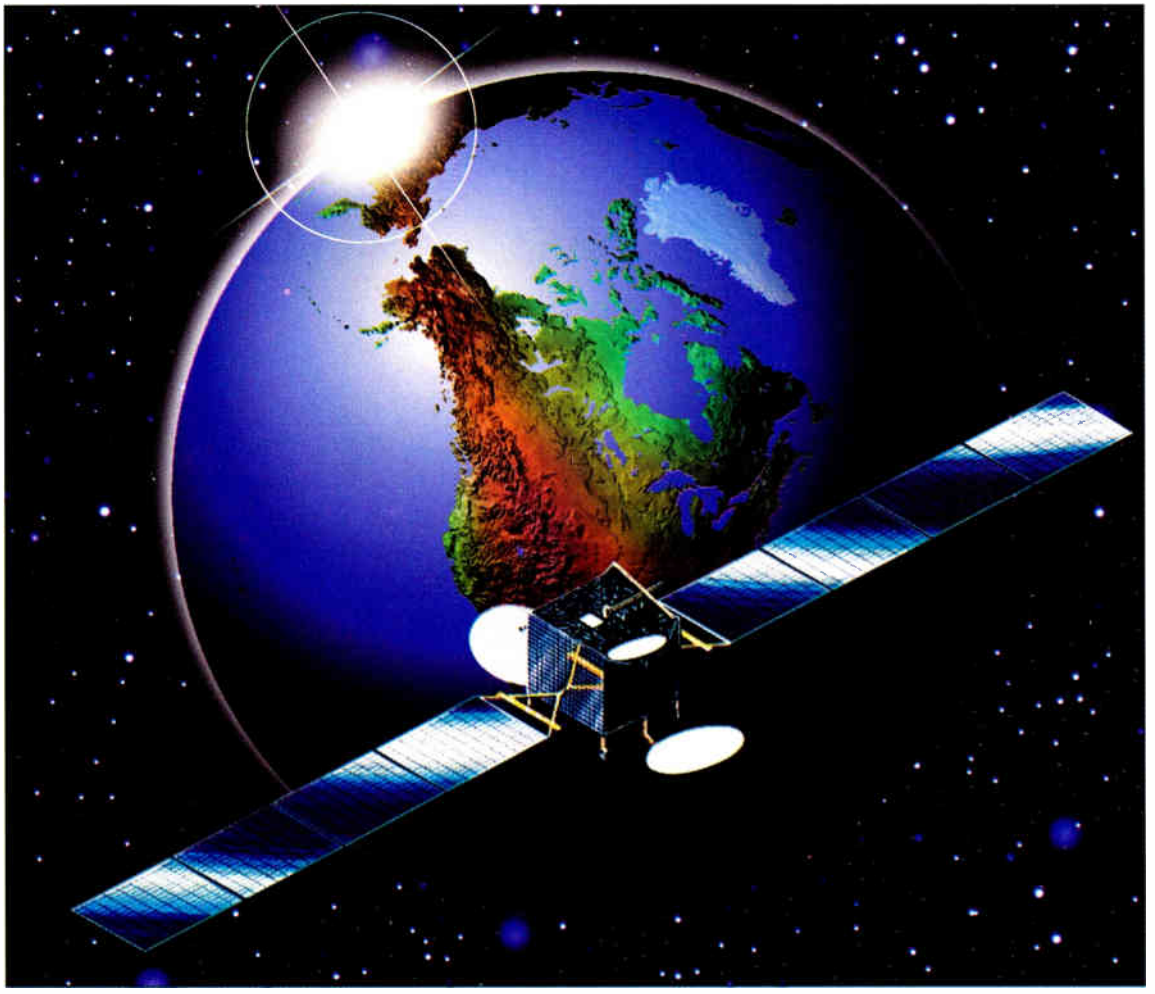
BARCO

DBS: A minor headache? Or a real pain?

Prices headed down, sales taking off

By Michael Lafferty

From all indications, the cable industry's 'What me worry?' response to the phenomenal growth of Direct Broadcast Satellite (DBS) systems seems to be growing a little thin, if not downright unbelievable. The signs, the studies and the expert opinions touting DBS as a robust, long-term challenger to the cable TV status quo are everywhere and getting stronger.



No one is predicting DBS will score a 10-count KO over cable operators. But when cable contenders are weighted down with debt, an uncertain regulatory climate and indecision on which technology paths to take into the 21st century, it only takes a few solid punches in the market share midriff to put a wobble in the cable strut.

"One of the things you have to recognize, for example," says Michael Alpert, founder of Alpert & Associates and former senior officer of Comsat Corp., "is that a good percentage of the DirecTv subscribers are coming from cable areas and they're happy (DBS) subscribers. Cable (operators) are so heavily leveraged that if they start losing a significant percentage of their subscriber base, say just five or 10 percent, it's going to have a significant impact on their bottom line.

"The cable industry had better wake up...It looks like close to 58 percent of the DirecTv and USSB subscribers are in cable areas. Nearly 65 percent of all home satellite viewers live in cable areas...And, of those living in areas without cable, more than 65 percent said they were not interested in cable if it came."

DBS: above & beyond expectations

Despite a generally flat 1995 holiday sales season for most retail sectors, computers and DBS systems were a notable exception. A recent report in *Multichannel News* noted that retailers around the nation were touting "extremely strong" 1995 sales of Digital Satellite System (DSS) dishes that are used to receive DirecTv and USSB satellite services. In fact, sales were so encouraging, the divisional vice president and general manager of home electronics for Sears, Roebuck & Co. (with 900 stores selling DSS equipment) said the company was predicting a doubling of current penetration estimates (10-20 million) to eventually achieve sales of 30 to 40 million units.

Many DBS critics take issue with DBS' burst from the gate (DirecTv/USSB: 1.2 million subs; PrimeStar: 1 million subs) during its first year of full-scale operations. These 2+ million subs, the argument goes, represent the peak of the so-called "early adopters," the cutting-edge consumers who have money to splurge on the latest gizmos or hottest trends in the market.

While the logic of that argument may ring largely true now, it may be a hollow truth for cable operators by the year 2000. That's when a number of DBS watchers are predicting direct-to-home satellite service will: a.) at the very least take a nasty bite out of cable's subscriber base; b.) chew a huge hole in cable's market share; or c.) have a well-bal-

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anced meal of cable revenues, with an especially tasty portion of the rich pay-per-view (PPV) cash cow.

Alpert tends to believe consumers have a big DBS appetite. "I think it (the DBS subscriber base) could be as high as 20 million (by the year 2000)," says Alpert. "It depends completely on the price of home equipment. If the home equipment comes down to about $300 and cable hasn't made their moves, DBS will make big gains.

"Don't forget it costs a lot to rewire (the cable plant). Just with normal coax, it costs almost as much to wire one of the boroughs of New York City as it costs putting up three high-powered satellites that cover the whole country. The economics are staggering."

Table 1: Projected U.S. DBS and CATV household penetration rates

	1996 (E)	1997 (E)	1998 (E)
Aggregate Size of Target Markets (000)	**97,920**	**99,280**	**100,660**
DBS System Subscribers (000)	4,625	7,609	9,964
DBS System Penetration	4.7%	7.7%	9.9%
% Growth of DBS System Subs.	115.5%	64.5%	31.0%
New Subs. - Not Prev. CATV Subs. (000)	1,335	1,443	1,140
New Subs - Prev. CATV Subs. (000)	1,144	1,541	1,215
Existing CATV System Homes Passed (000)	89,600	90,850	92,120
Existing CATV System Subs. (000)	60,017	59,922	59,811
Existing CATV System Penetration	67.0%	66.0%	64.9%

Sources: Morgan Stanley Research Estimates, Warren Publishing, Sky Report

DBS: chowing down on cable's lunch?

This year DirecTv/USSB and PrimeStar are joined in the battle for market share by two new DBS providers: Connecticut-based AlphaStar Digital Television and Colorado-based EchoStar Communications Corp.

Many might think this increased competition will cause a subscriber feeding frenzy primarily within the DBS industry itself. Others disagree. In fact, they say historical demand trends for consumer electronic products would tend to bolster the idea that the subscriber feeding frenzy is going to take place around cable's table instead. Some observers believe a more "polite" (i.e., conservative) view of the coming scramble for subscribers is more accurate, but no less disturbing for cable interests.

In September 1995, Morgan Stanley & Co. released its 95-page U.S. Investment Research Report entitled "Cable Television Metamorphosis — The Arrival of DBS and RBOC Competition." The report's financial

PrimeStar dish

and operating projections for the cable TV industry were based on four fundamental conclusions regarding the emerging competition from DBS and other multi-channel video service providers. They include:

✔ High-power, and to a lesser extent medium-power, DBS "will become the largest competitors to the cable television industry, with an estimated 12.0-12.5 million in aggregate satellite customers by the end of the decade." (see Table 1.)

✔ That DBS penetration will vary in five key types of markets, including achieving a "20-30% household penetration in the 28.0-29.0 million current homes" located in small communities with 40 or less channels of cable TV service or are not passed by cable; and a 7-8% penetration rate in urban markets that currently total 42 million homes.

1999 (E)	*2000 (E)*
102,060	*103,480*
11,551	*12,491*
11.3%	*12.1%*
15.9%	*8.1%*
779	*500*
808	*440*
93,410	*94,720*
60,074	*60,526*
64.3%	*63.9%*

✔ DBS (and to a lesser extent RBOC video service) penetration rates by 1996-97 will erode cable subscriber growth (from a 4-5% average growth rate), "eventually leading to net subscriber losses in 1999-2000." The overall result, concludes the report, is that "total cable television industry subscribers should remain essentially flat" during the 1995-2000 period.

✔ The most successful cable television operators will combat the DBS threat with new service deployments that include digital video services (near video-on-demand, games and à la carte services) and telephony.

Researchers at Morgan Stanley and other observers in the telecommunications industry believe that DBS' future is, to a large extent, tied to the price tags DBS equipment will be sporting in the next 18 months. To bolster that premise, the Morgan Stanley report documented the critical importance price has played in consumer electronics product adoption in the past (see Table 2).

Among others, the report tracked the historical price/penetration rates for cellular phones, personal computers and VCRs. While none of the three is a perfect substitute for DBS dishes and receivers, strong inferences can be drawn, especially from the VCR example which Morgan Stanley called "one of the best proxies for DBS systems."

Michael Alpert

The report noted that between 1981 and 1993, the average price of a VCR unit "declined 70 percent while the number of annual units sold rose from 1.47 million to 12.5 million, with household penetration reaching 78 percent." Of critical importance for cable interests was the fact that once "the price of the VCR fell below $500 per unit (1984-85), penetration rose dramatically to 30 percent by the end of 1985."

For cable operators, 1996-97 may be 1984-85 all over again.

The DBS players

What follows is a brief rundown on recent and projected near-term developments among the four DBS providers that are expected to help punch a hole in the $500/unit DBS equipment dam that's expected to flood the market in the next 12 to 18 months.

DirecTv/USSB — The "granddaddy" of U.S. DBS services has been boasting about its achievement in securing more than 1 million subscribers in its first year of operations, which it says moves "DirecTv into the ranks of the country's top-10 largest multiple system cable operators."

EchoStar's MPEG-2/DVB compliant decoder

DirecTv is a unit of General Motors' Hughes Electronics Corp. U. S. Satellite Broadcasting (USSB) is a unit of Hubbard Broadcasting Inc., the St. Paul, Minn. cable company. Together they've put together the DSS receiving system that is capable of delivering more than 175 (MPEG-2 compliant) digital channels from its state-of-the-art Broadcasting Center in Castle Rock, Colo. Retailers say a major attraction to the DirecTv/USSB system is its out-of-market sports packages that include all four major sports leagues and "thousands of collegiate sports match-ups."

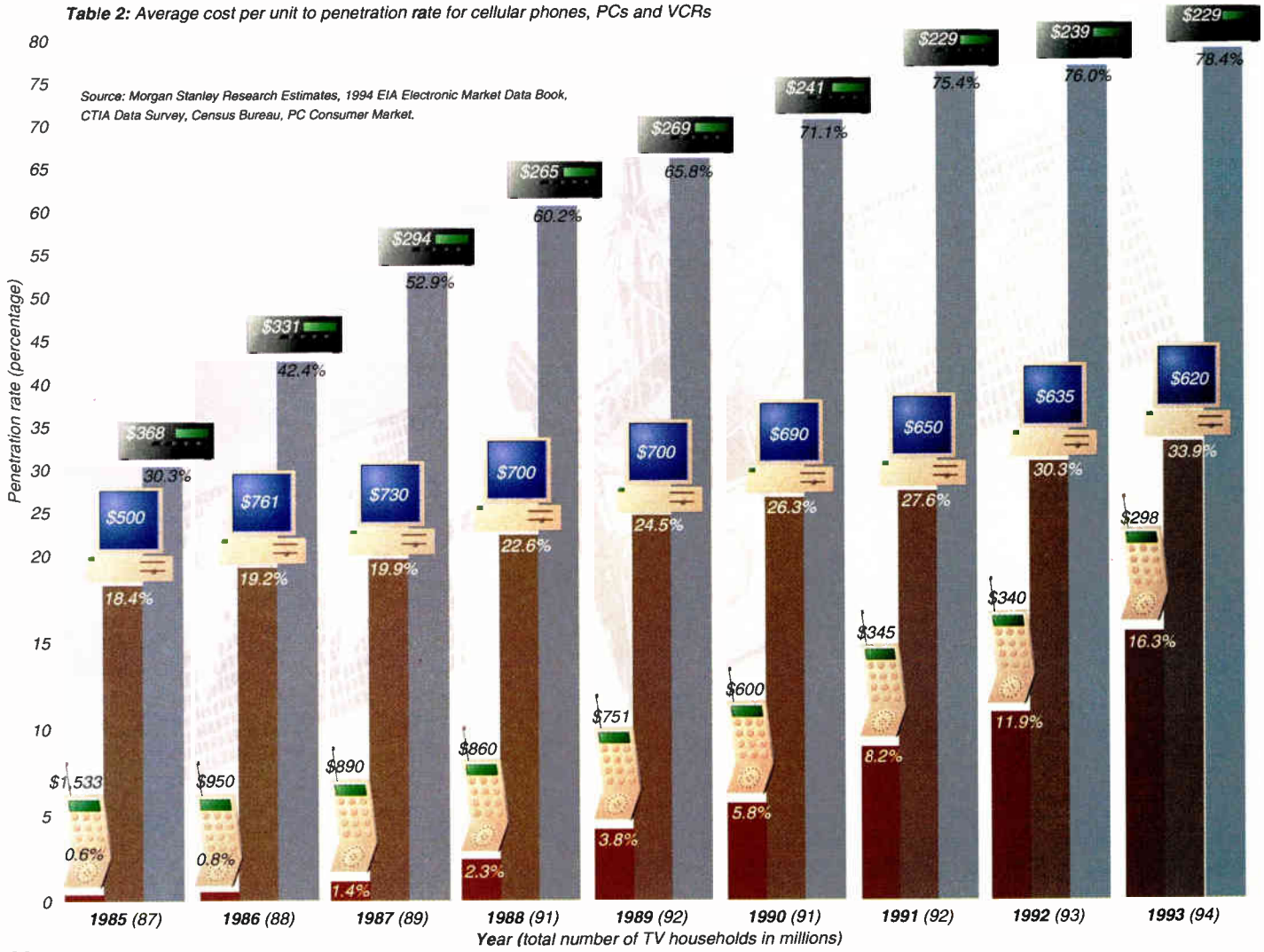
DSS hardware is currently manufactured by Thomson Consumer Electronics, under RCA and GE brand names, and Sony Electronics Corp. The breach of the $500/unit barrier may take place later this year when the DSS licensee roster undergoes a major expansion. New DSS equipment manufacturers coming up to bat include Toshiba America Inc., Samsung Electronics Co. Ltd., Sanyo Electronics Co. Ltd., Uniden America Corp., Hughes Network Systems and Daewoo Electronics Co.

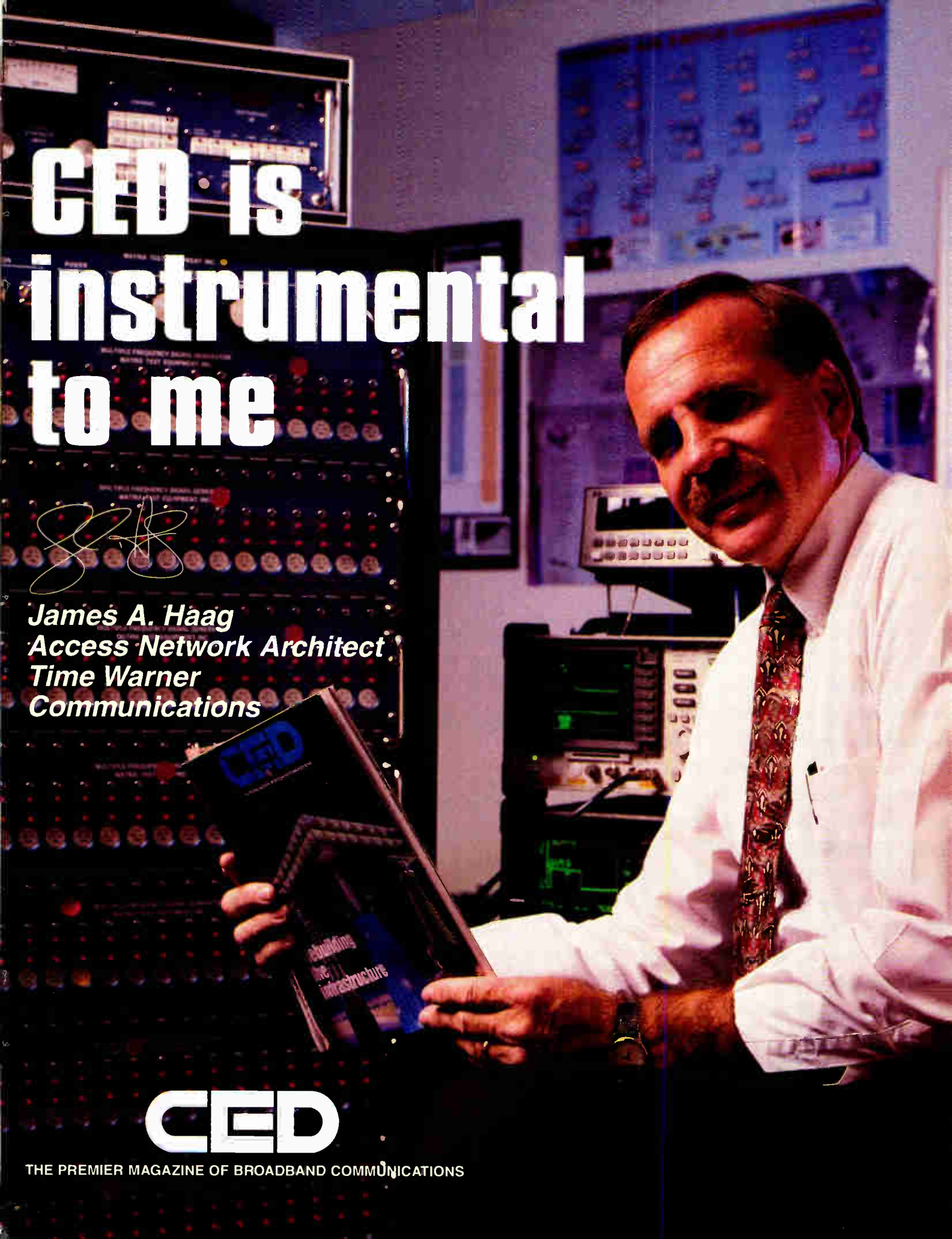
Meanwhile, one of the most oft-heard criticisms of DBS, i.e., its inability to have more than one television hooked up to the system, seems to have been solved by Sony. During the recently concluded Consumer Electronics Show in Las Vegas, Sony debuted its Multi-Room Distribution (MRD-D1) system. Scheduled to be shipped in early summer ($249 retail), the system brings in one video source from the DSS receiver and another video source from the VCR, cable system or a broadcast channel, then splits them into as many as five different signals that can be transported to different TV sets around the home through standard coaxial cable.

PrimeStar Partners L.P. — Taking the "if-you-can't-lick-'em, join-'em" philosophy to its natural telecommunications conclusion, PrimeStar is cable's answer to DBS competition. PrimeStar backers include Comcast Cable, Continental Cablevision,. Cox Cable Communications, Newhouse Broadcasting, Tele-Communications Inc. (TCI), Time Warner Cable and G.E. American Communications Inc. PrimeStar offers consumers an equipment lease option that skirts the equipment purchase challenge faced by other DBS suppliers.

This past year, PrimeStar suffered a setback in its $1 billion plan to become a high-powered DBS service when the FCC International Bureau bucked tradition by refusing to give Advanced Communications Corp. an extension of its DBS operating license. ACC's license covered 27 orbital slots at the coveted 110 degree position, which provides a prized

***Table 2:** Average cost per unit to penetration rate for cellular phones, PCs and VCRs*

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James A. Haag
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national "footprint," and another 24 slots at 148 degrees west longitude. Through a variety of arrangements involving PrimeStar partner TCI, PrimeStar was slated to acquire the 110 degree slots so that it could make the transition from a medium-powered to high-powered DBS service.

The FCC, in a major break with its own long-standing DBS policies, announced its plans to put the disputed orbital slots up for auction (currently scheduled to take place January 24). Since the decision was announced late last spring, a flurry of lawsuits and various appeals have been filed by a number of parties, including PrimeStar which already had satellites in production and launches tentatively scheduled.

PrimeStar has bowed out of the auction and opted to secure long-term capacity on a GE Americom medium-power satellite scheduled for launch at the end of 1996. Instead, the auction may provide MCI the opportunity to finally channel its $2 billion investment in Rupert Murdoch's News Corp. in a potentially dramatic direction.

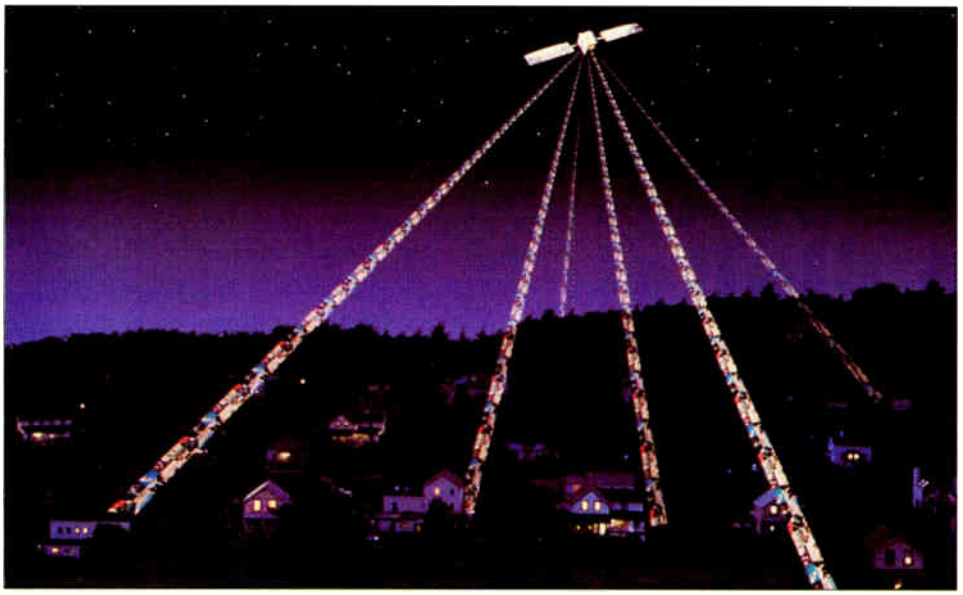
EchoStar's Cheyenne, Wyo. broadcast center

Meanwhile, PrimeStar has continued to sign on subscribers and improve its services with the recent announcement that it would expand its channel capacity to 150 in 1996. PrimeStar also announced it will introduce a dish designed for multiple dwellings (another DBS shortfall), enhanced remote capabilities in the home and improved digital services, including high-speed download capabilities from the Internet.

EchoStar Communications Corp. — One of the newest DBS players on the block, EchoStar, took off, literally, at the end of December with the successful launch and orbital positioning (119 degrees west longitude) of its first Ka band satellite. The new DBS provider is scheduled to be operational in March and the final piece of its DISH (Digital Sky Highway) Network will be in place in mid-1996 with the launch of a second satellite. With a 1 million subscriber breakeven threshold, EchoStar will be offering more than 200 channels of (MPEG-2/DVB compliant) video, audio and data services from its new broadcast center in Cheyenne, Wyo.

DISH receiving equipment will be manufactured and distributed under Magnavox and Philips brand names through Philips retailers nationwide. Headquartered in Englewood, Colo., EchoStar will also use its existing TVRO dealer network to distribute its DBS receiving equipment under the EchoStar and HTS (Houston Tracker Systems) brand names.

AlphaStar Digital Television — This year will also see the debut of another DBS provider, AlphaStar, which is owned by Tee-



Added DBS advantage: Niche or narrowcast programming

Comm Electronics, one of North America's largest manufacturers of home satellite (TVRO) systems. Tee-Comm is also one-third owner of ExpressVu Inc., Canada's first national digital television service.

Starting in early 1996, AlphaStar will be the first DBS digital (MPEG-2/DVB compliant) provider to serve all 50 states, from its broadcast center in Oxford, Conn., providing digital video and audio channels (120 in 1996, up to 200 in 1997) via AT&T's 402R satellite. The company is leasing 14 60-watt, 27 MHz transponders on the satellite positioned at 89 degrees west longitude. Because it has avoided the cost of building and launching a satellite

DBS: 100+ channels and counting

and it's developed a unique marketing/distribution plan that bypasses more expensive consumer electronics distribution channels, Murray Klippenstein, AlphaStar's president and CEO, says its breakeven point "is around 500,000 subscribers."

"We have put together distribution agreements that are quite different than the others," explains Klippenstein. "Certainly we will continue to rely heavily on the TVRO satellite industry that we've worked with for the past 13 years at Tee-Comm where we've built up an approximately 20 percent market share in the analog industry...We've already received over 3,000 applications by mail from dealers who wish to become (AlphaStar) dealers.

"We've also put together a very compelling arrangement with O'Rourke Brothers Distribution, the biggest of all the TVRO distributors. They have about 25 percent of the marketplace and they'll be representing us. And, we've put together an Amway distribution relationship."

The Amway connection is not only an innovative distribution strategy, but it also exemplifies another DBS strength, niche or narrowcast programming. AlphaStar and Amway are putting the finishing touches on a distribution/programming deal that spreads AlphaStar's sales efforts through more than 2 million Amway distributors. In return, Amway will get its own dedicated channel over the AlphaStar system.

"Our agreement," says Klippenstein, "accomplishes what amounts to be a win-win solution for both companies...It's one of those sweet little deals that is good for both parties that provides not only an internal sales mechanism, but also gives them a product they can sell."

AlphaStar is pressing its programming advantage to aggregate niche audiences with the launch of the Asian Television Network (ATN) in late February. The 24-hour channel will provide a full range of programming, in English and several major South Asian languages, targeted to more than 2.5 million South Asians in North America.

This ability for narrowcast programming is what Alpert believes is going to make DBS stand out from the competition, particularly cable. He believes the latest entrants into the industry, EchoStar and AlphaStar, are in a better position to exploit the advantage. While the total subscriber numbers for any one niche service may not sound like much, the bottom line economics tell a whole different story.

"From a DBS operator's standpoint," explains Alpert, "if they can get 100,000 subscribers paying $10 a month, they've hit a home run. If they've got 200,000 subscribers paying $10 a month, they've got a grand slam. The critical factor in the whole setup is marketing."

Even DirecTv is getting into the act with its ongoing tests for a real estate based network called RealNet Direct, a joint effort between Member Direct Television and the 750,000-member National Association of Realtors. Alpert foresees DBS niche programming efforts not only in trade oriented programming like RealNet Direct and foreign language efforts like ATN, but also in "minor" U.S. sports (rugby, fishing, soccer) and various cultural programming (opera, ballet, independent films).

According to Alpert the expanding DBS industry has all the pieces in place and is positioning itself as a strong, long-term competitor in the telecommunications industry. "I've always said the key issue to this business is pro-

EchoStar's satellite receiving dish

gramming. And then price. And customer service," says Alpert. "There are a lot of different ways in which you can structure an offer...And clearly, as the price of home equipment comes down, which it will over time, you're going to open up DBS opportunities to whole new segments of the population." CED

Techniques such as frequency hopping that are meant to overcome noise might not be adequate for long-term needs

Canadian MSO. "So far, we're getting good results with 64 QAM (quadrature amplitude modulation), 256 QAM and 16 VSB (vestigial sideband), but we're just getting underway."

Hamilton-Piercy notes that a large portion of homes in the MSO's serving areas have been newly wired or rewired within the past five years. But more testing will be necessary to confirm early results, especially since the MSO hasn't looked at the impact of second outlet terminations on the digital signals.

As research at Bellcore has demonstrated, microreflections from such unused termination points can wreak havoc on digital signals (see *CED*, 10/95, page 80).

Equally important, as many engineers have noted, ingress from all kinds of sources in the home can add up over the coaxial bus to create a disastrous impact on upstream signals from any given serving area.

"If we get to the ugly conclusion that we need traps to isolate in-home wiring, we might have to think about going to smaller node sizes," Paff says.

Arguing further for deeper fiber penetration, he adds, is the possibility that, with bandwidth in the upstream at a premium, techniques such as frequency hopping that are meant to overcome noise problems might not be adequate for long-term needs.

Finding power solutions

Another area of continuing uncertainty is the means by which operators will provide power and backup power to network components, given the lifeline requirements that come with telephony. Here, too, there is an impact on the drop issue, insofar as most operators in field trials so far are relying on a separate twisted pair connection from a power tap to deliver electricity to the home, rather than using the drop itself, thereby adding significant costs to the system.

"Do we want to power down that drop?" asks David Large, a principal in the consulting firm of Media Connections Group, who clearly believes the answer is no. "The answer isn't 412 (gauge coax) to the house, but we need to do something."

Both Large and Paff point to eliminating the F-connector and going to hard wiring as a possible solution. "We have to come up with a migration path from the current tap system," Paff says, noting that re-use of the existing drop cable will be possible only "if the power can be distributed down the drop center conductor."

Backup power adds further complications, given the environmental and maintenance hassles associated with

maintaining lead acid batteries at every fiber node. Here the industry is searching for new solutions and is evincing some preliminary support for a new technology based on the principle of flywheel energy storage.

Satcon Technology Corp., a startup based in Cambridge, Mass., plans to have flywheel power units available for field trials by the fourth quarter of this year, with commercial production slated to get underway next year, says Richard Hockney, vice president and CTO of Satcon. The units, designed for underground installation at pedestal- or utility pole-mounted node distribution sites, are capable of generating one kilowatt of power for up to two hours in the event of a power outage, he says.

"This is a good idea," says Dan Pike, vice president of engineering for Prime Cable. "There's a lot of interest in the technology."

Forging ahead

While MSOs want answers, they also understand they can't wait forever to push forward with the upgrades required to support full service ambitions. While companies are hesitant to plow more money into recently upgraded systems that operate at the 550 MHz, 2,000 homes per node tier, they understand fibering aggressively is the name of the game.

Glenn Jones, chairman and CEO of Jones Intercable, counsels an aggressive approach to expansion, noting that "we can't wait for the RBOCs to find another way into the home with high bandwidth services before we get there."

"You can't go wrong by fibering the networks," Jones says. "That's a winner no matter how it goes with regard to data and telephony."

Continental has the same view, having embarked on a company-wide upgrade to 750 MHz that is to be completed by the end of '98, with most of those systems being activated for two-way communications as they are upgraded.

"The transition to fiber-rich HFC will add the capacity to do more with pay-per-view, service multiplexing and adding new tiers to the core business, no matter where we go with data and telephony," Cooper says. "And fiber gives us the signal quality and service reliability we need to make us more competitive with satellite services."

In fact, the core business imperatives behind fibering the networks are cable's best guarantee that it will be in a position to launch voice and data services. As Cooper puts it, "Ultimately, the engine for entry into new business is cash flow from our core business." CED

While MSOs want answers, they also understand they can't wait forever to push forward with upgrades

John A. Brouse. Jr.
Director of Network Development.
Jones Intercable. Inc.

John, your exemplary deployment of fiber optics has truly made you one of our industry's "Rising Stars."

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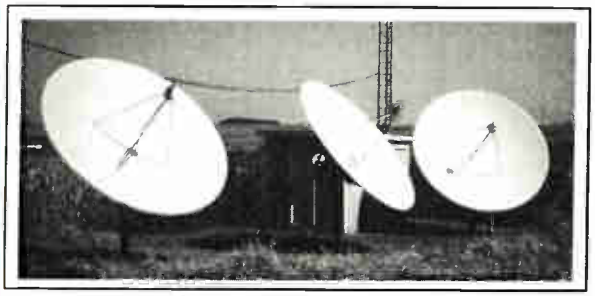

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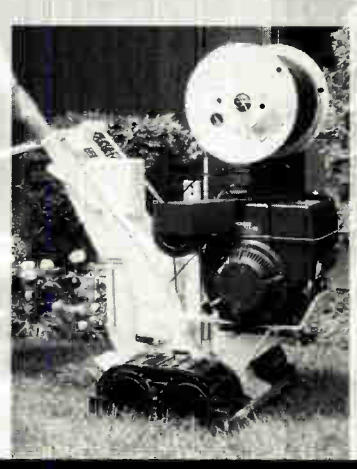

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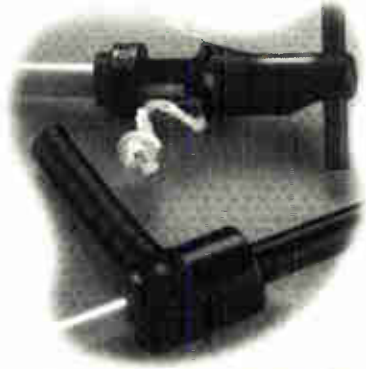

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Literature & Source Guide–Winter '96

Unattended/Automated Playback for Local Origination

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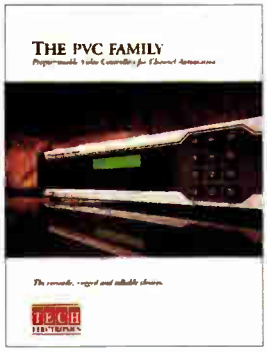
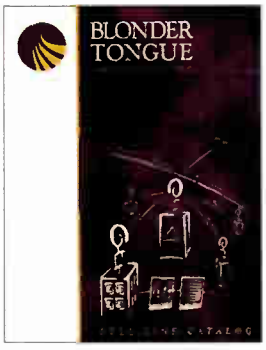


Circle Reader Service No. 121

Blonder Tongue's Full Line Product Catalog

For over 40 years, **Blonder Tongue Laboratories, Inc.** has been manufacturing professional quality, commercial cable television products. Our catalog includes product photos, descriptions, specifications, and application notes for our entire product line. Look for extended frequency range to 750 MHz on our complete family of headend and distribution products, 13 and 18 GHz microwave systems, and VideoMask, our new interdiction system. Call or fax today for a FREE copy. Tel: (908) 679-4000 Fax: (908) 679-4353



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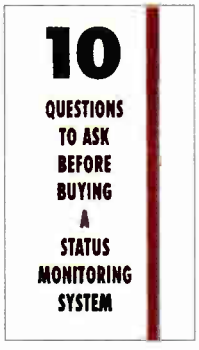
Cheetah's Answer to Monitoring

Cheetah™ provides an integrated network monitoring solution that is designed to evolve with your network requirements. This solution offers flexibility, reliability and the ability to integrate equipment from multiple vendors. Cheetah provides status monitoring of headends, fiber nodes, power supplies, amplifiers and end-of-lines. For the "10 Questions You Need To Ask Before Ordering A Status Monitoring system." call **Superior Electronics Group** at (941) 756-6000.



Circle Reader Service No. 123

ADC Frameworx Fiber Frame Architecture

This complete package contains information on ADC's integrated approach to total fiber distribution frame cable management. Frameworx is a platform on which service providers can build a total fiber distribution frame management system that provides automated record keeping, remote test capabilities, patch cord traceability, optical amplification and advanced circuit schematics such as signal monitoring, switching, attenuation and wavelength division multiplexing. **ADC Telecommunications** (800) 366-3891.

Circle Reader Service No. 124

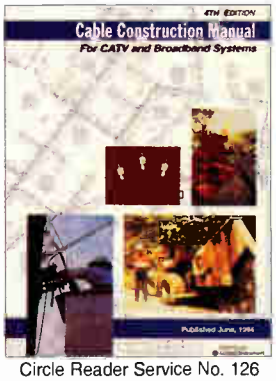
Headend Power Protection

Continuing its tradition of providing cost-effective state of the art power protection for the telecommunications and cable television industries, **Alpha Technologies** introduces a rack-mount configuration of its CFR Uninterruptible Power Systems. With a wide variety of power ranges available, you can protect selected critical revenue-producing equipment, such as pay-per-view or ad insertion hardware, or provide full protection for the entire headend. Call (360) 647-2360 for more information.

Circle Reader Service No. 125

Cable Construction Manual for CATV Broadband Systems

CommScope is now making available a revised and updated edition of its widely distributed and use Cable Construction Manual for CATV and Broadband Systems. The new manual includes sections on storage, testing and construction procedures for coaxial trunk and distribution cables in aerial and subsurface applications, fiber optic cables as well as safety procedures. For more information, call **CommScope/GI** (800) 982-1708.



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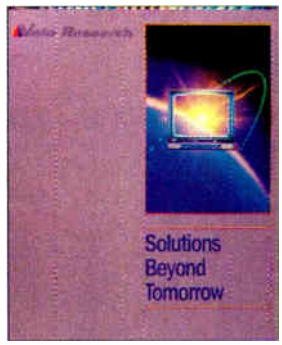
Vela Research for Video Servers, Encoders and Decoders

Vela Research Inc. designs and manufactures video servers, encoders and decoders. Their Perspective 2000 video server stores digitized video (movies, video clips, commercials, etc.) in a compressed digital format (MPEG-1, MPEG-1+ and MPEG-2) and can deliver multiple NTSC or PAL video outputs. Vela's MPEG Encoder can compress and multiplex audio and video signals into MPEG compliant data streams. Vela's MPEG decoder boards are designed for a wide range of video applications. Contact Vela Research at (813) 572-1230.



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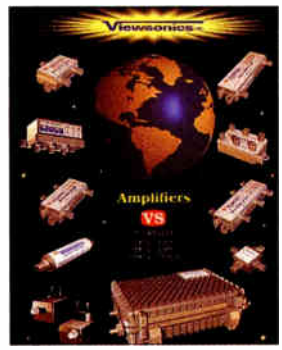
NEW! Amplifier Catalog

Viewsonics Inc. full color catalog contains photos and specifications of all of their amplifiers, including their newest low noise models with the figure at 3dB and 3.5 dB, depending on the gain, as well as several new 2-way models. You'll find their amps all over the world including places you've never heard of, so call 1-800-645-7600 and/or fax 407-998-3712 for your free Viewsonics Amplifier Catalog today.



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FREE Handbook

The FREE pocket size Cable TV Power Supply and Battery Handbook contains 125 pages of information for installers, maintenance technicians, system designers and cable TV engineers. Subjects such as power supply evaluation, plant layout, installation, maintenance and common problems encountered in the field are fully covered. Included is a special section on battery selection, management and testing. **Performance Cable TV Products**, Roswell, GA 30077-0947 (800) 279-6330 e-mail to: jud.williams@industry.net

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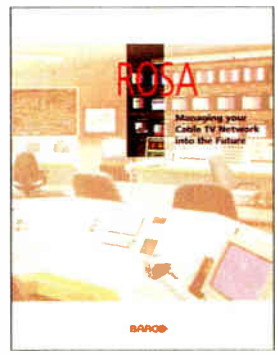
BARCO ROSA CATV Network Monitoring System

ROSA is a Remote Control and Diagnostic System (RCDS) for head-end and network performance monitoring and automatic service restoral. The RCDS Open System Architecture (ROSA) provides network-wide monitoring and control through an easy-to-use Windows graphical environment, controls both BARCO and non-BARCO network equipment, and interfaces to most leading data base packages. Call **BARCO** at (770) 590-7900 or Fax (770) 590-8836 for more information.



Circle Reader Service No. 132

NCTI Spanish/English CATV Illustrated Dictionary

The National Cable Television Institute (NCTI) offers a new Spanish/English illustrated dictionary of cable television and broadband technology terms. The first section presents English terms with Spanish translation and Spanish definition. The second section offers Spanish terms with English translation and English definition. Cost $29.95 plus S/H; quantity discounts. Please contact: **NCTI**, 801 West Mineral Ave., Littleton, CO 80120-4501, (303) 797-9393, Fax (303) 797-9394.

Circle Reader Service No. 133

Optical Links Literature

AEL Industries, Inc. offers a full set of product data sheets on their AELINK family of products entitled High Performance Optical Links for the Cable and Cellular Industries. Line performance information, power requirements, and physical characteristics are described in detail. AEL Industries, Inc., 305 Richardson Road, Lansdale, PA 19446-1485.

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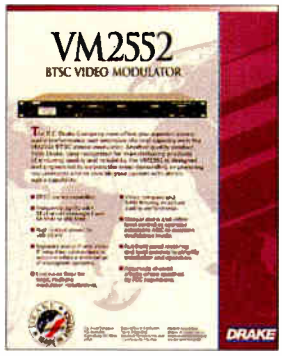
DRAKE VM2552 Stereo Video Modulator

Bring Stereo audio into your cable system at an affordable cost. The Drake VM2552 modulator incorporates BTSC stereo encoding, providing a significant cost savings when compared to purchasing separate components. Professional noise reduction circuitry reproduces the BTSC signal with good stereo separation and audio fidelity. The frequency-agile VM2552 features frequency coverage up to 550 MHz with a powerful output of +60 dBmV. Contact Mr. Philip Hawkins, **R.L. Drake Company**, (513) 847-4523.



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ESR1260 IRD Earth Station Receiver

The Drake ESR1260 IRD is a high quality commercial integrated receiver descrambler with synthesized frequency tuning of IF and subcarrier audio frequency. The VideoCipher® RS module can be accessed directly through the front panel, providing added convenience for the operator. Major operating functions are also selected via the front panel and programming is simplified with liquid crystal displays of operating parameters. The ESR 1260 IRD's compact design optimizes valuable rack space. **R.L. Drake Co.** (513) 847-4523.

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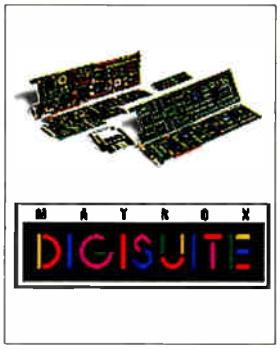
The video industry is in the midst of a mass migration to digital technology. PC-based open systems are the wave of the future. Move from expensive black box solutions to competitively-priced, PC-based open systems. Make the transition for your product by building it on Matrox DigiSuite–a solid foundation of digital video hardware and software development tools that you put together in myriad configurations to meet your requirements. Call **Matrox Video Products Group**, 1-800-361-4903 or (514) 685-2630, Fax (514) 685-2853, Internet: http://www.matrox.com/video



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FREE Design Guide–Hennessy Outdoor Enclosures

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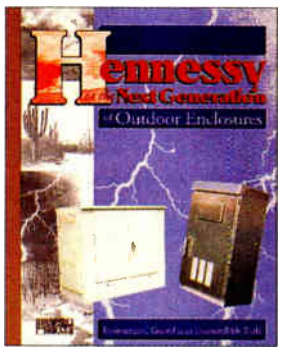

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E-TEK's Catalog

E-TEK combines innovative excellence, affordability and fast delivery for a wide range of fiberoptic applications. Products in this catalog include optical isolators, couplers, passive components, active devices, instruments and systems, plus new products including Bandpass WDMs, 980nm Pump Laser Module and touch-screen instruments. Also listed are E-TEK's worldwide sales representatives. E-TEK Dynamics, Inc., 1885 Lundy Ave., San Jose, CA 95131 Phone (408) 432-6300, Fax: (408) 432-8550

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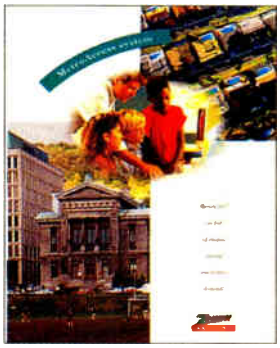
Zenith's MetroAccess™ System

MetroAccess is a complete, cost-efficient family of RF data communication products from **Zenith Electronics Corporation**. It uses proven, high-speed technology for hybrid fiber/coax systems linking businesses, communities, schools and residences for a wide range of applications, including work-at-home, distance learning, real-time video conferencing, Internet access and on-line services. For more information, call 1-800-788-7244.



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With more than 15 years of experience in the Network Systms areas, **Zenith Electronics Corporation** has extensive development and deployment expertise in advanced analog set-top decoder technology, including video and audio scrambling, real-time two-way cable systems, digital transmission technologies and computer networks, and is the industry-leading supplier of high-speed cable modems to more than 300 cable systems worldwide. For more information, call 1-800-239-0900.

Circle Reader Service No. 142

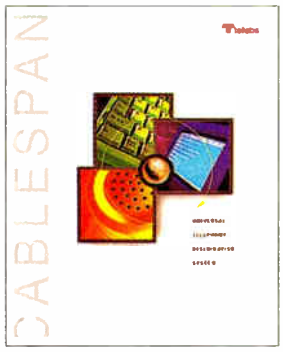
FREE: Wavetek's New 1996 CATV Selection Guide

The new 27-page *Cable Television Selection Guide* presents a full line of sophisticated test equipment designed to meet cable television's specific system testing needs. The guide features **Wavetek**'s new leakage meter and combination leakage/signal level meter, the CLI-1450. The new CMS 1000 Central Monitoring System is included, along with info on the complete line of MicroStealth signal level meters. In addition, the popular Stealth System Sweep, Flash Mini OTDR, and other test equipment are featured. **Call 800-622-5515.**

Circle Reader Service No. 143

New CABLESPAN™ Brochure from Tellabs

A new, full-color brochure from **Tellabs** describes the benefits of the company's CABLESPAN 2300 Universal Telephony Distribution System, which allows cable television operators to provide telephone and data services using the existing CATV infrastructure. Alternate-access providers will also find the CABLESPAN system to be a unique, innovative approach to providing business and residential telecommunications services around the world. To receive a copy of the brochure, call 1-800-445-6501.



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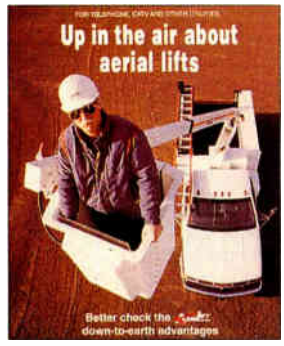
Up in the Air About Aerial Lifts?

ARMLIFT, the aerial lift that provides you with years of dependable service–lifts built tailored to your needs. With up to 34' working height, Armlift offers a variety of power sources, two speed operation on all units, gravity or hydraulic bucket leveling, choice of buckets and 720 degree non-continuous rotation. Truck or van mounts with a full line of equipment options. **Armlift, Div. of TG Industries**, Inc. Call (712) 864-3737.



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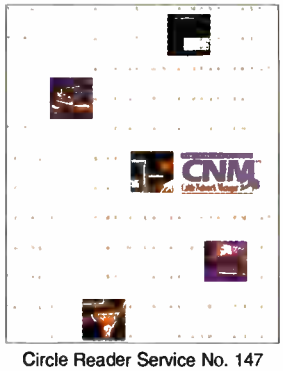
Cable Network Manager™

C-COR's Cable Network Manager (CNM)™ is the complete network management system for the complex communication systems of the 1990s. The new challenges of network management include managing hybrid fiber/coax systems, redundancy/failsafe control and inventory management. CNM manages all of these and even records any accessories that are installed. Call C-COR, the Network Company, at 1-800-233-2267.



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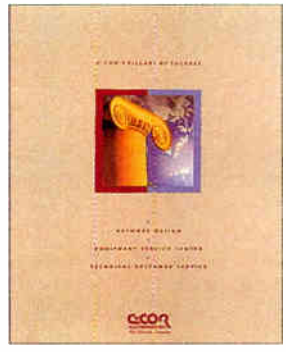
SystemSelect™...Strength in Service

C-COR's comprehensive service organization provides the support you need to plan, design, build and maintain today's complex communication networks. Whether it's network maps, a bill of materials, installation assistance, training programs or more, C-COR's customer driven approach is designed to serve you diligently, creatively and promptly. Service is C-COR's strength. Call C-COR, the Network Company, at 1-800-233-2267.



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Cable Leakage Technologies, Inc.

CABLE LEAKAGE TECHNOLOGIES (1-800-783-8878) offers a new family of **WAVETRACKER** products. The **WAVETRACKER** system has undergone major enhancements, with a new compact size, a VGA quality LCD display, and a **NEW LOW PRICE. CLT's** new **Windows™-based A.P.L.A.S. Software** offers **ONE STEP** data processing, using the **newest, most current mapping product available.** The **DELTAWAVE** Differential G.P.S. Base Station now offers 2 to 5 meters accuracy.

Circle Reader Service No. 149

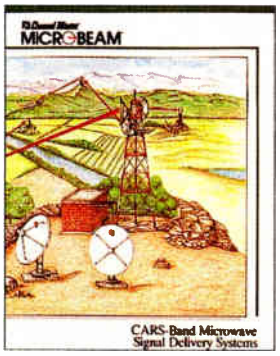
Free Catalog–Filters/Traps for Broadband Systems

Catalog Vol. 1 No. 4 describes a complete line of filters and traps for CATV featuring the full line of "brickwall" filters deleting single or multiple channels without sacrificing adjacent channels while passing up to 1 GHz. A selective line of bandpass filters is also described which suppress adjacent channel, off air interference while maintaining low loss in the passband. Other products are: notch and bandpass filters, co-channel eliminators, pay-TV traps, bandsplitters, CARS band filters and terrestrial interference filters. Call **Microwave Filter Co.** (315) 437-3953.

Circle Reader Service No. 150

FREE Microwave Catalog

Point-topoint 13 GHz and 18 GHz Systems. Channel Master® manufactures a complete line of 13 GHz and 18 GHz point-to-point microwave equipment for franchised CATV, private and wireless cable. For a free catalog, write to **Channel Master**, MICRO-BEAM® Division, 1315 Industrial Park Drive, Smithfield, NC 27577 or call MICROBEAM® Sales Manager Glenn Martin at 919-989-2234.



Circle Reader Service No. 151

New Catalog from TRILITHIC

From signal level meters to leakage detectors, from frequency counters to calibration equipment, the new Instruments Catalog from **TRILITHIC** has all of the products you need to test and maintain your CATV/Broadband distribution system. Updated in September, the catalog now includes such popular new instruments as the TRICORDER II and III and the SUPER PLUS leak/ingress locator, and the current price list. Trilithic Inc., 9202 E. 33rd St., Indianapolis, IN 46236 Phone (800) 344-2412

Circle Reader Service No. 152

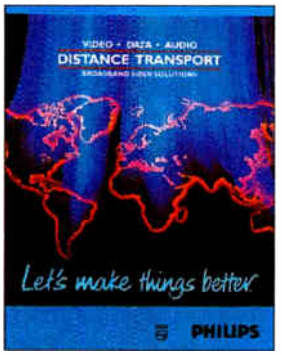
Philip's Rack-Mounted Transmitter

Philips Broadband Networks, Inc., is initiating a series of colorful product datasheets, starting with one detailing our 862 MHz Diamond Net™ fiber-optic receiver, RF amplifier and Diamond Transport™ rack-mounted transmitter (pictured here). Also, available is a sheet describing our new 9000T Series Telephony Tap. These information sheets will soon be available for all new products and many of the company's most popular established product lines. Call (315) 682-9105 or Fax (315) 682-9006 for more info.

Circle Reader Service No. 153

Philip's FM Distance-Transport Systems

Philips Broadband Networks, Inc., offers a four-page product brochure on the company's FM distance-transport systems. The four-color piece describes the advantages of Philips interactive video equipment and lists specific applications in education, data and telephony services, surveillance and business and training. Call (315) 682-9105 or Fax (315) 682-9006 for more information.



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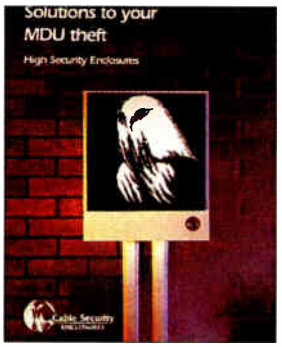
Cable Security™ provides Ultimate MDU Security Package

Cable Security manufacturers of the Beast™ box and distributors of Cable Ready™ ultra high security steel molding has merged the products together for the ultimate MDU security application. When these product groups are used together they will supply the Telecommunication Industry with the highest security level for multiple dwelling units available today. Please call 1-800-288-1507.



Circle Reader Service No. 155

FREE Catalog for Powering Broadband Networks

Power Guard is the leader in providing powering solutions for advanced broadband networks. If you're building a CATV plant or an advanced broadband network carrying voice, video and data, we have a power supply to meet your requirements. Power Guard can offer the most technically advanced, cost-effective systems on the market, because we have invested more toward research and development than all of our competitors combined. For a free catalog and to see how we can help call 1-800-288-1507.

Circle Reader Service No. 156

NEW Trilingual Catalog and New Training Video

Ripley Company's Cablematic Div. has a new trilingual catalog on its CATV, telecommunication and fiber optic cable preparation tools. New tools have been added, including the JCST for three preparations in one tool, new CR assembly tools for compression connectors, TW Torque Wrenches and DP Adjustable Jacket Strippers for fiber optic applications. Ripley's new training video demonstrates proper cable preparation techniques, available in English or Spanish, in NTSC or PAL format. Call 800-528-8665 or 860-635-2200.

Circle Reader Service No. 157

FREE 1996 Fiber Optic Test Equipment Catalog

Noyes Fiber Systems announces its new FREE 1996 Fiber Optic Test Equipment Catalog. The full color catalog provides an overview of the products and services offered by Noyes Fiber Systems including Optical Power Meters, Light Sources, Loss Test Sets, Return Loss Test Sets, OTDR's, Fiber Scopes, and Fiber Identifiers. Call Noyes Fiber Systems, PO Box 398, Laconia, NH 03247 (603) 528-7780, (800) 321-5298 or FAX (603) 528-2025.

Circle Reader Service No. 158

The issue: outages

As cable companies enter a competitive era with other service providers, one key to eventual success or failure could be network reliability and outages. This month, we'd like your thoughts on the strides you're making to reduce outages and bolster reliability.

The questions:

1. Assuming that an "outage" is defined as a loss of signal for any length of time, how many outages does your system suffer in a typical month?

❑ 0-2 ❑ 3-5 ❑ 6-9 ❑ 10+

2. Of those, how many are caused by system testing, maintenance or other internal operational policies over which you have control?

❑ None ❑ Few ❑ Half ❑ Most ❑ All

3. Of those outages you have no control over, what are they most typically caused by?

❑ Weather ❑ Cable cuts ❑ Electronics

❑ Traffic accidents ❑ Other

4. Has your system taken specific steps within the last 12 months to reduce the number of outages it suffers?

❑ Yes ❑ No ❑ Don't know

5. Do you think your system could do even more than it already has to reduce outages?

❑ Yes ❑ No ❑ Don't know

6. In comparison to two years ago, has your system reduced the number of outages it suffers, on average?

❑ Yes ❑ No ❑ Don't know

7. Has your system worked with the local power utility to reduce outages?

❑ Yes ❑ No ❑ Don't know

8. Overall, would you consider your local power company to be reliable and easy to work with?

❑ Yes ❑ No ❑ Don't know

9. Has your system performed surveys to determine subscriber attitudes about service interruptions?

❑ Yes ❑ No ❑ Don't know

10. In your opinion, can your system's cable network be made as reliable as the local telephone network?

❑ Yes ❑ No ❑ Don't know

Your comments:

Fax us at 303-393-6654

Make a copy of this page and fax it back to us at the number above, or mail it to *CED*, 600 South Cherry Street, Suite 400, Denver, Colo. 80222.

*Every month, we'll pick one response from those we receive and award $50. See official rules below.

Names won't be published if you request your name to be withheld, but fill out the name and job information to ensure that only one response per person is tabulated.

Your name and title

_____

_____

_____

System name:

_____

Location:

_____

Your MSO:

_____

Your job function:

_____

Daytime phone #:

Official rules: No survey response necessary. Enter by returning the completed survey via fax or mail to the locations indicated above, or print the words "CED Return Path" on a 3"x5" card and mail it along with your name, address, daytime phone number and signature. To be eligible for the drawing, entry forms must be received by 5 p.m. on March 31,1996. CED is not responsible for lost or misdirected mail. One entry per person. Forms mutilated, illegible or not in compliance with these rules shall be considered ineligible in the sole discretion of the judges. Odds of winning depend on the number of entries received. A random drawing from eligible entries will be held on or about April 1, 1996. Winner will be required to provide his/her social security number and proof of identification and is solely responsible for all federal, state and local taxes incurred. Prize is not transferable to any other person. Sweepstakes participants agree to waive any and all claims of liability against CED magazine, Capital Cities Media Inc., Capital Cities/ABC Inc. and its affiliated and independent contractors for any injury or loss which may occur from participation in this sweepstakes or receipt of the prize. Winner consents to publication of his/her name for publicity purposes without further compensation. Participants must be 18 years of age or older. Employees of CED magazine, Capital Cities Media Inc., Capital Cities/ABC Inc. and its affiliated and subsidiary companies, and their respective employees, agents and independent contractors, and their immediate families are not eligible to participate. Void wherever prohibited, license required, restricted or taxed by law. Sweepstakes sponsors reserve the right to change or modify the sweepstakes rules while the sweepstakes is in progress. Participation in the sweepstakes constitutes acceptance of all sweepstakes rules.

RESULTS

The issue: Interconnects

Cable companies that are serious about entering the telephony or high-speed datacom markets will have to be able to send and retrieve signals across traditional cable system franchise boundaries to cover wider geographic areas. This is a major break with tradition, where each cable system was its own island. Some say it can't be done easily. This survey attempted to see what you think.

The results:

Cable network operators are steadily adopting the idea of creating central "superheadends" but are much slower when it comes to developing strategies to interconnect their system with neighboring cable plants, according to our latest survey on interconnects.

In fact, operators are split over the issue, with half having considered the concept and half not. In addition, a paltry few have actually approached their neighbors, so few really know how they would react to such an arrangement.

Yet an overwhelming majority believe interconnects will become increasingly important in the future–and would result in more revenue from data delivery, advertising and other applications. Almost everyone agrees the industry needs to do more to determine the feasibility of interconnecting, however.

Surprisingly, there seems to be little industry support for Sonet technology, perhaps because operators are wrestling over the benefits vs. additional costs for hardware.

Congratulations to Joe Van Dyke of Las Cruces Cable for winning $50 in our latest giveaway. To make yourself eligible for a future drawing, fill out the survey on the previous page and send it in!

1. Has your system consolidated headends by adding fiber to your system?

Yes	No	Don't know
55%	**36%**	**0%**

2. Has your system considered constructing one regional "superheadend" to serve the community?

Yes	No	Don't know
64%	**18%**	**9%**

3. Has your system either considered interconnecting or already completed an interconnect project with an adjacent cable system owned by other MSOs to fully "cover" the metro area you serve?

Yes	No	Don't know
27%	**73%**	**0%**

4. Do you think such an interconnect could save your system money over the long term?

Yes	No	Don't know
45%	**36%**	**9%**

5. Do you think your neighboring MSO would welcome the opportunity to interconnect with your system?

Yes	No	Don't know
27%	**18%**	**55%**

6. Do you believe an interconnect could bring your system more revenue through data delivery to businesses, advertising or other services?

Yes	No	Don't know
64%	**27%**	**9%**

7. How important will interconnects be in the future?

Very	Somewhat	Not at all
55%	**45%**	**0%**

8. Today, would you be inclined to deploy Sonet equipment or go with a less costly analog or proprietary uncompressed digital fiber system?

Sonet	Proprietary	Don't know
18%	**45%**	**36%**

9. Do you think cable operators can overcome individual preferences (i.e. signal security) to be able to interconnect their systems effectively?

Yes	No	Don't know
64%	**18%**	**18%**

10. Do you think a new set of standards should be created to allow for neighboring cable systems to interconnect seamlessly?

Yes	No	Don't know
45%	**17%**	**17%**

11. Do you think the cable TV industry should do more, less or about the same amount of work to determine the feasibility of interconnecting?

More	Less	About same
91%	**9%**	**0%**

Your comments:

"It sounds real good, but getting operators to work together in order to bring interconnects to the front lines will be a problem."

– Kim Collins, TCI, Marietta, Okla.

FEBRUARY

5-9 Broadband Communications Network Design, produced by General Instrument. Location: St. Petersburg, Fla. This five-day course includes a high-level overview of the network with a focus on operational theory and design. Call Lisa Nagel at GI (215) 830-5678, or fax (215) 830-5602.

6-7 Arizona Cable Television Association's 1996 Annual Meeting. Location: Doubletree Suites Hotel, Phoenix, Ariz. Call the ACTA office at (602) 955-4122.

6-8 Telecommunications Network Engineering for Technicians, produced by General Instrument. Includes technical instruction on distribution networks, architectures and fiber transport. Location: St. Petersburg, Fla. Call Lisa Nagel at GI (215) 830-5678, or fax (215) 830-5602.

7 West Virginia Mountaineer SCTE Chapter, Technical Seminar. Location: Ramada Inn, South Charleston, West Virginia. Topic: Annual meeting and technical program. Call Steve Johnson (614) 894-3886.

8 SCTE Satellite Tele-Seminar Program. To be transmitted on Galaxy 1R, transponder 14, 2:30-3:30 p.m. Eastern time. Topic: Inside FCC form processing, from Expo '95 in Las Vegas. Call SCTE National Headquarters (610) 363-6888.

8 Hudson Valley SCTE Chapter, Technical Seminar. Topic: Broadband TV applications and connectors, with a representative from Augat Communications, and Cable security procedures, with Stan Durey of General Instrument. Location: Century House Inn, Latham, N.Y. Call Robert Price (518) 355-3086.

Trade shows

February

14-15 Sixth Annual Northern California Vendors Day. Location: Fairfield, Calif. Call Steve Allen (916) 786-1610.

21-23 Texas Cable Show. Location: San Antonio, Texas. Call the Texas Cable TV Association at (512) 474-2082.

12-13 Video Networks. Telcos Meeting Customer Needs in Video Services. Location: The Renaissance Atlanta Hotel, Atlanta, Ga. Call Pam Watson (312) 540-3856 for more information.

12-13 SCTE Regional Training Seminar. Topic: Introduction to telephony, with SCTE director of training Ralph Haimowitz. Location: Milwaukee, Wis. Call SCTE National Headquarters for more information (610) 363-6888.

13-15 Wheat State SCTE Chapter, Testing Session. BCT/E certification exams to be administered. Location: Wichita, Kan. Call Joe Cvetnich for additional information (316) 262-4270.

14 Dakota Territory SCTE Chapter, Technical Seminar. Topic: Headend video and subscriber proofing, with Tony Gauer of TSB Inc. Location: Mandon Service Center, Bismarck, N.D. Call Tony Gauer (605) 426-6140.

14-15 Utilities-based Telecommunications: Implementing Strategies to Increase Market Share. Location: The Renaissance, Atlanta, Ga. Call (312) 540-3083.

14-16 SCTE Regional Training Seminar. Topic: Introduction to fiber optics, with SCTE director of training Ralph Haimowitz. Location: Milwaukee, Wis. Call SCTE National Headquarters (610) 363-6888.

15 Dakota Territory SCTE Chapter, Technical Seminar. Topic: Headend video and subscriber proofing, with Tony Gauer of TSB Inc. Location: Governor's Inn, Pierre, S.D. Call Tony Gauer (605) 426-6140.

15 Michiana SCTE Chapter, Technical Seminar. Topic: BCT/E Category III tutorial–transmission systems, with Ron Hranac of Coaxial International. Location: Comfort Inn, Buffalo, Mich. Call Russ Stickney (219) 259-8015.

16 North Country SCTE Chapter, Testing Session. BCT/E and Installer certification exams to be administered. Location: Columbia Heights, Minn. Call Bill Davis (612) 646-8755.

20-23 Fiber Optic Training, produced by The Light Brigade. Featuring a new, four-day format. Location: Honolulu, Hawaii. Call Pam Wooten at (800) 451-7128 for more information.

20-23 Fiber Optic Training, produced by The Light Brigade. Featuring a new, four-day format. Location: Tampa, Fla. Call Pam Wooten at (800) 451-7128 for more information.

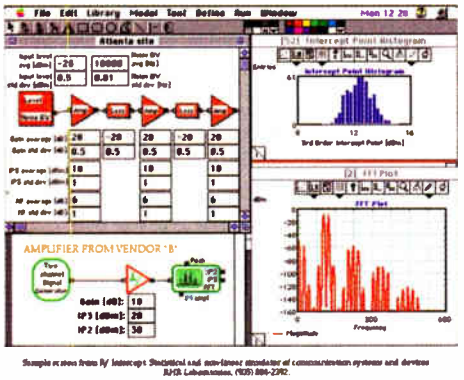
21 New England SCTE Chapter, Testing Session. Installer certification exams to be administered. Location: Worcester, Mass. Call Tom Garcia at (508) 562-1675.

23 Wheat State SCTE Chapter, Testing Session. BCT/E and Installer certification exams to be administered. Location: Great Bend, Kan. Call Joe Cvetnich for more information (316) 262-4270.

27 Desert SCTE Chapter, Testing Session. BCT/E and Installer certification exams to be administered. Location: Palm Desert, Calif. Call Bruce Wedeking for additional information (909) 677-2147.

Comm system simulation tools

RICHMOND HILL, Ontario–RHR Laboratories has introduced RfIntercept, a communications system simulation tool which provides statistical system simulation and time-domain analysis of non-linear behavior. The package provides four ways to analyze comm systems and their components, including the capability to: allocate channels for minimum intermodulation distortion interference; reduce



RfIntercept from RHR Laboratories

a chain of devices to an equivalent single device described by its gain, equivalent noise figure, second and third order intercept points; obtain the statistical distributions of overall system gain, output level, noise figure, intercept point, and signal-to-noise ratios, given the statistical distributions of the system components; and simulate the response of non-linear devices to arbitrary input, such as triple-beat distortion and channel loading simulations.

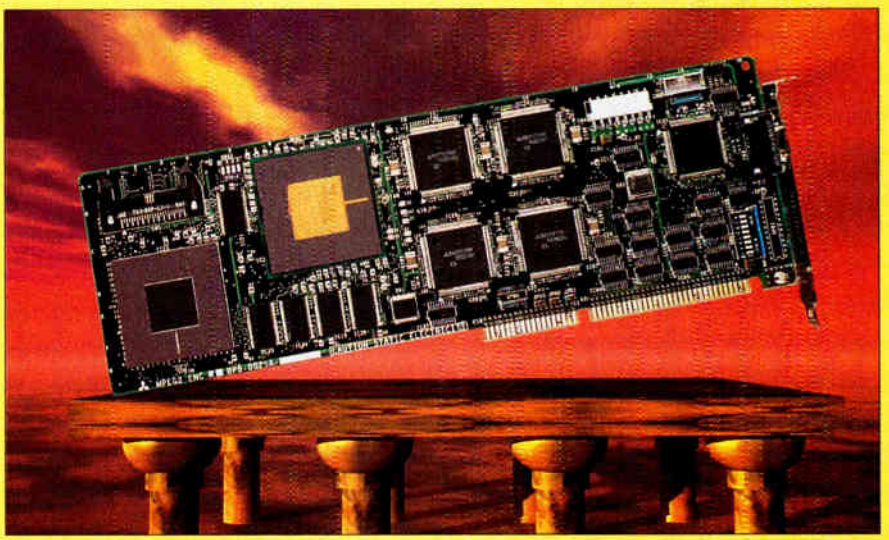
RfIntercept can successfully analyze radio and microwave frequency receivers, exciters, feedforward amplifiers, balanced amplifiers, cable television distribution systems and microwave hops.

Circle Reader Service number 61

FM receiver

MIAMISBURG, Ohio–The R.L. Drake Company has announced the FMR1000, a commercial grade receiver that utilizes AFC to lock into frequencies and eliminate the opportunity for frequency drift. The economical FM broadcast receiver is intended for SMATV/CATV installations, background music/programming, monitoring and other applications demanding a reliable receiver. Cable companies can utilize the FMR1000 to apply audio as background music to video channels that run program listings.

Circle Reader Service number 62



MPEG-2 encoder chip set

SUNNYVALE, Calif.–The Electronic Device Group of Mitsubishi Electronics America Inc. has announced a real-time MPEG-2 encoder chip set that provides high integration and good performance.

The new encoder can provide Main Level @ Main Profile encoding with one controller, one pixel processor and four to eight motion estimators, depending on search window resolution required. The chip also encodes I-, P- and B-frames.

The company's integrated 10-chip MPEG-2 solution will enable significant reductions in MPEG-2 digital video encod-

Fiber optic transmitter

PALO ALTO, Calif.–Hewlett-Packard Company has announced a fiber optic transmitter and receiver pair designed for operating Ethernet backbones over singlemode fiber.

These new LED-based singlemode components cost substantially less than typical laser-based singlemode fiber transmitters and receivers, according to the company.

HP's HFBR-0305 components can be used in proprietary singlemode fiber data links operating at distances up to 14 km, vastly extending the distance of Ethernet connections beyond the 2 km specification for multimode fiber backbone connections. The HFBR-0305 series consists of the HFBR-1315TM transmitter and HFBR-2315T receiver. Both have ST style connectors and a 2x4 dual-inline footprint–pin-compatible with and having the same footprint as HP's de facto industry standard HFBR-1414, 850-nm transmitter, and HFBR-2416, 850-nm receiver for multimode fiber. Substitution of the HFBR-1315TM and HFBR-2315T for the HFBR-1414 and HFBR-2416, with the change of a few component values, converts a multimode fiber Ethernet product to singlemode fiber operation, without any changes to board layout. The HFBR-1315TM transmitter incorporates a 1,300-nm wavelength edge-emitting LED. The HFBR-2315T receiver contains an InGaAs PIN photodiode and a low-noise transimpedance preamplifier that operate in the 1,300-nm wavelength region.

Circle Reader Service number 63

Optical return loss meter

WESTLAKE VILLAGE, Calif.–Aerotech World Trade has launched a high-performance optical return loss meter in North America following the signing of an agency agreement with Australian manufacturer Kingfisher International.

Optical return loss meter

The KI 5000 Series requires no user calibration or warm-up period and is designed for use in rugged environments. The unit employs an easily disassembled optical interface to allow rapid cleaning in the field. Versions are available for fiber line testing as well as extended range measurements at 1300 and 1550 nm or dual wavelengths.

Measuring 190 x 120 x 95 mm, the KI 5000

Mitsubishi Electronics America Inc.'s MPEG-2 encoder chip set

ing and transmission for the television and cable broadcast industries, according to the company. It will also enable lower-cost video servers and authoring systems for digital video disks.

Adding to the high integration of the MPEG-2 solution is the fact that external synchronous DRAM, used for frame memory and I/O buffering, is controlled by the chip set, eliminating the need for a separate memory controller.

The encoder chip set supports all MPEG-2 prediction modes–I-, P- and B-frames–and offers real-time encoding of 720 x 480 pixels at 30 frames per second (conforming to ITU-R-601-resolution video). Another key feature of the chip set, which is fully MPEG-2 compliant, is its ability to provide ML@MP encoding with exhaustive search windows, scalable from ±32 x ±16 (horizontal x vertical) pixels (with four motion estimators) to ±64 x ±16 pixels (with eight motion estimators) with half-pixel resolution.

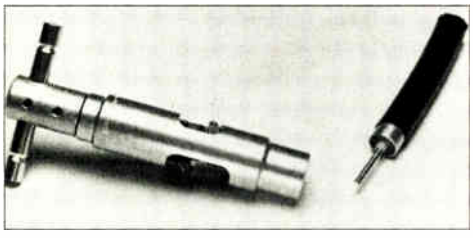
Circle Reader Service number 60

Series will operate for 10 hours using its nickel-cadmium battery power source, and features a 0-40 dB LED and 0-60 dB laser range. The display has a 0.1 dB resolution and accuracy is +0.5 dB. The meter will accommodate either slant polish or physical contact types of connectors, while screw-on adapters allow the unit to be employed with all standard connectors.

Circle Reader Service number 64

Cable preparation

CROMWELL, Conn.–Ripley Company's Cablematic Division has introduced a new tool for preparing trunk and distribution cable. The



JCST tool

JCST tool simultaneously removes the outer jacket, cores the inner dielectric and strips the outer sheath with a smooth, beveled cut in one fast, precise operation. Several models are available, each designed to connector manufacturers' specifications to assure correct cable preparation dimensions. Tools are available for CommScope P3, Times Fiber T6, T10, TX and Trilogy MC² cables. All tools are durable all-metal construction. Strip stops can be ordered for easy changes to different jacket seizure connector types. Sheath cutting blades are heat-treated for extra long life and can be replaced without changing the coring bit. A long tool housing and compact diameter design eliminate lateral movement. The standard models have a "T" handle with a built-in 3/8-inch drill adapter. A ratchet "T" handle model is available with a separate drill adapter.

Circle Reader Service number 65

Quad splitter

MELVILLE, N.Y.–Vicon Industries Inc. has introduced the GSP430 Monochrome Quad Splitter. The GSP430 is a full-featured quad splitter in a compact package.

The GSP430 accepts video from four cameras, processes it digitally, and displays the complete video from all four in each quadrant on one monitor screen. The quad splitter includes alarm response capabilities for each camera input, and a dual alarm relay output is provided for connection to additional equipment, like a VCR. A video loss alarm is also provided. A user-programmable, eight-character title is available for each channel. All operating and programming functions are performed with on-screen menus and front panel keys. The unit can be remotely operated by a dry-contact switch closure system or an RS-232 system for control by a host computer.

The GSP430 offers manually selected full-screen display of individual cameras and a sequencing program that displays each camera full screen and then the quad image as part of the sequence. Each camera can be assigned its own dwell period, as can the quad display.

Circle Reader Service number 66

Optical power meter

VANIER, Quebec–EXFO is announcing the FOT-40, a Wavewise-optical power meter and integrated light source. Wavewise, an intelligent signaling protocol, communicates with another compatible power meter which immediately matches the sending wavelength to the receiving wavelength. It acts as an advanced productivity tool, allowing the user to test fibers more quickly, without error. Communication problems are avoided, and efficiency is increased.

The FOT-40's five calibrated wavelengths and its Wavewise feature work well in a variety of environments such as LAN, data comm, cable TV and telco. It measures in dBm, dB and watts. The unit comes equipped with 2 kHz generation and detection features for easy fiber identification. Each meter benefits from a rugged PVC holster which not only protects the unit, but also provides space for a spare battery and optical adapters.

Circle Reader Service number 67

Cross-connect system

PAWCATUCK, Conn.–Ortronics has introduced its 110 Cross-Connect System that is used to facilitate the administration of cross-connect fields for voice and data systems. The high-density, quick connect terminating system is designed to support TIA/EIA-568A specs. It includes 110 wiring blocks, 110C connecting blocks, 110 patch cords, 110 cross-connect system terminal blocks and optional accessories.

The 110 wiring blocks are offered in 100 and 300 pair sizes and are used with 3, 4 and 5 pair 110C connecting blocks. These 110 cross-connect system terminal blocks are available field or factory terminated. The pre-assembled blocks are available with or without legs for either frame or direct wall mounting. The modular design of the wiring blocks and troughs allows for future expansion.

110 Cross-Connect System

The terminal blocks are available in 300, 600 and 900 pair configurations which include wiring blocks, connecting blocks, connectorized pigtails, and horizontal jumper troughs for patch cord arrangement. The wiring blocks and troughs are mounted on a metal backboard equipped with cable troughs at top and bottom.

Circle Reader Service number 68

"Green" utility line markers

STOW, Ohio–GreenLine Products has introduced a new line of utility cable markers. Utilizing advancements in polymer technology, GreenLine markers are designed to withstand substantial field abuse. Temperature stable from -100 degrees F to +200 degrees F, the markers can handle vehicle impacts, livestock rubbings and vandalism in virtually all weather conditions, according to the company. The new line is more durable than fiberglass-filled products that can absorb water, delaminate and splinter, or commodity grade plastic products that can become brittle when exposed to sunlight or cold temperature, says GreenLine.

The markers contain more than 50 percent post consumer recycled engineered polymers.

Circle Reader Service number 69

C-COR to supply new build in Japan

STATE COLLEGE, Pa.–C-COR Electronics Inc. will supply equipment to Titus Communications Corp. for a 1,050-mile new build in Tokyo, Japan. The network, which will eventually link two million homes, will provide telephony services over cable. The is the first of three phases, with construction expected to begin in early 1996, and to be completed by December 1997.

C-COR will provide FlexNet trunks, bridgers and line extenders for a hybrid fiber/coax network that will service 2,000 homes per node. In addition, the company will be providing field engineering service and has received a network design contract for up to 1,000 miles of design. The amplifiers have been designed with a 55/70 split, specially for the Japanese market. A larger reverse path bandwidth allows more telephony capacity. The amplifiers, which are 90 volts capable, will initially function at 60 volts, conforming to Japanese regulations. Titus is a joint venture company that was started by US West Inc., Time Warner, Toshiba Corp. and ITOCHU Corp. to offer both cable TV and telephony over cable networks.

In other news, C-COR has been chosen as the recipient of the Region 4 Job Creator Award by the Pennsylvania Department of Labor and the Employer Advisory Council (EAC). Region 4 consists of Juniata and Mifflin Counties. C-COR was nominated for the award by Gary Gill, manager of the Lewistown Job Service Center, for the efforts made during the start-up of the manufacturing facility located in Reedsville, Pa. By creating approximately 300 jobs in the Juniata/Mifflin area, C-COR earned recognition for helping to improve that area's economy.

Jones Satellite goes digital audio

DULUTH, Ga.–Wegener Communications has received an order from Jones Satellite Networks for digital audio transmission products to convert its six in-house radio formats from analog to digital. Jones Satellite Networks (JSN) will purchase Wegener's Addressable DR96Q QPSK SCPC Digital Audio Receivers for the conversion.

The custom addressable DR96Q takes advantage of QPSK modulation to reduce the bandwidth required for digital transmission. The receivers use the ISO-MPEG Layer 2 digital audio algorithm and feature real-time diagnostics. Link analysis, data rates, acquisition history, current frequency assignments and other features are available using a terminal or PC running communications software. The JSN receivers will be controlled through Wegener's ANCS (Addressable Network Control System).

CableSoft, GI announce partnership

BURLINGTON, Mass.–CableSoft Corp. and General Instrument Corp. have entered into a non-exclusive marketing agreement to co-market the first suite of commercially-supported, integrated, turnkey software applications for interactive television.

CableSoft develops software for interactive television applications that operate on GI's advanced, analog addressable CFT 2200 set-top terminals. The company's locally-branded, locally-based, on-demand applications can enable cable operators to derive commercial revenues by implementing services such as interactive classified advertising, interactive yellow pages and LocalWorks, the company's interactive community directories. The applications will operate as virtual channels that use the vertical blanking interval in a television signal for data transport.

Cablevision building N.E. Ohio system

CLEVELAND, Ohio–Cablevision Systems Corp. and its subsidiary, Cablevision of Ohio, will invest $300 million in northeast Ohio to construct a new fiber optic telecommunications system. Cablevision has begun constructing the 750 MHz system that will provide a platform for programming choices and advanced two-way communications services.

"The initial benefits that customers will immediately recognize are more basic choices and channels for traditional video program services," said Lawrence Drake II, senior vice president and general manager for Cablevision's Midwest Region. "The new telecommunications network will initially provide 77 analog channels with future digital capacity. In the near future, those programming choices will be joined by the...new capabilities that our fiber optic telecommunications system allows, including video-on-demand, interactive services and high-speed computer connections."

Continental picks Fleetcon in Florida

AUSTIN, Texas–Continental Cablevision has awarded Arrowsmith Technologies Inc. a contract, in excess of $1.6 million, to provide Fleetcon to the MSO's Pompano Beach, Fla. operations.

Continental's Pompano Beach operation serves 165,000 subscribers and contains 1,500 miles of plant. Arrowsmith's Fleetcon system will manage a 100-technician workforce. This is the second purchase of the Fleetcon system by Continental; the first was at the Continental system in Chicago. In Chicago, Fleetcon has been installed with a real-time interface with the CableData billing system.

E/O starts shipping FDS-1

HAYWARD, Calif.–E/O Networks has begun shipping its "fiber to the farm"–Fiber Distribution System (FDS-1) product–to rural, independent telephone companies. Four telephone companies based in the Midwest have taken delivery of the product, which will reach 406 customers initially.

FDS-1 is a fiber-based telecommunications distribution system designed to benefit customers seeking first-time or improved access to telephone and advanced communications services in rural, low-density areas. With FDS-1, telephone companies can economically deliver basic telephony and enhanced voice, data and video service to customers' homes up to distances of 75 miles.

A single FDS-1 system delivers support for: 384 telephone subscribers on a single fiber ring; 750 MHz of broadcast video (up to 110 channels of AM video, 500-plus channels of digital video); all high-speed data services up to 1.5 megabits, including Ethernet and ISDN; a fiber distribution loop covering 150 miles (75 miles from the central office); and 30 Optical Network Units (ONUs).

TV Guide On Screen taps Probita

ENGLEWOOD, Colo.–TV Guide On Screen has chosen Probita Inc. to design, develop and implement a data management system for its interactive program guides. The system will incorporate a database that allows for easy integration of all types of video servers, transport carriers, delivery systems and set-top boxes used for TV Guide On Screen's program guides.

The data design for TV Guide On Screen enables the download of information from a variety of sources, including program information from satellites. The data architecture also addresses the differences among cable systems nationwide and accommodates last-minute program changes. The system allows operators to change their mix of technologies and services without disrupting the delivery of accessible, easy-to-understand program information to viewers.

California Amplifier gets IBC contract

CAMARILLO, Calif.–California Amplifier has received a $7 million order to provide the company's MultiCipher products to International Broadcasting Corp., PLC (IBC), a wireless cable system operator in Thailand. The contract represents product requirements for IBC to outfit its current installed subscriber base in Bangkok and other parts of Thailand with MultiCipher product. Currently, IBC transmits multichannel TV programming "in the clear." CED

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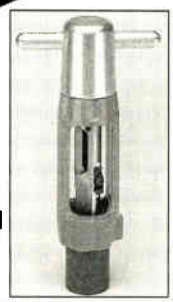

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Making the return path work

By Archer S. Taylor, Director and Senior Engineering Consultant, Malarkey-Taylor Associates

Some observers, and not just those born and reared in telephony, believe upstream cable is too burdened with noise and ingress to compete successfully for telephone or interactive services. Not many cable TV return paths have actually been activated yet. However, it is undoubtedly true that many of them do provide a "hostile environment" for upstream voice or data transmission. But this is neither intrinsic nor mysterious. Engineers and suppliers already know how to make return paths work, and are ready to roll whenever favorable regulations and business plans are in place. It would be a mistake to underestimate the technology of a two-way HFC (hybrid fiber/coax) architecture.

Favorable conditions

The factors for successfully using HFC return paths are well known:

- ✔ Small optical node serving areas
- ✔ Segregated return bandwidth
- ✔ Proper hardware and software protocols
- ✔ Skillful installation
- ✔ Maintenance and test.

Ideally, the coaxial networks would be entirely passive, limited to 150 or fewer living units per optical node, with no RF amplification. However, return paths can be successful even with RF amplifiers in the network, but at the cost of more demanding maintenance. Twenty 64-kbps digital telephone return lines can be accommodated per megahertz of useable bandwidth. Thus, the sub-split 5-30 (or 5-40) MHz upstream spectrum available at each node could be expected to accommodate several hundred living units, depending on subscriber penetration, traffic statistjes, potential demand for multiple lines, and higher upstream data rates.

Each 5-30 (or 5-40) MHz band must be separately transmitted to the headend. This may be accomplished by means of separate fibers between the node and the headend; or by block conversion to different frequency bands; or by optical wavelength division multiplexing (WDM). This is the least developed component of the upstream architecture, although suppliers have begun to offer four, or even 20, different block conversions for the upstream band, and some WDM devices are being tested, with separation as low as one nanometer.

Aggregate noise and ingress

Reducing the size of the serving area also minimizes the impact of cumulative noise and interference in the upstream transmission paths. Aggregate Gaussian (random) noise decreases the signal-to-noise ratio (SNR) by about 10 times the logarithm of the total number of return amplifiers in the serving area. For up to 1,000 or so living units passed per optical node (assuming an aggregate of fewer than 50 RF amplifiers), Gaussian noise is not likely to impair digital return transmissions, even at data rates of several hundred kilobits per second.

The overriding concern, however, is with ingress interference, generally resulting from a variety of abnormal conditions. Complete continuity along the inside surface of all components of the coaxial system is the essential condition needed to prevent ingress. If the coaxial system is securely and completely enclosed, ingress cannot occur. Solid sheath aluminum cable is impervious, providing the connectors are tight, and the sheath is not damaged. Connectors with integral internal sleeves are essential to ensure complete sheath continuity. Enclosures for active and passive equipment must be tightly closed and consistent with EMC (electromagnetic compatibility) practices. External grounding and bonding have negligible effect on ingress interference. Drop cables should have high shielding efficiency, with F-connectors designed for low leakage and competently applied. Unused tap ports should be sealed with a leak-proof terminator. Additionally, it is important that even the center conductor connections remain free of oxidation or corrosion in order to avoid internally generated intermodulation interference.

TV sets, VCRs and various unauthorized equipment connected in the home to the coaxial network tend to pick up all kinds of interference generated by devices in the home, or radiated from outside. The high/low-pass diplexer filter, incorporated in a properly designed modem, connected to the network with well-shielded cable, effectively blocks interference originating in the user's premises. However, a high pass filter should be installed in non-user service drops at the point of entry.

A continuous and systematic program for monitoring and maintenance is needed to assure the continued integrity of the return path. The FCC requirement for periodic measurement of CLI (cumulative leakage index) is a major first step. While 64 dB may be an acceptable CLI for downstream transmission, satisfactory service on the return path probably requires more restrictive criteria. Instrumentation is available for continuously monitoring the return path facilities for ingress, signal levels, bit-error rates and outages. Reliable communication, even under less than perfect conditions, can be assured for upstream (and downstream) digital voice and data transmission on HFC networks by means of error correction protocols and dynamic frequency assignment.

It should be no more difficult to provide dependable voice and data return transmissions for telephony and interactivity on HFC networks than to upgrade a comparable, end-of-the-war, analog telephone network of copper subscriber loops for modern digital services. The business motivation and the technological know-how already exist. The hard part will be revamping the existing multi-layer regulatory framework, embedded in decades of monopoly control and political habit, so as to remove the obstacles to competitive service. CED

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