Communications Technology

OFFICIAL TRADE JOURNAL OF THE
SOCIETY OF CABLE TELECOMMUNICATIONS ENGINEERS
JANUARY 1998

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FEATURES

Western Show Wrap • 40

Data, data everywhere—Senior Editor Laura K. Hamilton and Executive Editor Alex Zavistovich bring the high-speed buzz home from the Western Show: Data delivery.

Bandwidth Per Home • 46

How can scalable nodes protect your network's future? Find out the answers in this article from Eric Schweitzer of Harmonic Lightwaves.

Interactive Bandwidth • 56

Horacio Facca and Gary Chandler with Philips Broadband Networks examine methods of forward path narrowcasting and reverse-path segmentation and apply these to helping you lower entry costs in deploying interactive services such as data and telephony.

Data on HFC • 64

Join Telecommunications' Bruce McLeod as he develops the case for increased speed with symmetrical data delivery on hybrid fiber/coax (HFC).

Standards Review • 72

The Society of Cable Telecommunications Engineers' Director of Standards Ted Woo, Ph.D., outlines the SCTE standard Data-Over-Cable RF Interface specifications. The standard introduces an all-coax HFC two-way transmission network with the principal function of Internet protocol (IP) transmitted between the headend and the subscriber location.

Software Standards • 76

Be certain that the network and element management software you purchase for your system really is "SNMP (simple network management protocol) compliant." *But how can you be sure?* Take these questions and tips presented by Bob Feather of Superior Electronics Group and grill your software vendor!

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Scientific-Atlanta's Lamar West, Ph.D., tackles conventional wisdom in design techniques in this article on better ways to determine return path clipping.

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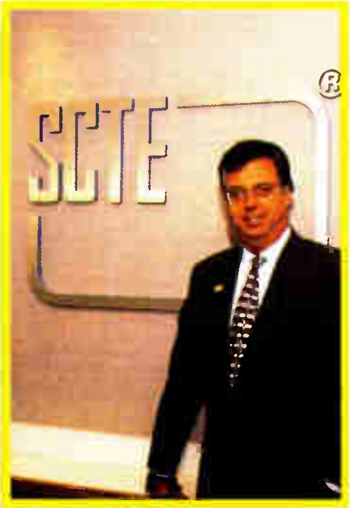

"The real reason I took the SCTE job was that I saw a need for the organization and felt that I could make a difference."

Bill Riker,
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NEWS & OPINION

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By Rex Porter

How to Have A Happier New Year

Welcome to the New Year, 1998. Lots of people are working hard to make this the best year ever for cable engineers.

CableLabs continues to offer new answers to data questions about compatibility with its OpenCable solutions. They've not only been concerned with keeping us free of hardware, or software, which might end up controlling our future; they have provided for Multimedia Cable Network System (MCNS) compliance that will ensure cable modems and headend gear that complies with industry standards.

The Society of Cable Telecommunications Engineers continues its far-reaching efforts toward training, certification and standards. The Broadband Communications Technician/Engineer (BCT/E) subcommittees are truly important to you as we move into such complex fields as high-speed data, Internet Protocol (IP) telephony and digital TV. We will truly appreciate the efforts of the Standards Group, under the direction of Dr. Ted Woo, in future years when cable TV becomes a power in data service.

So, with so many other people working on your behalf, what should every technician and engineer be doing to make 1998 a happier year?

1) JOIN the SCTE.
2) ATTEND SCTE's Conference on Emerging Technologies in San Antonio, TX.
3) VOLUNTEER for the board of directors of a local chapter. I have been a board member, the president and chairman of the board of chapters during my career. This involvement can help your career.
4) VOLUNTEER to speak on some technical subject at a chapter meeting. If you are going to survive in this competitive world, you are going to have to brave the nervousness and speak. And, after all, the members of that group are your fellow technicians and engineers.
5) ORDER a tape or manual from the SCTE. Pick a subject about which you feel least sure and, when you are finished, pass it along.
6) ATTEND the SCTE Cable-Tec Expo during June in the beautiful city of Denver.
7) SUBSCRIBE to the SCTE-List. This is a place on the Internet where you can ask technical questions and get answers from engineers and technicians worldwide. Manufacturers lurk on this list and they also will give you expert guidance about how their equipment should be installed, tested and maintained.
8) ARRANGE a meeting with your system manager. Discuss the importance of your SCTE chapter meeting and ask how more personnel from your system can attend. Then come back to the chapter board members with input from that meeting.
9) HELP ensure that Cable Games become part of your state or regional cable show schedule.
10) VOTE in our upcoming National SCTE elections. We have some of cable's elite serving on our board each year. Their voluntary efforts are to be applauded. The way we applaud is to VOTE. Each of them would like to know the majority of the members cast a vote to put them there instead of wondering if they won because few members cared enough to VOTE.

So there you have it: Ten ways to have a happier new year. And I didn't even get into your job description!

Rex Porter,
Editor

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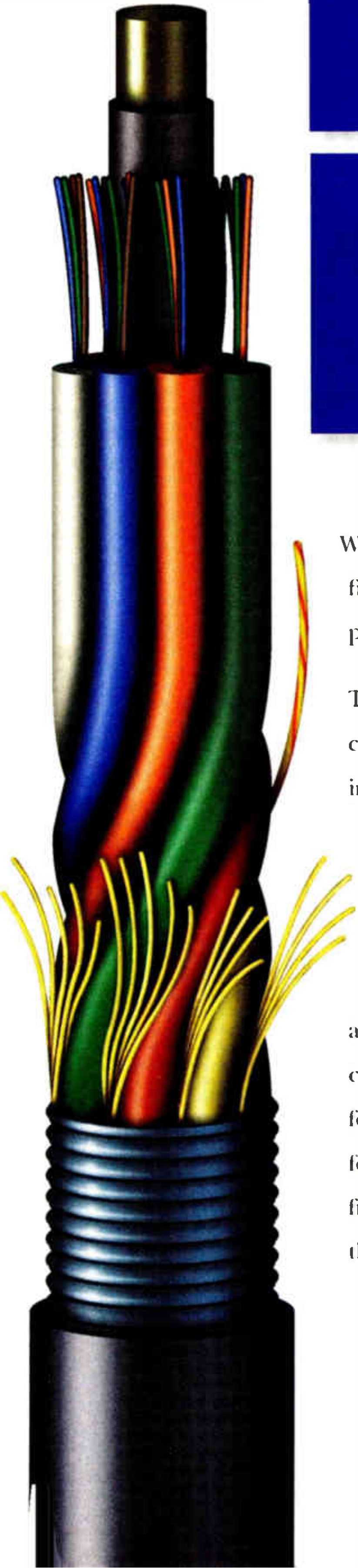

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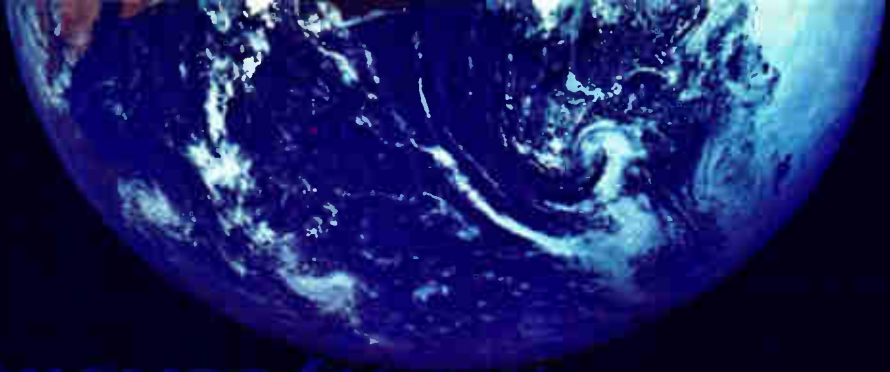

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Reader Service Number 205

Time and a Half

Kenneth Ross, a state engineer for a local cable company in North Carolina, commissioned a local artist to paint "Time and a Half," shown here at right. His intentions were to present the "climbers" in the cable TV, electric, and phone industries with a gift to pay tribute to the person who climbs for a living—the linemen. If you wish to order prints of "Time and a Half," contact Kenneth Ross, 2122 Regatta Ln., Denver, NC 28037; (704) 483-3990 or via e-mail at krosstvman@aol.com.

NextLevel Lands $4.5 Billion Set-Top Deal, Other Financial Changes Announced

NextLevel Systems has entered into long-term understandings to supply at least 15 million advanced digital set-top devices to nine leading MSOs under the industry's OpenCable specifications. According to the company, the agreements are worth at least $4.5 billion over the next three to five years. The MSOs were not named at press time.

In other news, NextLevel is changing its name back to General Instrument Corp. (GI). As part of the understandings established by GI, the MSOs will receive warrants to purchase some 16% of GI equity at a approximately $15.00 per share. These warrants will vest only as set-top orders are actually shipped, in the years 1998-2000.

In exchange for some 10% of GI equity, TCI will provide the digital transport and authorization functions of TCI's Headend in the Sky (HITS), as a platform for digital deployment. GI plans to establish strategic partnerships with consumer electronics companies, "to pursue future digital technology development and retail distribution."

In related news, GI has announced other elements of its plan to get back on sound financial footing. Edward Breen, formerly president and acting CEO, has formally been named chairman and CEO of the new General Instrument Corporation. The company will be cutting costs at its cable/satellite TV operations, including job reductions at its San Diego and Puerto Rico satellite TV facilities and consolidation of its Chicago corporate headquarters into its Horsham, PA cable TV facility. The facility will become the headquarters for GI Corporation. According to the company, these measures will result in annual earnings improvement of five to seven cents per share for the new GI, beginning in 1998.

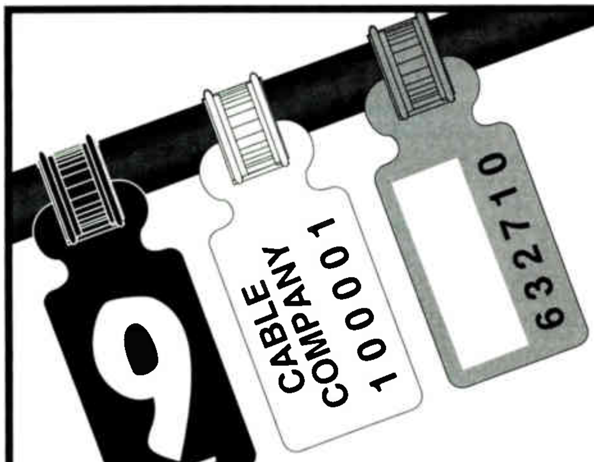
"We have accomplished a great deal in the past 60 days to increase shareholder value and put our business on a growth track for the future," said Breen.

Clarification

Rather than Jeff Walker, Thomas Margarita, senior trainer, IP technology Motorola ISG, should have been listed as the co-author of the IP Multicast article that ran on page 54 of the November 1997 issue. Margarita works out of Motorola's Mansfield, MA, offices, and may be reached at (508) 261-4000.

NEWS BITES

- Belden Wire & Cable Co. has formed the North American Fiber Optics Product Group to develop, manufacture and market an expanded line of tight buffer and loose tube fiber optic cables.
- NextLevel Systems and RELTEC have signed an agreement of understanding to jointly market and execute turnkey solutions for voice/video/data networks.
- Microsoft Corp. has appointed John Canning as its cable industry marketing manager.



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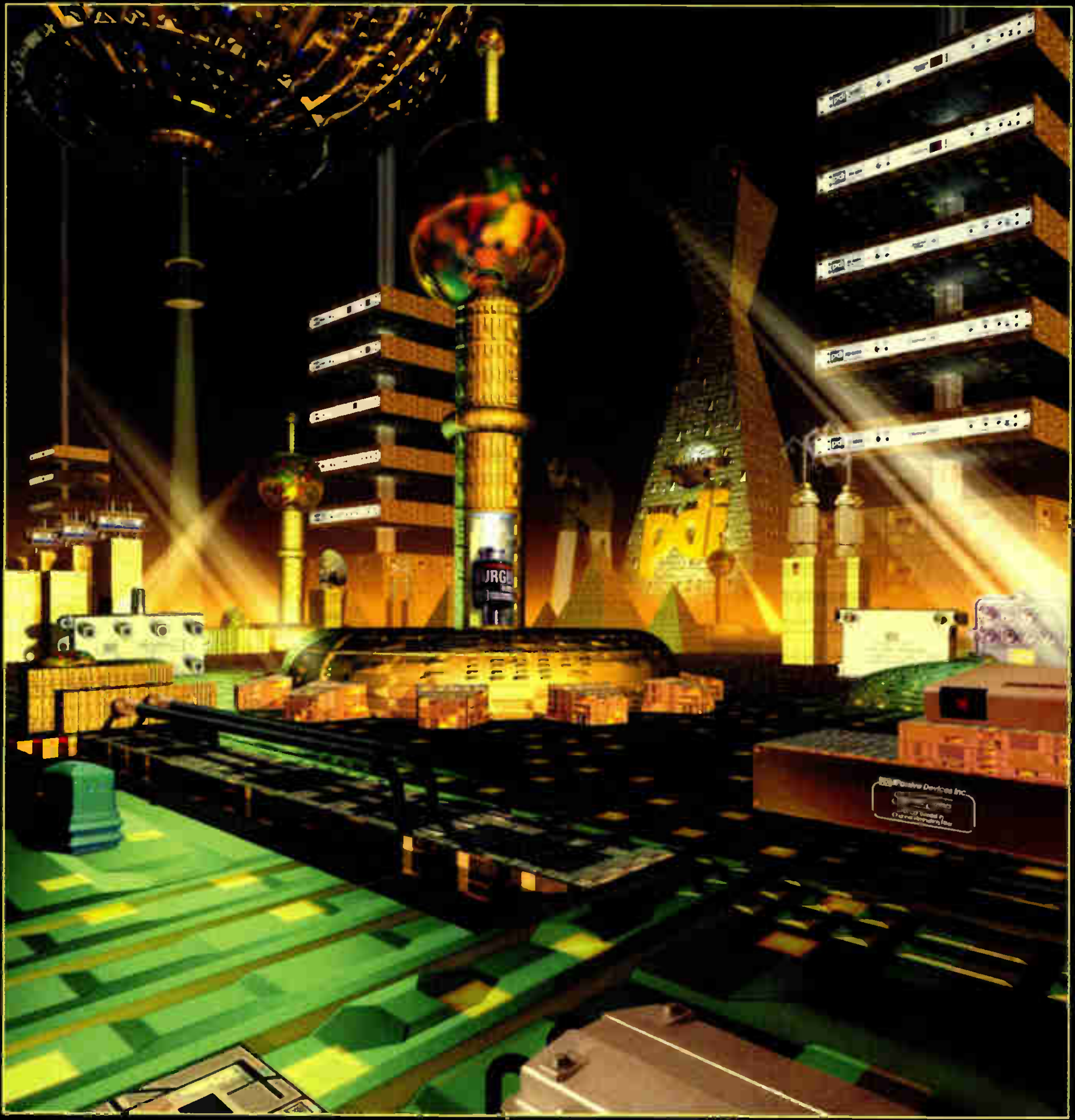

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INNOVATIVE

Figure 1: A node with analog video and a Mbit/sec. data service.

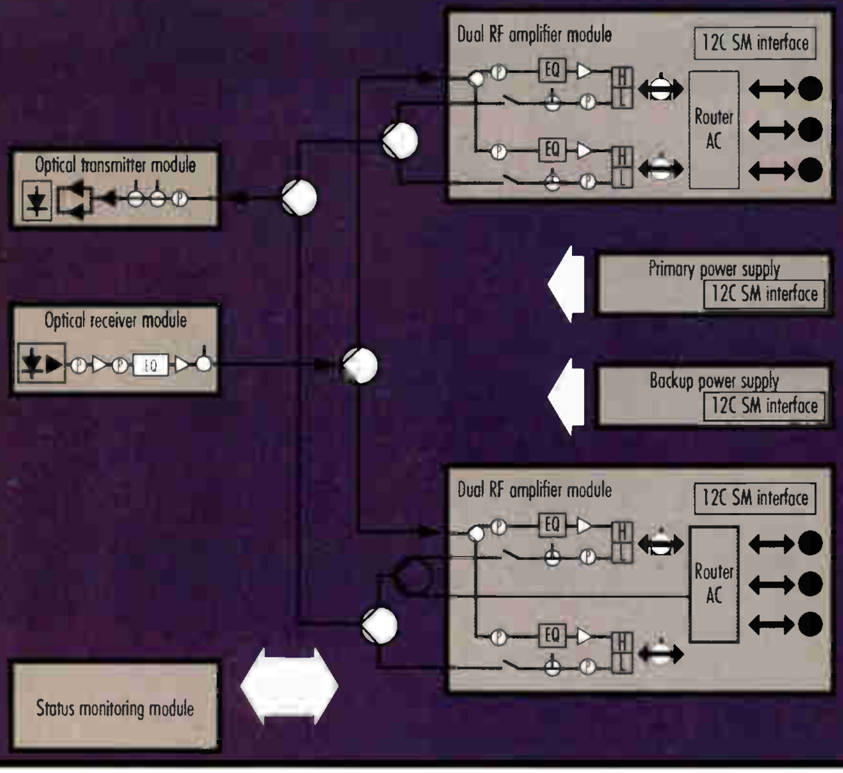
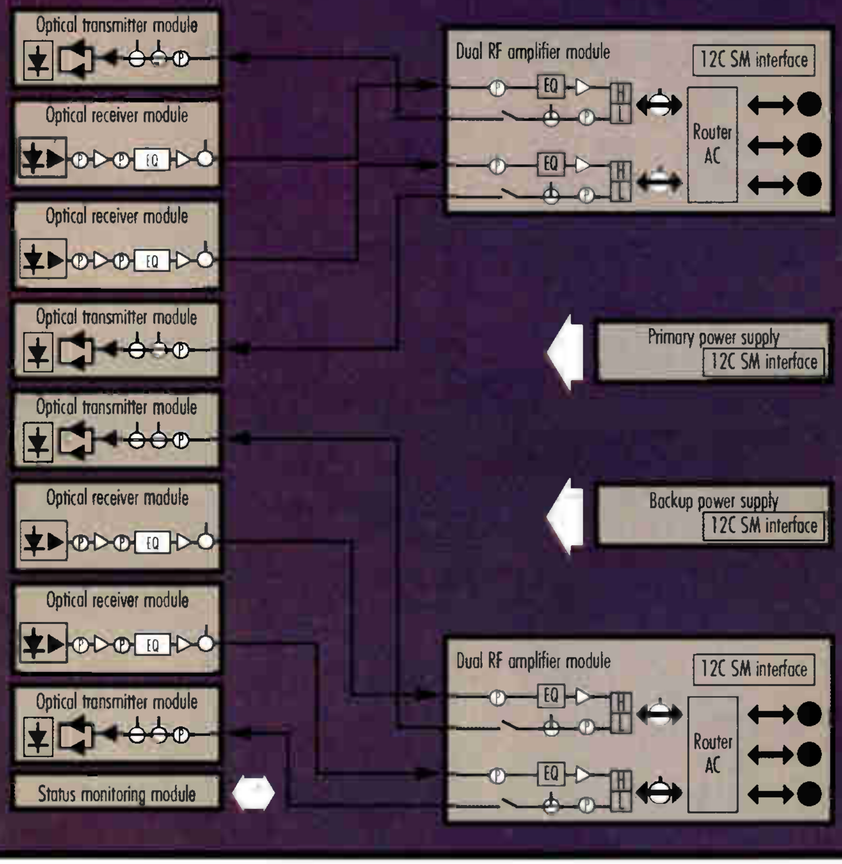


Figure 2: A node with analog video and 4 Mbit/sec. data service.



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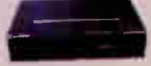

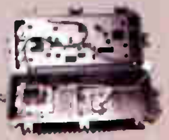


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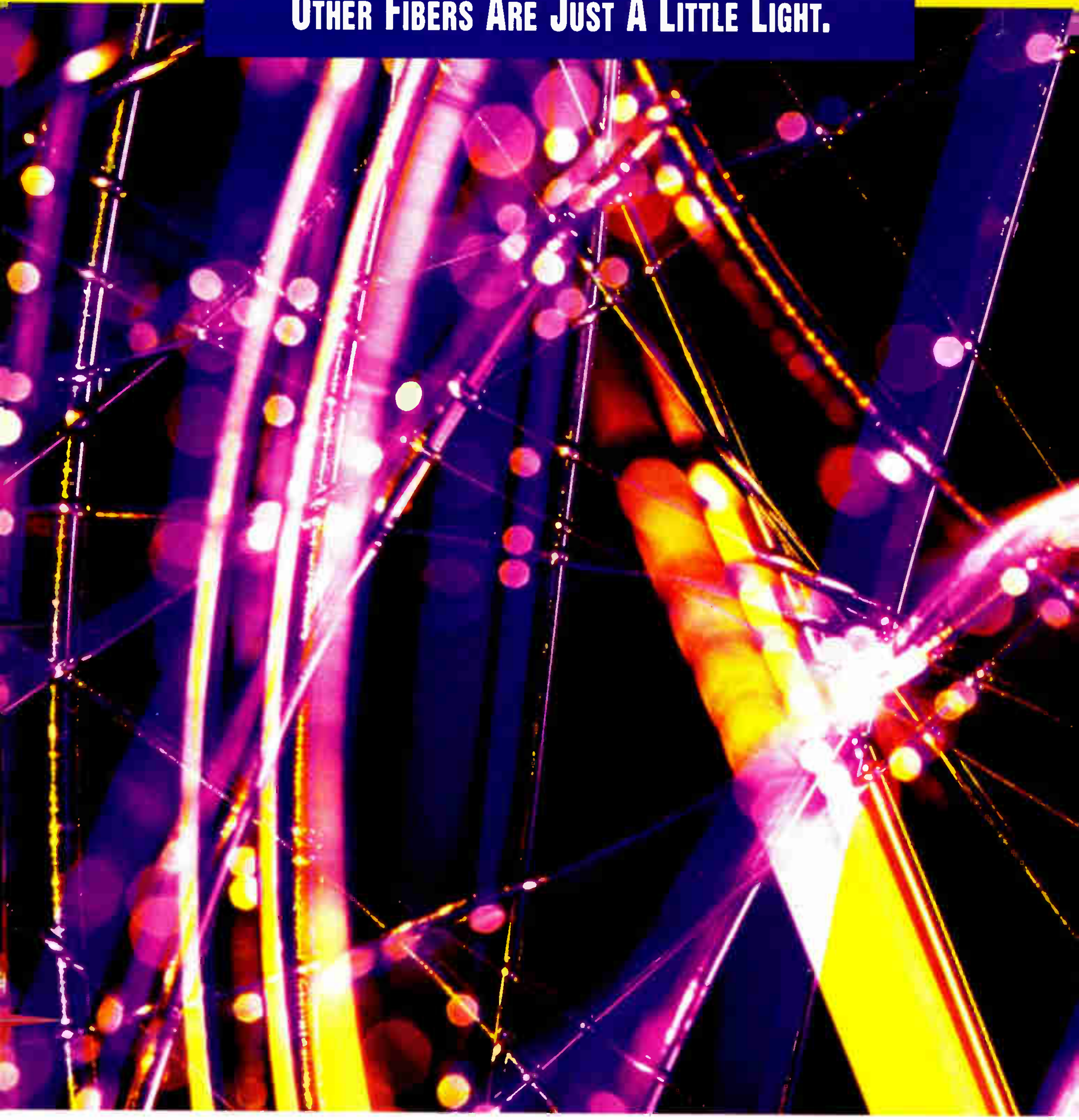
segmentation to 500 to 1,200 homes passed-per-node will be insufficient.

One method of dealing with this upgrade problem is to use a node that is scaleable, meaning that new modules t support new services can be added to t node as needed in a very cost-effective manner. At installation there are 500 to 1,200 homes passed-per-node. In the fu ture, optical receivers and/or return tran mitters can be added to the node that w increase the available bandwidth per home. The node can be configured for these optics to access some portion of th RF system connected to the node. This an efficient way to subdivide the node without doing a major rebuild.

Figure 1 shows a node in a configuration that is adequate for today's service assuming 500 to 1,200 homes passed-p node. A single fiber for each of the forward and return paths is used to bring video downstream and 1 Mbit/sec per home in both downstream and upstrea to all 500 homes connected to the nod Figure 2 shows how this node could be scaled to offer four times the data rate home by adding optical modules. This lows four times the bandwidth per hom 4 Mbit/sec per home, to be obtained w out rebuilding the optical or RF plant. This scaleable architecture provides the bandwidth-per-home needed to suppor modest point-to-point services today in cost-effective manner. The architecture can easily be scaled to provide more ba width per home when it is needed.

In order to support the current requi ments of their customers, cable operato must modify their networks to support point-to-point data communications today. While the majority of current us will only require high bandwidth-per-home to support high data rates in the downstream direction, it is clear that th is an artifact of the available connectio Once reasonably priced symmetrical hi speed transmission is available, there v be immediate applications. Those serv providers who are prepared to react qu ly and support these customers will be ones to profit from these changes. CT

Eric Schweitzer, Ph.D., is product mana receiver systems for Harmonic Lightwa He may be reached at eric.schweitzer@h monic-lightwaves.com or (408) 542-2780.



price of fast processors and large disk drives is becoming low enough that a dedicated hobbyist can afford a computer capable of being an Internet server. Internet server software also is becoming easier to set up and use. Once reasonably priced, high-speed connections to the Internet are available, it is clear that more and more individuals will have everything they need to set up a personal Internet server.

All that is missing is a need—the "killer application" for a personal Internet server. At this stage it is impossible to tell what the killer application will be. One possibility is an Internet server introduced by Hotline Software that supports news, chat, file transfer and messaging—all activities that will grow in demand as users become more sophisticated. (More details about the Hotline server and clients can be found at http://www.hotlinesw.com/)

Another potentially hot Internet application is the bidirectional transmission of real-time video—"videoconferencing"—which has the potential for making the long-promised video phone a reality. While videoconferencing software does exist today, its use has been limited because of the limited speed of most Internet connections. Inexpensive, high-speed Internet connections would certainly make the use of this technology more common. How many grandparents would jump at the opportunity to see their grandchildren every week rather than just speak to them on the phone?

Typical user bandwidth requirements

Given that symmetrical, bidirectional bandwidth is required for these high-speed applications, the next questions is, how much will a typical user need in the future? To answer this question we can draw on current experience.

A modestly popular Internet server today will need to supply around 10 Gbytes/day. This works out to an average of just about 1 Mbit/sec. This can be supported very nicely by a T-1 connection to the Internet at 1.55 Mbits/sec. Video transmission at 1 Mbit/sec also is quite good using existing compression technology. So, giving each user 1 Mbit/sec of data bandwidth seems like a reasonable starting point.

One 6 MHz channel can easily support Ethernet speeds of 10 Mbit/sec. If a channel is dedicated to data transmission on each of the forward and return paths, all subscribers accessing that channel will share a 10 Mbit/sec connection. If a system needs to support 1 Mbit/sec/subscriber, then this channel should be shared by only 10 subscribers.

It is unlikely that all subscribers will be needing data access simultaneously. In order to determine how many users can share a single 10 Mbit/sec channel, some assumptions about usage must be made. If we want to design the network to support 30% of the users simultaneously, then this data channel could support 30 subscribers.

Web browsing requires access to high-speed data transmission, but makes use of that bandwidth relatively infrequently. To support Web browsing, sharing a 10 Mbit/sec channel with 50 to 100 subscribers would allow users 1 Mbit/sec most of the time it is needed. Most cable systems can support four to six 6 MHz return channels and at least that many forward channels. Therefore, the return band can support 200 to 600 subscribers.

The upgrade problem

A broadcast network in which all subscribers have access to the same information is clearly unacceptable. Subdividing the network will be necessary to support directed data transmission. One obvious way of dividing a hybrid fiber/coax (HFC) network is to have different information sent to each optical node. If this is done, then each node can support 200 to 600 subscribers. Assuming a 30% takeup rate, each node can support 600 to 1,800 homes passed.

Five hundred to 1,200 homes passed-per-node is a typical build today. This level of segmentation actually matches quite well with the scenario of having 1 Mbit/sec available to subscribers for Web browsing. However, the personal servers and video transmission will place much higher demands on system bandwidth. Internet servers will be operating all day, and clients can and do access the servers at any time.

Once personal Internet servers and video transmission become popular, having 50 to 100 subscribers share a 10 Mbit/sec channel will not be sufficient. Therefore,

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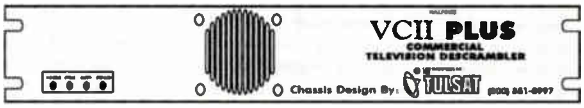

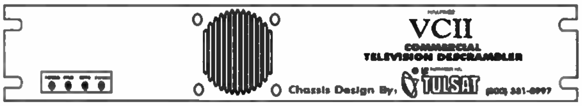

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Bandwidth Per Home

Scalable Nodes Protect Your Network's Future

By Eric Schweitzer

By definition, a broadcast system delivers the same information to everyone on the system. Therefore, the information transmission capacity is limited by the frequency bandwidth.

For example, 500 MHz is required to transmit 80 NTSC-M channels. In contrast, a network that supports point-to-point communications must allocate dedicated bandwidth to each point. The information transmission capacity of a point-to-point communications network is, therefore, defined by the bandwidth available per point.

Cable TV networks were designed as broadcast systems with a high bandwidth. This bandwidth makes cable systems attractive for the transport of nonbroadcast services. Many cable systems are currently being modified to support Internet access. This is a form of point-to-point data communications.

In the near future, this trend will certainly accelerate. Indeed, all currently envisioned advanced services—Internet access, telephony, video-on-demand (VOD)—require point-to-point transmission of data.

The upgrade of evolving cable TV networks from broadcast systems to point-to-point data communications systems will be time-consuming and expensive. It is in the cable operators' best interest to ensure that this changeover is done in a manner that can support services for several decades. The alternative is to miss out on future opportunities or to incur the cost of sequential upgrades.

Data's demands

Most upgrades today are done to support Internet access. The Internet is simply a worldwide computer network that allows computer clients to access servers. As the names imply, the servers provide some service that the client wants. This is illustrated by browsing the World Wide Web. A user (client) runs Web browser software on a computer that is connected to the Internet. The client decides that there is some information he wants on a server somewhere on the Internet. The Web browser sends a command to the Web server requesting that information. Special software running on the server interprets the commands and sends the information requested to the clients. The Web browser then displays the information for the users.

In this scenario, the client sends simple commands to the servers and the server responds by providing larger amounts of data. Therefore, the servers require much more bandwidth (and greater processing speed as well as larger storage capacity) than do the clients. Servers also require symmetrical bandwidth—a high capacity for both receiving and transmitting data. Clients generally require only a high capacity for receiving data.

Because of these demands, most servers today are based within large organizations, such as corporations or universities, which can afford a high-bandwidth Internet connection, fast computers and large disk drives. These organizations also have highly trained computer professionals to set up and maintain the Internet servers.

The scenario is quickly changing. The

BOTTOM LINE

Bandwidth for the Masses

Most people recognize the exciting potential of the Internet—instant access to virtually any information—but they also have experienced the frustration of endless waiting for information to download to their computer.

Cable operators hold the solution to this problem—high bandwidth networks. The problem is how to keep up with the ever-increasing bandwidth demands to support today's advanced services, not to mention those that haven't even been conceived of yet.

You could upgrade your system today and just hope that your implementation will be sufficient to service your customers in the future. However, with this short-sighted attitude. Your competitors are going to leave you in the dust.

One way to ensure that your evolving network will not only meet the needs of today, but also will deliver the services your customers will demand in the future, is to upgrade your network using scaleable nodes. This cost-effective solution will allow you to purchase and install today only the modules that you need to meet your current network demands, and upgrade tomorrow when you discover what the next high-bandwidth application will be. This positioning will allow you to keep up with your customers and ahead of your competition. Don't get left behind!

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is us.” According to Kuhns, most two-way systems don’t work properly because “we don’t do the basics.” Kuhns showed several examples of problems he has seen in the field. One unusual problem he has seen several times is excessive hum in the return path being caused by ingress. “Go figure,” said Kuhns. “We usually assume hum to be related to a faulty power supply module or low AC voltage. But nearly every time we’ve seen this, we look for a leak, fix it, and the return path hum goes away.”

The panel’s final presentation was from Horacio Facca and Gary Chandler of Philips Broadband Networks. They highlighted a novel way to increase return path bandwidth by using two return lasers at the node rather than one. Assuming the traditional four coaxial feeders at a node being combined into a single return laser, return bandwidth can be increased by installing a second laser in the node. One method segments the node’s return symmetrically using a “2 x 2 narrowcast” approach, with two coaxial feeders per laser. A second alternative is to use a configurable switching technique so that the two return lasers may be fed asymmetrically, say, one feeder for one laser, and three feeders for the second laser.

Cable telephony

This year, the business of telephony over cable has been quietly gaining momentum in preparation for several commercial U.S. offerings in 1998. In the show’s panel session “Cable Telephony Today: Are the Phones Ringing?”, Justin Junkus, president of KnowledgeLink, hosted an update and discussion by two leading cable telephony vendors and an MSO that is now actively in the telephony business.

Vendors have been using 1997 as a time to prepare for commercial cable telephony service in this country. While they have been conducting telephony trials in selective regions of the United States, they also have brought HFC technology into commercial service in the Pacific Basin and Australia.

What has surfaced from both types of introduction is that it takes a combination of technology and business planning to succeed.

“There is no shortage of experience with field implementations of cable telephony. During the planning of this panel, a number of vendors and operators volunteered to present their experiences.” said Junkus.

Arris Interactive’s President and CEO Robert Stanzione presented his viewpoint on why telephony makes sense as a business opportunity for cable operators. Stanzione’s firm can point to several successful commercial implementations of its HFC product in the international arena. He showed how the proper combination of services and cost structure that makes telephony a profitable business in other countries can do the same thing for domestic operators.

Ericsson’s Vice President of Broadband Systems Staffan Nilsson discussed the application of asynchronous transfer mode (ATM) technology in cable telephony, and the ways it makes multiple services possible.

Alex Best, senior vice president of Cox Communications, discussed an operator’s view of what is necessary to be successful in telephony. In addition to applying the technology that is offered by vendors, operators need to solve the challenges of interconnection with several carriers, and network maintenance. Best’s perspective comes from experience. His firm has already addressed these challenges in its Orange County, CA, telephony service offerings.

This panel was an opportunity to not only hear about the telephony business, but to also questions first hand those who are making it happen.

New products

For copies of the *CT/IC Daily* published at the show, contact cwalker@phillips.com or scarp@phillips.com.

These dailies were one of the best places to read about all the new products unveiled. Also watch “Marketplace” in this magazine for Western Show product releases. CT

Ron Hranac of Coaxial International and Jay Junkus of KnowledgeLink contributed to this wrap-up. Philips’ Business Information’s Group Editorial Director Dave Jensen took the photographs.

Laura Hamilton is senior editor and Alex Zavistovich is executive editor at “Communications Technology.”

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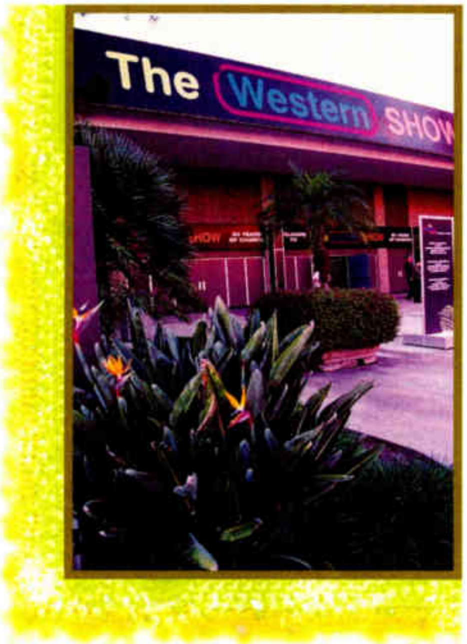

(Top left) A moment's peace graces Anaheim; (Right) CableNet hosted the brightest stars in technology; (Bottom) Yvette Gordon accepts the Women in Technology award. From left, Society of Cable Telecommunications Engineers' Bill Riker, Corning's Margot Botelho, Gordon, Jones' Pam Nobles, and Paul Levine of "Communications Technology" magazine.

consumer market in which they will all be able to compete.

Bob Gordon of Cisco Systems noted that this agreement proves that "leading vendors have a conscience. We're trying to avoid differing camps." Cisco has agreements with a number of vendors, including NextLevel, Hayes, Samsung and Terayon, among others.

CableLabs is "pleased to see these vendors come together toward the shared objective of interoperable systems," said the Lab's Bob Cruikshank. He noted the cooperation "bodes well for the growth of the industry."

Pressed about the next challenge for cable, interoperable digital set-tops, spokespersons for the companies acknowledged that lessons learned in achieving interoperability in this undertaking will be applied to the OpenCable initiative.

Success, in reverse

Panel moderator Ron Hranac of Coaxial International opened the Society of Cable Telecommunications Engineers-sponsored technical session "Two-Way Plant: Traveling Down the Road to Success, in Reverse" with an overview of a checklist for those getting started in two-way operations. Hranac commented, "This checklist includes common sense things that have to be done before you deploy two-way services. If you don't do the things on this list before you fire up the return, you'll most certainly do them afterwards."

The panel's first speaker, NextLevel Systems' Dean Stoneback, spoke on the subject of return path level selection and setup. Stoneback began with a comparison of forward and return path alignment procedures. He described how to determine node gain, a requirement of proper two-way operation. Stoneback then reviewed the use of constant power per hertz as one method of establishing return levels, and emphasized the importance of unity gain in both the forward and return paths.

Scientific-Atlanta's Kevin Murphy discussed two-way design considerations and return path alignment, detailing procedures for the fiber link, headend, coaxial plant, taps and drops. One key parameter, according to Murphy, is the need to fix levels at the return amplifier input port and use that as the unity gain reference point. "The goal," noted Murphy, "is to align the network so the target level at the receiver gives the proper level at other critical points." He added that it is important to design for minimum transmitter level variation.

Jim Kuhns, regional engineer for Comcast, brought an operator's perspective to the panel. He opened with Pogo's famous comment, "We have met the enemy and he

Show '97

Vendors Rally Around MCNS

By Laura K. Hamilton and Alex Zavistovich

The Western Show's technical spotlight was shining so steadily on one particular topic that it's almost unnecessary to point it out. As a matter of fact, even if you weren't there last month, you'd have a darn good shot at guessing that most of the buzz revolved around, well, you guessed it: high-speed delivery of data, and more data, and then, of course, a lot more data.

However, just because delivering data over hybrid fiber/coax (HFC) networks is the main thing pressing in the cable technical arena, that doesn't mean digital video, cable telephony (including Internet protocol telephony) and video-on-demand aren't out there too. It just seems that the promises of data are forefronting or driving these other technologies. Of course, you already knew that, and the Western Show simply reiterated it.

Exhibit hall conversations, press conferences and technical sessions made definitive rumblings that the technical community is on a serious mission to make data happen: Let's get behind some standards, continue to upgrade our systems to two-way, and conscientiously clean up the return. And let's do it now while the cable industry's competitive edge is sharp.

MCNS

You couldn't swing a piece of coax on the show floor without hitting someone who was talking about Multimedia Cable Network System compliance. And one of the bigger announcements at the Western revolved around that topic.

The future of cable modem deployment hinges on retail sales, and according to leading vendors of data over cable products, that means interoperability and compliance with the MCNS specs.

At the Western Show, seven companies announced they were joining forces to ensure that their products, at least, will be able to shake hands. CableLabs, which is working on promoting data interoperability, was enthusiastic about the agreement.

The participating vendors included 3Com Corp., Bay Networks, Cisco Systems, Harmonic Lightwaves, NEC America, Phasecom and Toshiba.

The announcement was an extension of the interoperability agreement made in November between Bay and 3Com. The two companies have drafted requirements to enable testing of cable modem and headend products during development. Technical staff from all seven companies will meet this month to establish the initial product testing schedule.

At the conference, Phasecom's Ron Victor noted, "MSOs don't want to buy cable modems; they want the end users to buy them. That can't happen without interoperability. We want to solve this fast."

Levent Gun of 3Com said the agreement enables the companies to create a

BOTTOM LINE

Wrapping up the Western Show

Did you miss last month's big confab? Or, did you go to Anaheim, CA, and were slightly overwhelmed by the amount of technological information there was to be had?

You might want to check out the California Cable Television Association's CD-ROM, or get a hold of copies of the *CT/IC Daily*, which was published each day of the show and covered new products as well as technical session overviews.

The CD-ROM offers verbatim session transcripts and case studies; audio and video highlights; exhibitor and product listings; speaker slides, biographies and contact information; easy-to-use interface, instant keyword search, Web links; transcripts formatted for screen and print; and highlights from the CableNET showcase. It supports both Windows and Macintosh computers.

Call (800) 301-2341 or outside the United States, call (818) 879-1131; Fax (818) 879-0533; or go to the CCTA's Web site (http://www.cct-assn.org/index.html).

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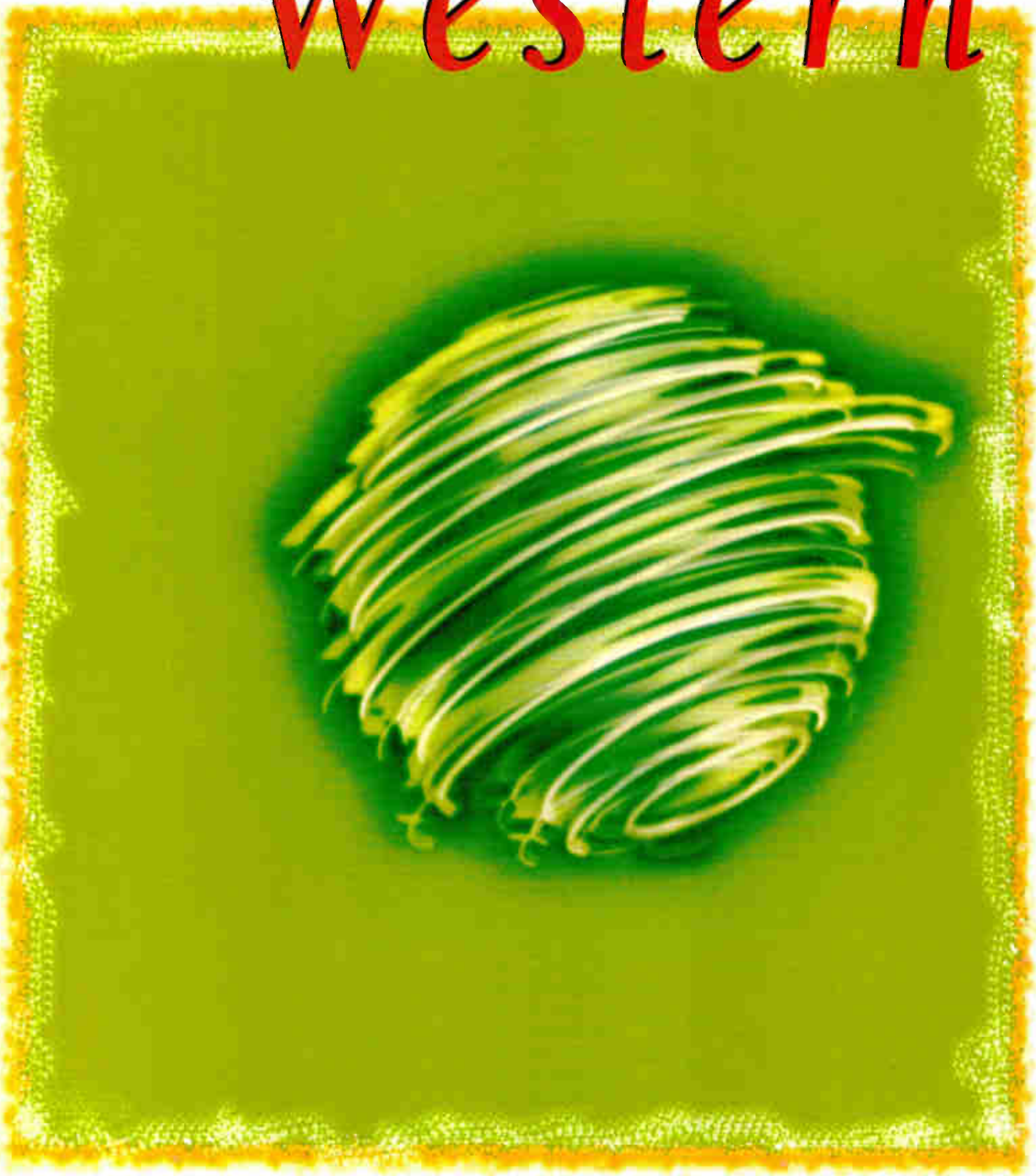

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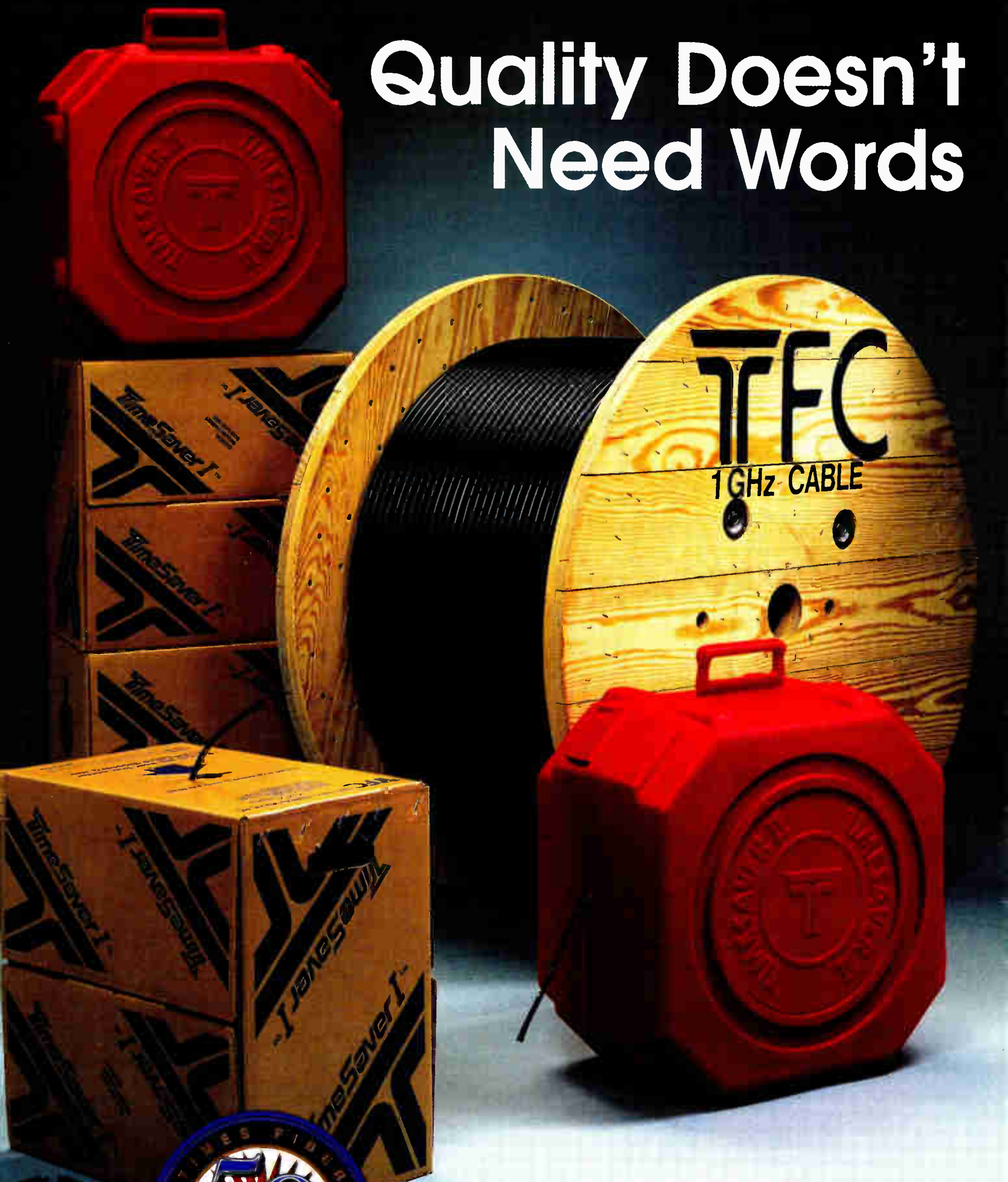

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Reader Service Number 240

By Laura K. Hamilton

Nix the N on NVOD

How One System Did it

For discussion's sake, let's define "true" video-on-demand (VOD). And that's VOD capitalized. Not pay-per-view (PPV). Not near-VOD (NVOD). And not pretty-darn-near-close-VOD.

Let's agree that VOD is an interactive service that offers subs hundreds of movies or other programming choices at any time they choose, and at just the touch of the remote control. It also requires VCR-type functionality, like the ability to fast-forward, pause and rewind.

That's always been a hefty order from an engineering standpoint, especially since the bandwidth requirements seem daunting. But let's say you're an engineer who has been upgrading your network to two-way hybrid fiber/coax (HFC). Your system's 750 MHz and designed to serve 500 homes (or less) per node. You can spare at least two 6 MHz channels.

One system outside of Philadelphia, Suburban Cable, used that as the basis for commercially launching VOD. Last month it offered the service off selected nodes in its service area to around 2,000 homes passed (with some big help from a digital VOD service provider).

This wasn't an overnight undertaking. According to Christopher Patterson, vice president of engineering for Suburban, the technical deployment of VOD started over a year ago. Add to that the fact that Suburban has been upgrading to HFC since 1992, and you can begin to fathom the amount of engineering that went into this.

But as Patterson says, Suburban looked at it from the standpoint that it would be launching several new multimedia-style services that all use reverse plant.

"We had to make the effort up front to balance the network properly and to keep the reverse path clean," says Patterson. The VOD system, like the high-speed data system Suburban also is working on, not only requires two-way plant capability, it requires *clean* two-way capability.

How it works

Key to this particular technology is a proprietary, scalable video server developed by the Sarnoff Corp. It is a massively parallel processing system designed exclusively for streaming video and capable of delivering thousands of movies to different customers simultaneously, even though only one copy of a title is loaded on the server.

The company that offers this service, DIVA (of Menlo Park, CA), says its "true VOD service is more bandwidth-efficient than PPV or NVOD." How? The digital video multiplexing ratio of 8-to-1 obviously is fundamental here. Also key is the parallel processing and video streaming in the server, which is located at the cable system's headend. These capabilities enable significant reduction in memory and processing requirements in the set-top.

A video session manager combines Moving Pictures Experts Group (MPEG) digital streams and distributes them using 64-QAM (quadrature amplitude modulation). This output is delivered to the cable op where it is combined with conventional analog channels for distribution. It also processes programming requests from the customer and controls server content output.

The sub's set-top processes both digital video services and conventional analog.

Headend requirements

According to Patterson, Suburban did the following to implement the VOD system into its headend:

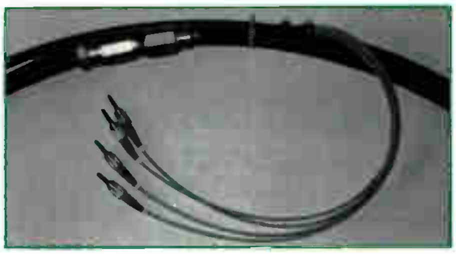
- Redesign the downstream and upstream (reverse) combining networks to support the requirement to narrowcast the two-way path to smaller segmented HFC node groupings. "Once designed we had to rebuild the combining network and match levels into our optical feeds for carriage of the QAM signals," says Patterson.
- Space was allocated in the headend for the server and video session manger (VSM) racks (about 144 square feet). Also, an additional uninterruptible power supply (UPS) was added to handle the critical up time needed for the server and VSM equipment.
- In order to provision service to the VOD customer, Suburban needed to add the optical node information within the billing system so it would know what HFC node segment the set-top sits in. "This is so we can provision the upstream channel between four designated frequencies to avoid problems with reverse signal collisions," reports Patterson.

Return plant

What did Suburban do to ensure a reliable return path? "Along with working the reverse in newly upgraded plant, we inspected the service drop to the house to make sure it met our standards," says Patterson. "Once in the home, from the ground block to all the TV sets in the home (and primarily to the sets where the VOD service was to be deployed), a service call was necessary to condition the drop."

Every non-VOD customer has a high-pass filter out at the tap. Also, high-pass filters are used within VOD homes to segment TV sets that a customer may have installed and which Suburban had chosen not to condition. (For example, drops might have been prewired before the house was built with improper wiring or sealed behind walls.)

Laura K. Hamilton is senior editor at "Communications Technology" in Denver. She may be reached via e-mail at lhamilton@phillips.com.



Fiber Optic CATV Drop Cables

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Reader Service Number 157

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Reader Service Number 159

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Reader Service Number 63

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Reader Service Number 136

within the number portability network architecture. This architecture is part of the common channel signaling (CCS) infrastructure that has been routing calls based on dialed digits for more than a quarter century. CCS already contained processors (signal transfer points) and databases (service control points) that tracked network status. Number portability adds to the tasks of these network elements, and introduces new network elements specific to number portability.

The ultimate copy of the database of ported numbers resides in one of these new network elements, called the number portability administration center, or NPAC. The NPAC database receives information from both the incumbent and the new service provider, including the LRN. It validates the information and downloads routing directions to the SCP/STP when it receives an activate message indicating an end user is physically connected to a new service provider's network.

The SCP correlates the called party's ported number with the carrier LRN, which identifies the carrier switch to which the call should be routed. Another new network element called the local service management system, or LSMS, manages the downloading of ported number information from the NPAC to the appropriate SCP.

All this information concerning ported numbers comes to the NPAC from service provider service order administration (SOA) hardware and software. The SOA interfaces with service provider order and provisioning systems. It receives orders from these systems, formats the data for NPAC input, and submits the data to the NPAC.

Fully automated SOAs are obviously complex, custom-designed systems that may be beyond the immediate resources of small service providers. To solve this problem, there are "low-tech" dial-up or Wide Area Network (WAN) alternatives to the SOA, which provide similar functionality.

Obviously, all this new functionality and interworking requires extensive testing to ensure that everything works together as it should. The first set of this testing was completed in 1997 in the Midwest, and the results have been documented in a Federal Communications Commission report published during the third quarter of the year. Five carriers, Lockheed Martin, and several network hardware vendors participated. Although the tests proved the architecture and the interfaces generall worked as designed, they showed that some changes in procedures and system interfaces need to be completed before widespread number portability become a reality.

Other regions are conducting similar tests, and eventually standards will need to be set so that portability can extend across regional lines. In the interim, local number portability will appear in phases, with service providers first offering more expensive interim solutions such as remote call forwarding, then regional portability based on the new architecture, and finally, national implementation, when standards are in place. CT

Justin J. Junkus is president of KnowledgeLin Inc., a training and consulting firm specializing in the cable telecommunications industry. To discuss this topic further, or to find out more about KnowledgeLink Inc., you may e-mail him at jjunkus@aol.com.

Acronym Glossary

CCS—Common Channel Signaling - System for call routing
LIDB—Line Information Database - Contains actual line termination data within the switch serving the ported number
LRN—Location Routing Number - Identifies the switch serving the ported number
LSMS—Local Service Management System - Interface between NPAC and SCP/STP
NPAC—Number Portability Administration Center - Ultimate location of ported number database
SCP—Service Control Point - Part of CCS
SOA—Service Order Administration - Network element where ported number information is entered
STP—Signal Transfer Point - Part of CCS

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Reader Service Number 184

SCTE UPDATE

SCTE Honors Local Volunteers

In a continuing effort to recognize innovation, commitment and leadership in the broadband telecommunications industry, the Society of Cable Telecommunications Engineers introduced several awards programs to honor these qualities in members of its chapters and meeting groups, and other volunteers.

As part of the new "SCTE Partnership Program," these awards spotlight the significant contributions local groups make to the industry through training and certification, communication programs, collaborations with other associations and leadership. "Hundreds of cable telecommunications professionals donate their energy, creativity and expertise to SCTE and the industry on an ongoing basis," said SCTE Manager of Chapter Development Steve Townsend.

Award categories include: Chapter of the Year (recognizes chapters that significantly exceed the Society's requirements for its local affiliates); Leadership Circle (honors exemplary volunteer leadership); Towering Achievement Award—outstanding educational programming; Towering Achievement Award—winning promotions/communications; Towering Achievement Award—effective partnerships award.

The deadline for nominations is Feb. 15, 1998. Nomination forms are available from SCTE national headquarters. The first series of awards will be presented at Cable-Tec Expo '98, to be held June 10-13 in Denver. For more information, contact Steve Townsend at (610) 363-6888, ext. 212; fax to (610) 363-5898; or e-mail to stownsend@scte.org. Information also is available on the Society's Website: http://www.scte.org.

Emerging Technologies is Texas-Bound

More than 1,400 engineering professionals are expected to converge in San Antonio, TX, this month for one of the broadband telecommunications industry's top technical shows, the annual Conference on Emerging Technologies. The SCTE is presenting this 10th anniversary event, titled "Building the Digital Platform," at the San Antonio Convention Center Jan. 28-30, 1998. The conference will feature presentations focusing on data transmission networks and digital TV technologies. The show agenda includes five top-notch sessions to feature some of our industry's engineering leaders, including representatives from the Federal Communications Commission, CableLabs, Microsoft, NextLevel Systems, Tele-Communications Inc. and Time Warner Cable, among many others.

A brand new addition to this year's conference is the SCTE Interface Practices Subcommittee (IPS) Test Procedures Demonstrations to be held during the IPS meeting on Jan. 27 and 28, and throughout the conference. These interactive sessions will illustrate the processes used in such test procedures as composite triple beat distortion, composite second order distortion, cross-modulation distortion, insertion gain and loss, frequency response, and bandwidth and noise figure, as well as test methods for group delay, isolation and return loss.

To add to the conference experience, special "Viewing Salons" will enable attendees to experience first-hand the future of digital TV, offering demonstrations of high definition TV (HDTV) and transmission techniques.

An exciting addition to this year's show is "Alternative Delivery Techniques" to be held Jan. 30, which will continue the popular "Who Are Those Guys?" topic first discussed at the 1994 Emerging Technologies conference in Phoenix, AZ. This interactive session will encourage communication among competitive service providers.

A welcome reception will be held Jan. 28. This special event, sponsored by NextLevel Systems and CommScope, will afford attendees the opportunity to interact with other engineering professionals. Also, the esteemed "Polaris Award" will be presented on Jan. 29 during a special reception to honor a leader in the pursuit of improved fiber optic technology. For more information, contact the SCTE Special Projects Department at (610) 363-6888, or fax to (610) 363-7133. CT

Interview with a Leader

By Rex Porter

The Cable Man Himself: SCTE's Bill Riker

Bill Riker
President, Society of Cable Telecommunications Engineers

William W. Riker is president of the Society of Cable Telecommunications Engineers Inc., a position he has held since 1984. As president, he is responsible for the overall operation of the organization, which has over 15,000 members in 67 countries.

Prior to joining SCTE, Riker held many technical positions in the cable TV industry, including director of engineering for the National Cable Television Association; director of engineering for Showtime Networks; headend engineer for McLean Hunter LTD; and chief engineer for AmVideo Corp., making him a 24-year veteran of the cable TV industry.

Riker holds a degree in electronic engineering from Monmouth University and a general class Federal Communications Commission license. He is a member of the board of directors for the National Cable Television Center and Museum, an active member of the NCTA Engineering Committee, Society of Motion Picture and Television Engineers, Institute of Electrical and Electronics Engineers and a senior member of SCTE.

Riker received the "Service in Technology" award from *Communications Technology* in 1989 and 1997. He was made an Honorary Fellow Member of the SCTE in the United Kingdom in 1990 and inducted into the Cable TV Pioneers in 1994. In 1995, he received NCTA's "Vanguard Award for Science and Technology," the highest recognition presented to individuals in the industry.

Communications Technology: *Could you remark about the condition of the SCTE when you first joined in 1977? The first "SCTE Membership Directory" was developed during that year, finally being published in 1978. It stated that the Society was in danger of running out of steam (out of money) with less than $700 in its national treasury and membership holding steady at 493.*

Bill Riker: I went to work for the cable industry in 1974 with Dick Loftus in Hoboken, NJ. In 1977, I went to work for Surburban Cablevision. One of Bob Bilodeau's policies, as president of the Society, was that all of his employees become members of the SCTE. So, I joined. The first meeting I went to was in Saddlebrook, NJ. The meeting was about using satellites for the transmission of programming. I wasn't really going as an attendee; I was going to the meeting on a project for Bob. I went to New York state and picked up a conical horn that was mounted on a tandem boat trailer. It was mounted so the horn end was at the back of the trailer and the feed horn was where the bow of the boat would be. We brought this thing down from New York state, set it up in the parking lot of the Saddle River Hotel and down-linked a Reuters news feed off of it and displayed that for the SCTE meeting. And that was my first exposure to the SCTE. I do remember an article in the *Interval*, which you may also remember, about the same time the "Bad News Bears" movie was popular and the article asked the question, "Is Judy a Bad News Baer?" ➤

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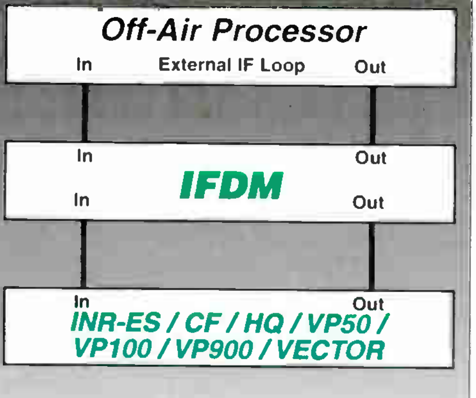

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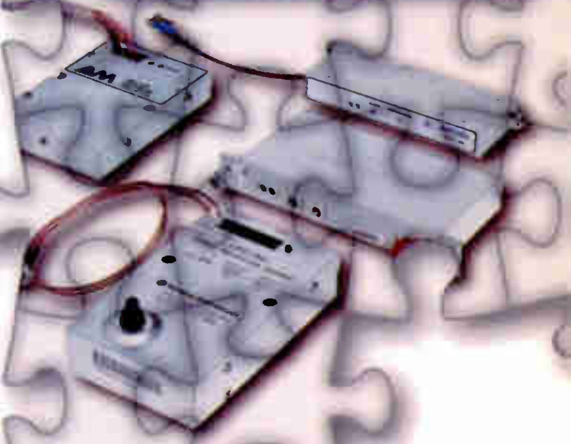

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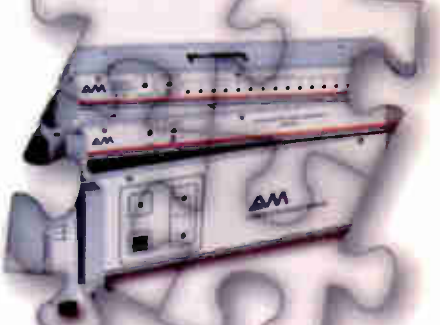

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It was an article about the fact that if people didn't pay their dues, there wouldn't be a Society around very long. That was my only real hint that the organization was in trouble back at that time.

Communications Technology: *The next membership issue of the "Interval" was published in September 1980. We had just added our 2,000th member. But the financial condition of the Society was as dismal as in the mid-70s. You were at Showtime, then with the NCTA. Did you ever seriously consider getting so involved with the Society at any point before you were contacted in 1984?*
Riker: Yes, I remember that directory when they announced their 2,000th member. But, again, I wasn't paying too much attention to the financial issues of the organization. In fact, much of the technical information I was getting was coming from *CATJ* magazine. *CATJ* was the technical journal that our company felt was the most valuable at the time. I was with Showtime from 1979 to 1982, when I went to work for the NCTA, as Wendell Bailey's director of engineering. At that point in time, the Society was not only having financial problems but Judy Baer had left the position of executive vice president and Steve Cox had taken over the helm. The Society was trying to engender support from the NCTA and had asked Wendell Bailey to attend board meetings and become more involved with the organization. Wendell asked me to act as liaison between the NCTA and SCTE.

As a volunteer member of the SCTE, the first job they gave me was to get involved with a certain Broadband Communications Technician/Engineer (BCT/E) Certification Program and made me chairman of the Category IV curriculum and examination committee. And then they said, "Oh, by the way, that will be the first exam to be introduced and we'd like to have it by the 1985 Convention." And so I actually started my involvement seriously with the SCTE as the NCTA liaison to the Society.

Communications Technology: *I sat on the SCTE Board of Directors when you came aboard as executive vice president. Prior to that, we had received complaints that the board was loaded with the same group of "good old boys." Did that bother you when you were interviewed for the job?*

> "My advice to installers, technicians and engineers is to stay on top of these technologies because, as they get merged together, they'll need to know how to work with all of them."

Riker: Of course, I was aware that some of the same people had been on the board for some time. But I did not know those people very well, so I wasn't concerned at this point. Basically, the reason I took the job was because I realized the potential of the organization. The real reason I took the SCTE job was that I saw a need for the organization and felt that I could make a difference. It's funny because, here I was, the liaison from the NCTA and I would go to board meetings and say, "Well, if you really want to rebuild this organization, you ought to do this, this and this!" And, as you know, when you open your mouth to suggest that people ought to do things, the first thing that comes back is, "Well, why don't you do it for us?"

And so that's really how I think it all came to pass—I was kind of the new guy on the block wanting to be proactive with a lot of energy. I had become very involved with the certification program. A lot of people felt that program was going to breathe new life into the organization. So, I began. And, when I did take the job, the three objectives the board gave me were: 1) to save the Expo (we were only three months away from Expo '85 and nothing had been done to prepare for it, yet); 2) to get the Society on a solid financial footing (the successful

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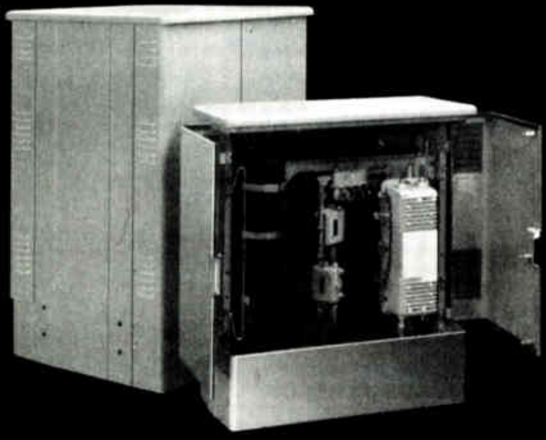
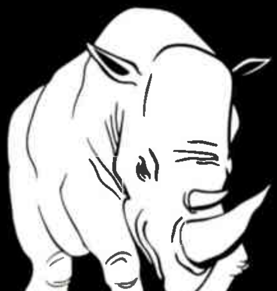
Expo '85 had a lot of impact toward doing that); and 3) to put emphasis on our Chapter Development Program.

Communications Technology: *One of the first "growth" projects I remember you completed during your first year was increasing the number of chapters to nine, from two, and the number of meeting groups, from seven, to 31. How did you know to emphasize chapter/meeting groups so that membership growth would follow?*
Riker: The previous philosophy had been to go and "hit up" the vendors for donations. And that's what they were doing when I came on board. I felt it was wrong to simply go ask companies to give us money. I didn't want to always have my hand out, asking for support without giving them something valuable in return. So, that's why I felt that holding the conferences and the Expo would bring support from the vendors but they would get "best value" in return. There were already two chapters in existence at that time: the Appalachian Mid-Atlantic and the Delaware Valley Chapters. The first new chapter I became involved with was the Golden Gate Chapter and I remember going out to California to hold a meeting with that group and having to take a "red-eye" from California to arrive in Florida the next morning for an organizational meeting with what later became the Florida Chapter. The people involved in that meeting were Cliff Paul, Richard Kirn, Jim Grabenstein and Ralph Haimowitz. I guess the biggest problem that I felt the organization had at that time was that the industry had lost confidence in the benefits of the Society. A lot of things had not been done in a professional manner. As you know, when I came aboard, the staff consisted of myself and one secretary. My first decision was that nothing was to leave the organization unless it was completed to the best of our ability. I had to rebuild member, vendor and industry confidence that we provided a worthy service. And, there were a lot of people in the field who wanted technical training. The need for local chapters was evident, and the people in the field were ready to make it happen. There was just myself to do this work—I would write the entire *Interval* newsletter on the airplane while I went about the work of chapter development.

Communications Technology: *Prior to your coming aboard, the SCTE had never owned its headquarters property. You must have had a great feeling of pride about each move toward your present headquarters in Exton, PA?*
Riker: When I first came on board, we were sharing a single room at the offices of Communications Construction Group (CCG). Tom Polis, of CCG, had been president of the SCTE and now Jim Emerson was president. There was a room with four desks; two were for SCTE and two were for CCG employees. After we had the successful Expo '85 and were able to move, on our own, we got a $10,000 loan so we could buy a couple of desks, a copy machine, a phone system and were able to rent office space in Exton, PA, about three miles away from CCG's office. Between 1985 and 1987, we expanded three times





within that same rental office building. We started in that building with four offices and, by the time we left, we had about seven 100 square foot offices. Then we were told that the building was going to be torn down to make way for a new highway. So we started looking around and found the Exton Commons facility.

We moved there in 1987. Certainly that was a big thrill for me because we bought the shell of the building and then the architects would custom design the interior. Since my father is an architect, he and I got together to design the interior of that building, ourselves. I would even go in on weekends to run the telephone lines and alarm system cables and such, because we couldn't afford to pay someone else to do that for us. We were very happy in that building, but again expanded three times while we were there.

We purchased the unit next to us and went from 1,000 square feet to 2,000 square feet, then finished off one of the basements for more space. We were very successful with our building fund efforts to buy the first Exton Commons unit. Our biggest contributor was Gerry Linfest; there were about 40 individuals and about 10 companies who contributed money to that fund. That allowed us to pay about 50% of the original $120,000 ticket toward the purchase of that new building. Our lawyer was next door, our printer was down the street, the bank was in the same office complex, so everything was right there. But we eventually outgrew it to where we had two or three people sharing the same office, and we no longer had expansion capabilities in that office complex.

I feel my job with this Society has always been to be thinking about two years ahead. In fact, when I took the job back in 1984, I had a vision of things I wanted to accomplish and it took ten years to realize the completion of that vision. In other words, even things accomplished as recently as within the last three years were things I thought about when I took the job. The new building we presently occupy represents what I am most proud of. Not because of the bricks and mortar, but because it is a physical testament to the growth of the organization. We were able to purchase our present national headquarters with funds we had amassed over the years, as well as a mortgage, obviously. And we were able to do it without raising membership dues or without raising fees for exhibitors or Expo or anything else.

After coming aboard with an organization which was effectively bankrupt, I have been very frugal with our members' money. The building cost $1.3 million to build; we paid $500,000 out of our savings and took out an $800,000 mortgage (of which I am proud to say we have paid off more than half). We paid $170,000 for eight acres of land. Only half of it is buildable but the wet-lands ensure our privacy and it is probably one of the most beautiful settings you could have. Plus, we can now double our present office space.

Communications Technology: *Two of the most important engineering events are the*

Conference on Emerging Technologies and Cable-Tec Expo. Your leadership has inspired dramatic growth for both events. Do you see changes for either event in the future?
Riker: That's a tough question because every year we do an Expo and we always come away saying, "That was the biggest and best Expo we have ever done." People tell us that and then ask, "How could you ever improve on that in the future?" And , as you know, Anna Riker, my wife, is in charge of the exhibit hall; she has a lot to do with the look of the show. My responsibility for Expo is the technical program, the audio/visual and the staging. So, she and I try to divide that show in half.

With technology changing so radically and our attendance growing so rapidly, Expo has been in a different location each year because we keep outgrowing the facility we were in the year before. But we constantly strive to make it a better show by making improvements each year. Those improvements are based on input from exhibitors and attendees. We try to make the Expo better each year and, as a result, it keeps getting bigger each year. Now that's Expo.

Emerging Technologies originally started as a fiber optics seminar, done jointly with the Florida Chapter. It was actually Bill Kohrt, a board member at the time, who said, "You know we just can't do fiber optics forever. There are other technologies we should address." So in 1992, we made it "Fiber Optics Plus" and, in 1993, we changed to "Emerging Technologies," which gave us the ability to change the focus of the conference in accordance with developments in the industry. This year, for the very first time, we are going to have "viewing salons," where people will be able to see demonstrations of digital TV transmission methods as well as high definition TV (HDTV) demonstrations. We will also be demonstrating test methods developed by our engineering committee, as part of our standard setting efforts for test procedures. So we are adding two new facets to Emerging Technologies in 1998.

Communications Technology: *The SCTE and IEEE now jointly sponsor technical meetings during the year. Would you remark about the importance of such joint meetings?*
Riker: This is something I had originally proposed to do for the last several years. In considering this, I really hadn't thought it would be IEEE. I thought it would be with SBE or SMPTE that we would do our first joint conference. It just kind of happened that we formed a joint engineering committee with the IEEE Communications Society, under Joe Terry's chairmanship, and the result was this conference. I think it brings together engineers who are outside our own industry with a lot of differing disciplines to share their perspectives on technology and also brings together SCTE's credibility in working together with other organizations. I still hope to be able to do joint seminars with other organizations such as SBE and SMPTE in the future.

Communications Technology: *CableLabs and the SCTE are working closely in the area of specifications and standards for cable telecommunications. What can we expect in the near future?*
Riker: Richard Green, president of CableLabs, and I have been close personal friends since back in the early '80s, when he was executive director of ATSC (Advanced Television Systems Committee), and I served as a volunteer secretary for that group. So, we have had a working relationship even before he came to work for CableLabs and I joined the SCTE. We have continued that relationship. Actually, we have a committee between Dick Green, myself and the NCTA that meets on a regular basis to make sure our activities are coordinated. This ensures we don't duplicate efforts and are able to move ahead together.

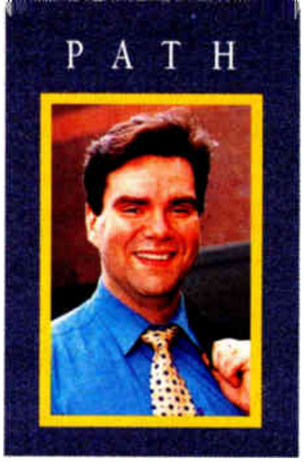
Communications Technology: *Tell us about the relationship between the American National Standards Institute and the SCTE.*
Riker: That was probably one of the most difficult projects we ever took on with this organization. We had applied to ANSI for standards development status in 1993 and the EIA-TIA objected to our becoming a standards development organization, saying that they also expected to set standards for the cable TV industry and that we should be expected to submit our standards under them. Then they would be the ones to push them through ANSI. We were not happy with that plan and it took two years of applications and re-applications to finally overcome their objections.

I credit Wendell Bailey with assisting me in overcoming two years' worth of disagreements between ourselves and EIA and finally having them remove their objections, at which time ANSI immediately gave us that recognition. Since then, we have submitted several standards to ANSI, all of which have moved through smoothly and we intend to continue that process. ANSI does not set specifications. They recognize specifications developed by other organizations and their job is to verify that a specification was created through due process, meaning everyone who had an interest in giving input was afforded that opportunity. That's why CableLabs cannot set specifications—because they are a "members-only" organization. But the SCTE is open to anyone with a legitimate interest in the activities of the organization and, therefore, being an open organization, we are the only ones in the industry able to comply with the requirements of ANSI to allow due process.

Communications Technology: *As we head toward new technologies such as digital TV, data transmission, IP telephony and others, what advice would you give to installers, technicians and engineers?*
Riker: That's a really tough one! This industry is changing. It's not just about changing connectors or handling RG-59 anymore. It is now about delivering new technologies through new delivery methods. So, my best advice to installers, technicians and engineers is to do their best to stay on top of these technologies because, someday, as they get merged together, they'll need to know how to work with all of them. One of the examples of the Society's desire to keep installers, technicians and engineers well-informed is not only our seminars, videotapes and publications but also the SCTE List, which allows members to interact on a daily basis, exchanging information in an open forum. CT

Rex Porter is editor of "Communications Technology." He can be reached in Mesa, AZ, at (602) 807-8299 or via e-mail at tvrex@earthlink.net.

By Alex Zavistovich



Wrapping Up Western

A Heady Experience

So there we were, some of the finest minds from Communications Technology magazine, and one of the leading vendors of network management equipment, sitting down to dinner. Our topic of discussion? Not the state of the industry, that's for sure. We were talking about how the members of the *CT* staff all seem to have such large heads.

That's the Western Cable Show for you: Three days of innovation, layered liberally with Dada-esque surrealism. (Of course, we at *CT* do seem to have unusually large melons, but let's not go down that road.)

This year's Western Show offered some exciting insight into the future of data delivery over cable. It was hard to hear the message sometimes, though, for all the giveaways at the show. Some operators seemed to be on the floor just to scarf up all the free stuff they could find.

VENDOR: Let me tell you about our new MCNS-compliant modem...
ATTENDEE: Great. Say, I like that necktie. Drop one in the bag for me?
VENDOR: Sir, this is my *own* tie. About MCNS...
ATTENDEE: Just put it in the bag. Got any T-shirts?

The upshot of the Western is that data delivery is hotter than ever. Most modem vendors concede that the industry has to standardize around MCNS (Multimedia Cable Network System) specs to be viable in the consumer market. Many also are making it as easy as possible to offer data services, providing products with dual return capability. If your reverse path isn't ready, you can still offer service with telco return. Then, when you are ramped up, you switch users to the HFC back channel.

There are new entrants in the modem arena, too. Samsung unveiled a prototype cable modem, named InfoLink, as an external PC peripheral. The modem, initially to be sold to operators, will be available in retail outlets in 1998. An internal PC card version and a telco-return model are expected by mid-1998.

Integrity Communications showed a broadband modem system for HFC and wireless networks. Trials of the modem are underway on Spike Technologies' MMDS network in Nashua, NH and MediaOne in Chicago.

Philips introduced the Crystal data.link, the latest in the company's Crystal line. Dubbed the "un-modem," the product is a printed circuit card housed in a subscriber interface unit mounted on the outside of the house. The "un-modem" offers 128 kbps data transfer speeds, reducing capital expenses and telephone switch traffic while maintaining optimum speeds during heavy network traffic.

Behind the scenes, some interesting stuff was going on with Com21. First, Philips announced a distribution agreement in which the company said it was buying up to 200,000 ComPORT modems for worldwide distribution. An agreement with Celestica to build the ComPORT cable modem means Com21 will be able to deliver volume quantities.

You'll notice a lot of interesting partnerships lately. For instance, 3Com is hedging its bets between marketing its own cable modem products under the US Robotics name and underwriting some of Com21's expenses (Siemens is in the picture, too.). Cisco Systems is also making some money from more than one source, with an equity interest in both Com21 and Terayon.

Another interesting partnership is between ADC and Phasecom. The Asymmetrical Cable Engine (ACE) from ADC is an asymmetrical, two-way cable modem, the newest product to be added to the Homeworx broadband platform. The modem will be manufactured by Phasecom, which has its own cable modem, SpeedDemon, available in external and PC card versions.

All that movement is designed to make cable modems a successful piece of consumer equipment, which takes away from operator's rental revenues, but will ensure deeper penetration into the market of PC users who subscribe to cable.

What happens then? Some folks have suggested IP telephony may be the next step in cable telecommunications. Will it eclipse RF telephony for MDU applications? Probably not as the primary phone line; as a *second* line, the premium tier in a data package, I think it shows a lot of promise.

All of this activity is likely to change the face of engineering, as well. You'll find over time that your crew will stand should-to-shoulder with more MIS types, software engineers rather than old-school techs and linemen. Someone has to maintain the data networks, update the home pages, and so on.

By the next Western Show, cable modems will be on the shelves in retail outlets. Then we'll see some real movement. Personally, I'm looking forward to anything that will turn the conversation away from the size of my head. CT

Alex Zavistovich is executive editor of "Communications Technology." He can be reached in Potomac, MD, at (301) 340-7788, ext. 2134.

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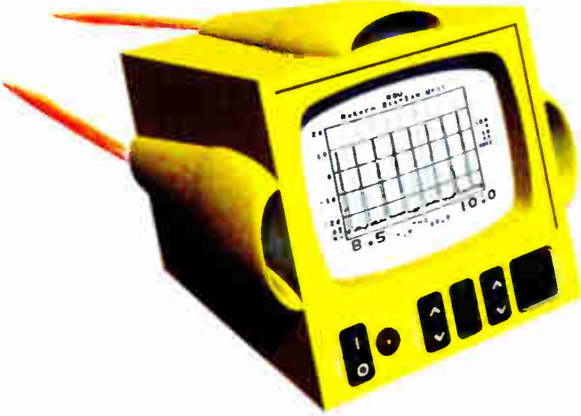
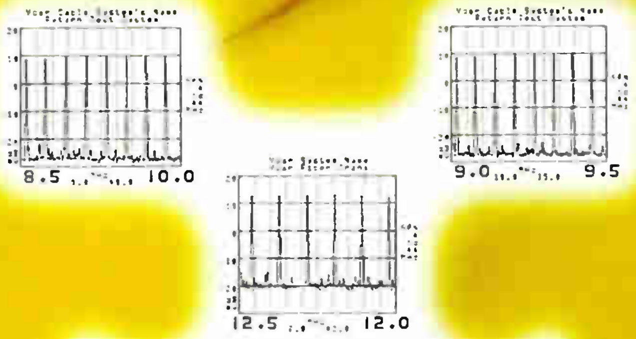


RDU: patent pending
RDU © 1997, Cable Resources Inc

The RDU is a new piece of test equipment. It allows technicians to monitor the return system from any point in the cable system without the traditional and cumbersome HE spectrum analyzer / camera setup.

The RDU allows system installers and technicians to view on any TV screen, the RF Levels, Ingress and Noise present back at the HE from a subscriber's home, system amplifier, feeder tap or fiber node.

The RDU processes the X / Y output data generated by an internal spectrum analyzer and converts it to NTSC video for input to a standard CATV modulator. A data output allows the analyzer screen to be viewed on a computer, same as video. Software is Windows 95 networkable so office possibilites are endless.



Above are samples of a TV screen that system installers or technicians would "see" in the field.

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Reader Service Number 80

HRANAC—Notes for the Technologist

By Ron Hranac

The Western Show

As I write this month's column, it's been just a couple days since I returned from the 1997 Western Cable Show. This was the 30th Western Show, and judging from floor traffic, I'd say it was probably a resounding success. The Anaheim convention center was pretty much wall-to-wall exhibits. What a change from when I first started going to the Western Show at Disneyland Hotel back in the '80s! While I didn't hear any specific attendance figures, it looked to me as if we're out of the slump that plagued much of the industry's trade shows during the past year or so.

By the time you read this, official numbers should have been published.

Besides the usual meetings and technical sessions, one thing I try to do at major conventions is walk the exhibit floor in search of interesting and unusual technology. Often the more unique gizmos are found in small companies' booths, hidden in corners at the far ends of the exhibit hall. This year I found goodies among large and small exhibitors. Here's an overview of some of the more interesting things I saw.

Test equipment

How many of you remember the old Avantek low level sweep system? This is the one I learned to sweep with back in the late 1970s. I assumed that the product had long since died and gone to test equipment heaven. Wrong. A Canadian manufacturer, Avantron Technologies, has resurrected the old Avantek low level sweep technology, and updated it with microprocessors and modern digital signal processing, and added a host of other features.

Avantron's AT2000R is a battery operated spectrum analyzer (not just a spectrum monitor like the old Avantek sweep receiver) that can do the usual CATV proof-of-performance measurements, and is capable of forward and reverse sweep. The sweep operates 40 dB below visual carrier levels—the old Avantek was 30 dB down as I recall—and is said by the manufacturer to be capable of sweeping through any signal (digital included) carried on the network without interference or the need to set up guard bands. Price depends on options and configurations, but is in line with other similar equipment on the market. Avantron can be reached at (800) 297-9726 or (514) 725-6652.

> "The CableNET exhibit brings together several companies displaying the latest digital and other interactive technology."

Hewlett-Packard was demonstrating a modified version of its HP8594Q, an instrument designed for the European DVB-C market. Housed in the same style enclosure as the popular HP8591C spectrum analyzer, the '94Q was designed to measure digitally modulated signals. For instance, it can provide a constellation display, measure average carrier power, adjacent channel power, and several other parameters such as modulation error ratio (MER) and error vector magnitude (EVM). The Western Show display model had been tweaked to work on North American MPEG digital signals, and production units are expected to be available early- to mid-1998.

My request: While HP engineers are doing necessary product modifications for North American downstream MPEG testing, how about making this instrument capable of doing upstream digital measurements, too? Considering its anticipated $25,000 or so price class, it should be a two-way box. Contact Hewlett-Packard at (800) 452-4844.

Hukk Engineering was part of this year's CableNET exhibit. Hukk demonstrated its CR-1200 QAM Monitor, a handheld instrument that shows constellation displays for 64- and 256-QAM digital signals. It will perform bit error rate tests (both pre and post FEC), errored and severely errored second counts, and average carrier power. The CR-1200 also serves as a traditional signal level meter for analog CATV measurements! Availability is planned for the first quarter of 1998, with a target price around $4,000. Here, too, I'd like to see an upstream box. Hukk Engineering can be reached at (888) 236-8948.

Tektronix had a couple prototype digital modulation analysis measurement instruments on display in its booth. Expected to be available later in 1998, the handheld devices will provide technicians the ability to measure 64-QAM signals in the field. Perhaps the most interesting technology from Tektronix was the PQA200 picture quality analysis system. This is a computer-based system that can objectively measure picture quality, based on a number of

Pelé

sophisticated algorithms. Intended primarily for lab and research applications (it's a $50,000 to $60,000 product), the PQA200 was an impressive demonstration of using computer technology as a "calibrated eyeball" instead of more traditional human viewer trials. Contact Tektronix at (800) 426-2200.

New technology

As has been the case for the past few years, the Western Show CableNET exhibit brings together several companies displaying the latest digital and other interactive technology. For instance, CableNET is where some of the first side-by-side comparisons of 28.8 kbps dial-up versus ISDN versus 10 Mbps cable modems were shown.

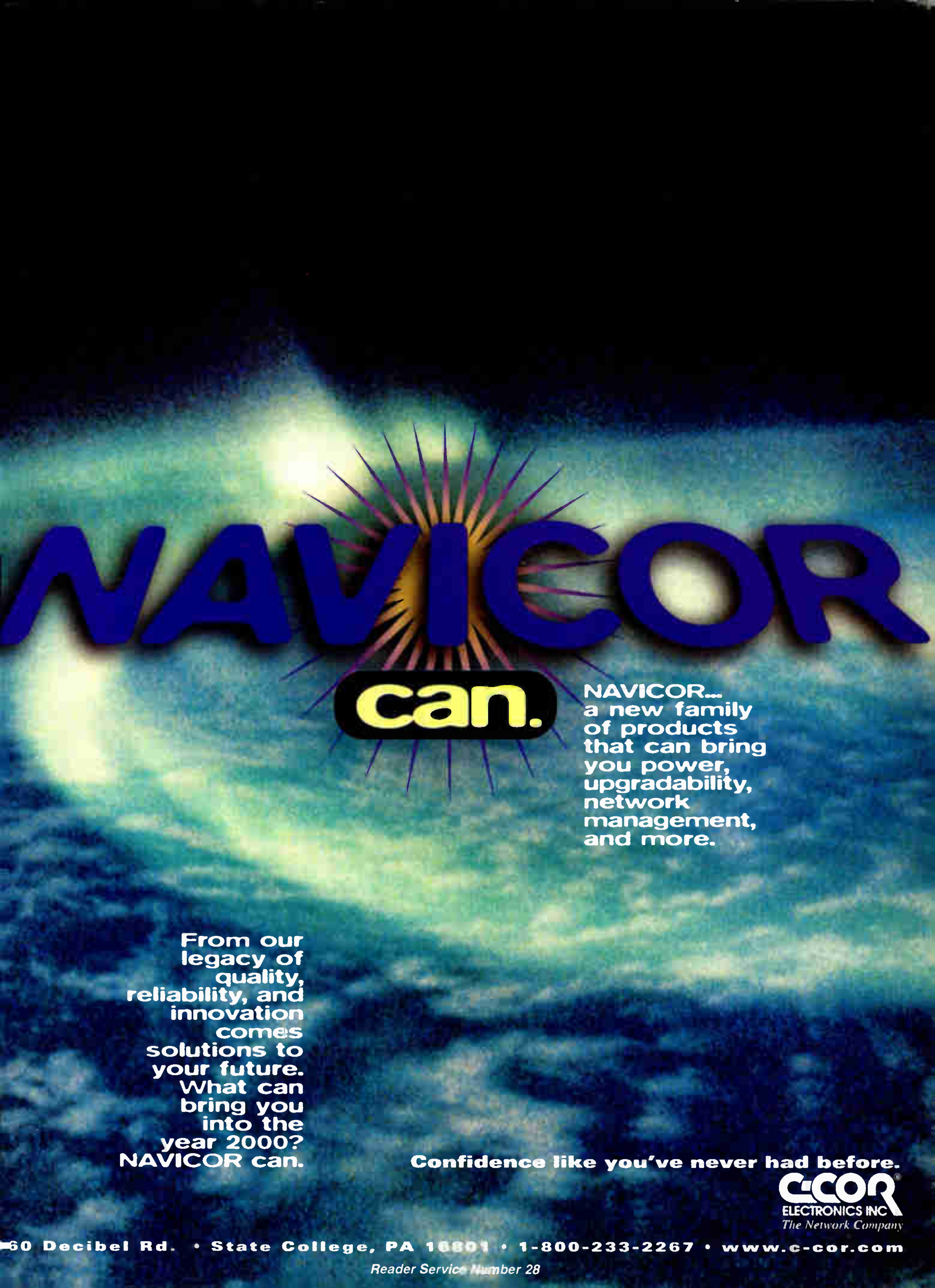
The buzzwords for cable modem technology were clearly "interoperable" and "MCNS compliant." It looks like our next generation modem technology is just around the corner. While it may be many months or even a year or two before we start to see cable modems in every Circuit City or CompUSA, that day will be here before we know it. Just for an operating reality check, I stopped by one booth and logged on to the American Radio Relay League's World Wide Web site to check claimed contest scores (I'm an avid VHF and microwave ham radio contest operator). Yes, I was able to view the ARRL Web site, and quickly, too.

> "Even more impressive were the gas plasma HDTV displays: TV sets only a few inches thick."

Mitsubishi, Fujitsu, Pioneer and Sony were displaying fully operational high definition television in the CableNET exhibit. At least one was 256-QAM digital to the set. Nice pictures! Near 35mm film quality. Even more impressive were the gas plasma HDTV displays: TV sets only a few inches thick. One was 50 inches diagonal! I was afraid to ask what those things cost. Still, it was easy to imagine a 100 inch home version showing the movie Star Wars. Someday...

Heroes

The programmers provided the usual opportunity to meet famous sports figures, Playmates, and movie stars. By far the most exciting for me was a chance to meet and chat with Apollo 12 astronaut Charles (Pete) Conrad, Jr., the third person to walk on the moon. In a time when the popular media has inappropriately made "heroes" out of professional athletes and actors, it was nice to meet a real American hero. Thanks to Speedvision for hosting Mr. Conrad's appearance. ➤



You don't have to be a big guy to get online

Just when you thought the industry's MSOs were the only ones capable of bringing cable modem service to the general public, along comes HSAnet. A Colorado-based company, HSAnet was founded to provide Internet and high speed data services to small and medium size cable operators. The best part, according to company president Ron Pitcock, is that this can be done for little or no cost to system operators. HSAnet provides everything but the bandwidth and a little headend space for required equipment. As I understand it, the company sets up a revenue sharing arrangement with operators, similar to what the home shopping services do. Nice idea for systems that can't afford to roll out data services themselves. For more information, contact HSAnet at (303) 979-8965.

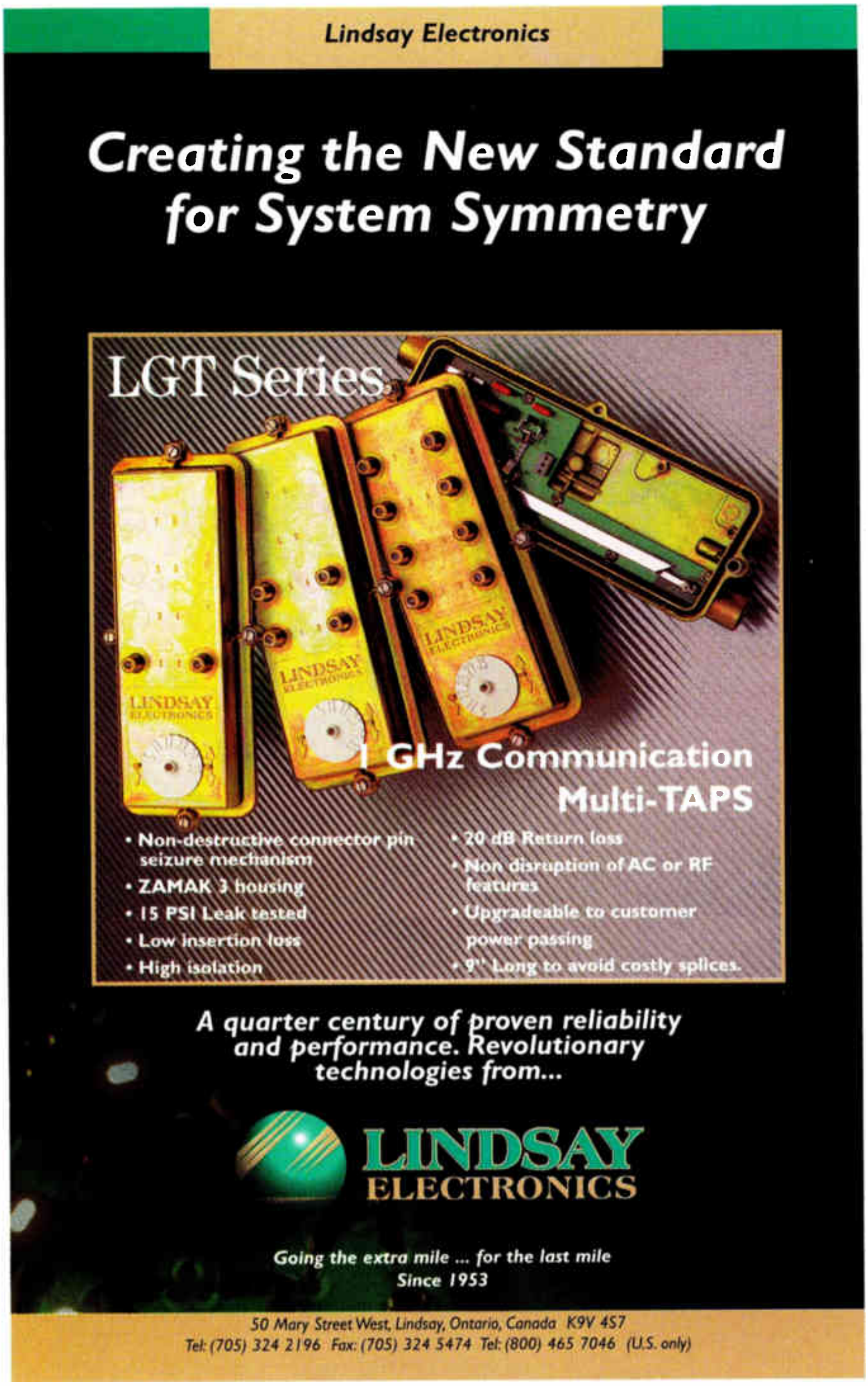
Technical sessions

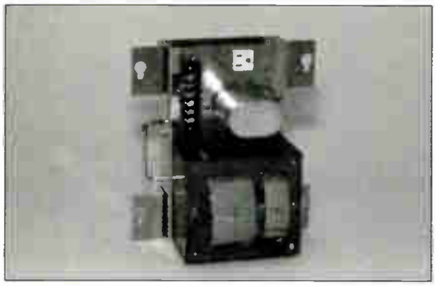
The Society of Cable Telecommunications Engineers once again sponsored the show's technical sessions. I was able to attend only a couple of them (I moderated the panel on two-way), but heard very positive comments from show attendees about the technical sessions in general. Nice job, SCTE. For those of you who stopped by the two-way session, you'll recall we sang Happy Birthday to one of the panelists, fellow SCTE board member Jim Kuhns. He should never have told me it was his birthday <grin>. I expect revenge, but it will have to wait until at least 1999. I'll be overseas when my birthday rolls around this month.

> "I heard very positive comments from show attendees about the technical sessions in general. Nice job, SCTE."

And finally, a note to Western Show organizers. First, a tip of the hat for a job well done. Second, the Western Show seems to be getting more and more like the National Show. This in itself isn't necessarily bad, but can attendees and exhibitors be encouraged to be a bit more casual like the old days? There are getting to be way too many suits and ties! CT

Ron Hranac senior vice president, engineering for Denver-based consulting firm, Coaxial Internaitonal. He also is senior technical editor for "Communications Technology." He can be reached via e-mail at rhranac@aol.com.





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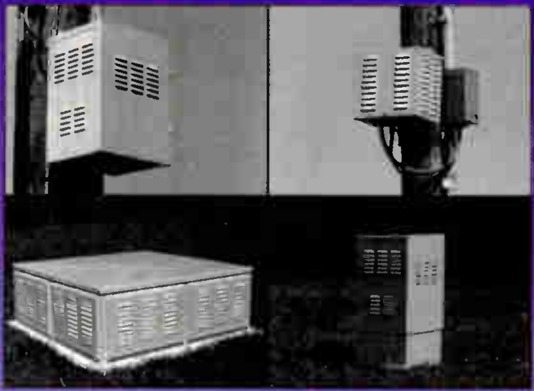

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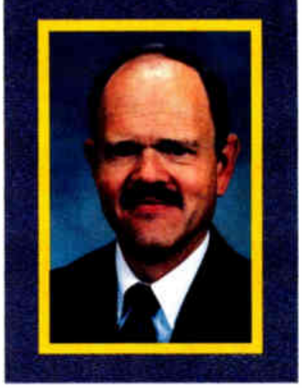
Reader Service Number 140

By Justin J. Junkus



Local Number Portability Depends on New Architecture

About a year ago in this column, we talked about local number portability and its importance to emerging telephony service providers, such as cable telecommunications companies. Since then, much work has been done in the industry to define the network structure that makes it possible to port a telephone number, or allow consumers to retain that phone number under any of several changes in service.

Because this ability to retain a phone number is so important to our potential customers, an update should be helpful not only for an understanding of the technology, but also for answering some of our customers' questions about how the telecommunications industry is meeting this challenge.

Let's start with a short refresher. There are three types of local number portability: service provider portability, location portability, and service portability. Service provider portability allows end users to keep their phone numbers when they change service providers, such as for a move from the incumbent telephone company to the cable company. Location portability is the ability to keep a phone number after a geographic move. Service portability means you can add new services to your line without having to change your phone number.

Of the three, service provider portability is the one that is most helpful to new market penetration by emerging telephony providers. The reason is explained by the source of the need for each type of portability. The need for location and service portability often arises as a result of consumer-initiated changes driven by their own needs, not necessarily related to telecommunications.

A move to a new location is an example. The need for service provider portability, on the other hand, is primarily driven by telecommunications considerations, and is often the result of marketing efforts initiated by the new service provider rather than by the end user. Implementation of service provider portability involves changing historical linkages between phone numbers and serving telephone offices.

> "Of the three, service provider portability is the one that is most helpful to new market penetration by emerging telephony providers."

Traditionally, the first three digits of a seven-digit local phone number designated a particular telephony switch that served that telephone subscriber. In fact, these digits became known as office codes or exchange codes, and have become synonymous with the building that houses the switch.

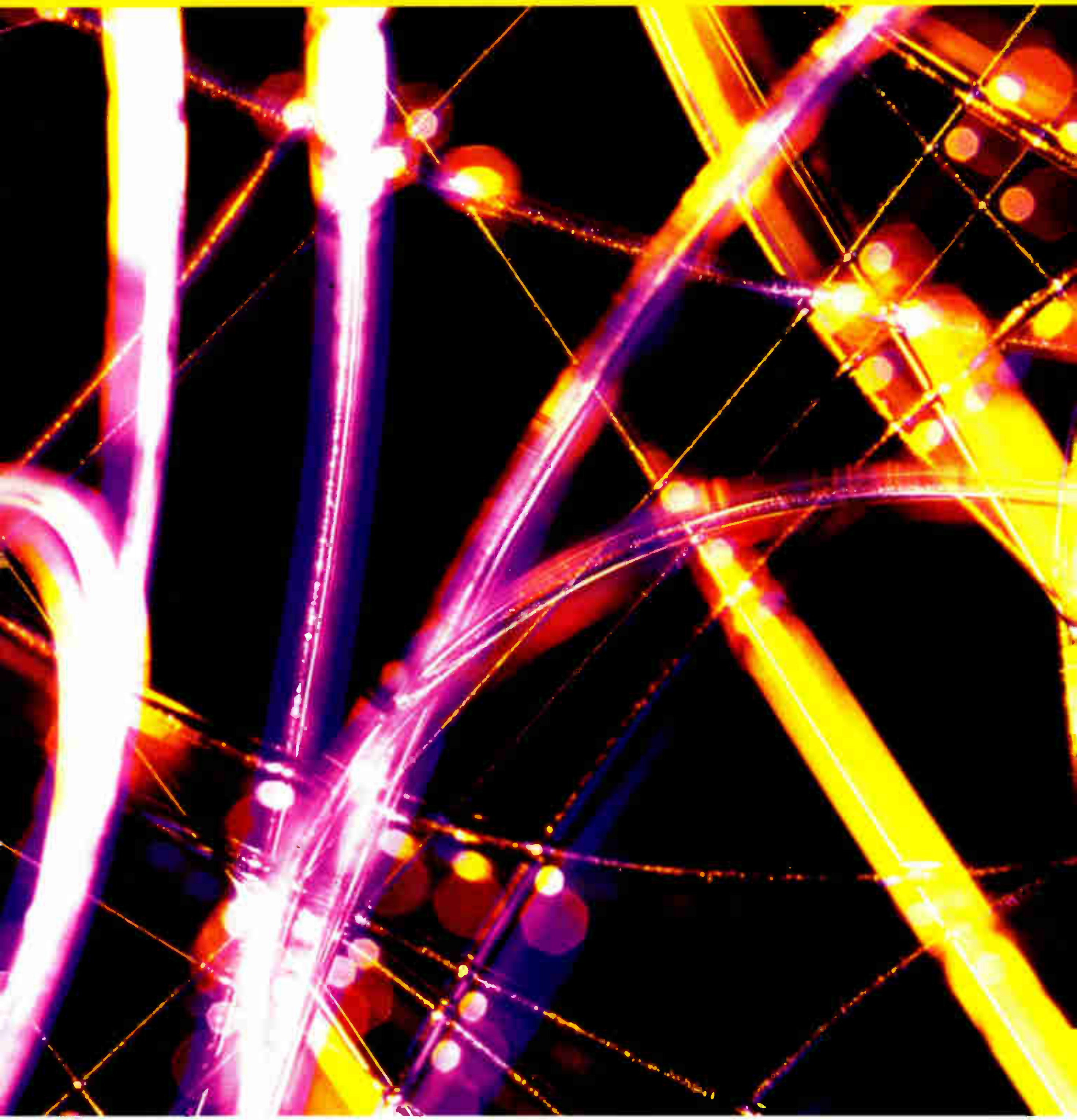
With the introduction of local number portability, the first three numbers of the seven-digit local phone number no longer identify a particular switch, since it is unlikely that the new service provider will be using the incumbent telephone company's plant to complete calls. Accordingly, a new way of identifying the end user's serving switch needed to be created, so that calls to that user could be routed properly.

This new identifier is called the location routing number, or LRN. Each switch that hosts ported numbers will have a ten-digit LRN assigned to it. When a call is made to a ported number, a network database associates the called number with the appropriate LRN. The call is then routed to the appropriate switch based not on dialed digits, but on information from the database. The actual line termination on the switch for the call to the ported number is determined by a ten-digit global title translation to a separate, but related, line information database, or LIBD.

In order to provide routing information, the database of ported numbers obviously must contain accurate information on which the service provider is serving each subscriber. It thus becomes the ultimate authority on who should receive the monthly revenue associated with that subscriber's local phone service. To ensure absolute fairness, the administrator of that database must be an independent third party, with no interest as a carrier in providing local phone service.

During 1997, two such administrators were chosen on a regional basis by committees of telephone carriers. They are Lockheed Martin and Perot Systems. Lockheed Martin is responsible for the Mid-Atlantic, Midwest, Northeast, and Southwestern states. Perot services the Western, West Coast, and Southeast states.

In actuality, data from the database is distributed to various network elements



Target Practice

Using Reverse Path Segmentation

By Horacio Facca and Gary Chandler

New methods in hybrid fiber/coax (HFC) reverse-path segmentation and forward path narrowcasting are enabling operators to target specific service areas in the forward path while increasing the network's return bandwidth availability per subscriber.

Broadband network operators will learn about the feasibility of adding this targeted service bandwidth and subsequently more data throughput without requiring costly reconstruction of the existing hybrid fiber/coaxial network. Let's examine the methods of forward path narrowcasting and reverse-path segmentation, and ultimately how they can be combined to help operators lower their entry costs in deploying interactive targeted services, like data and telephony.

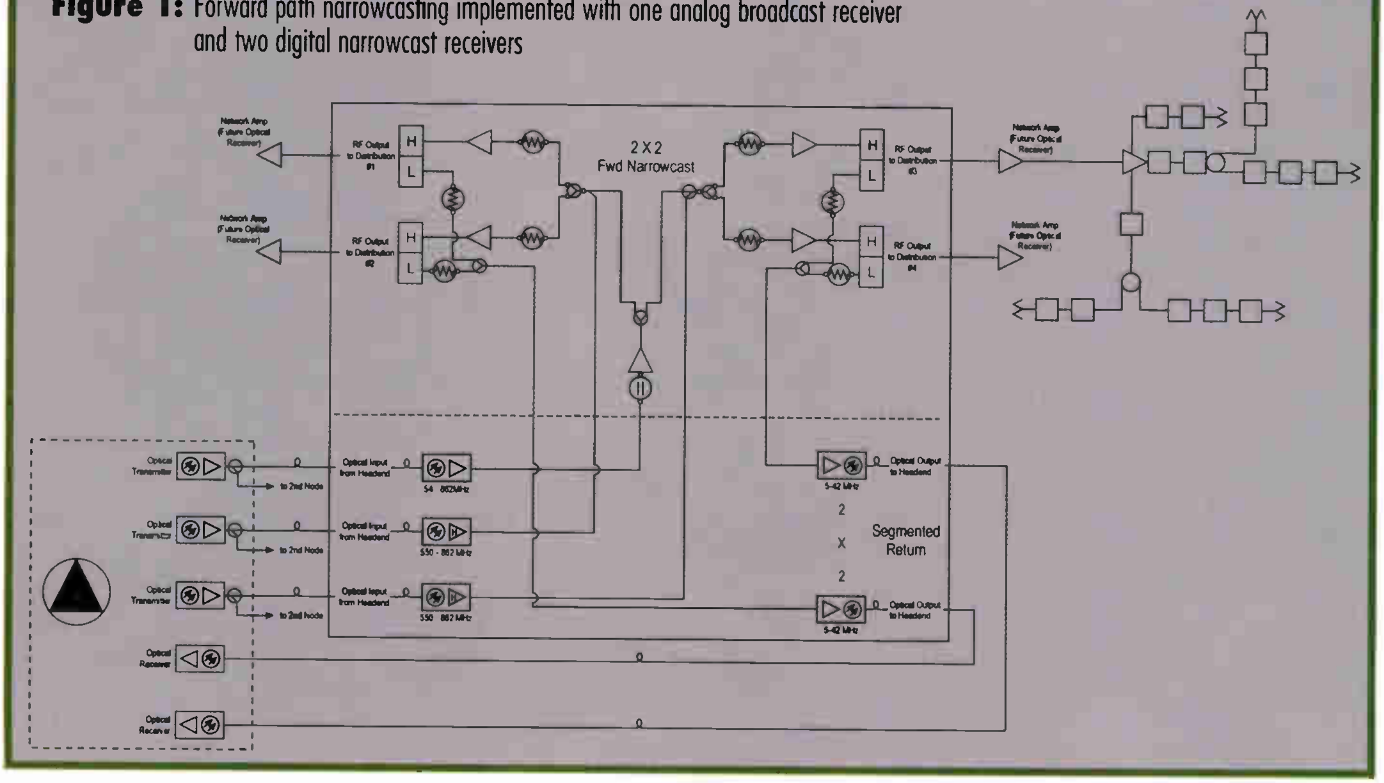
Standard node platforms existing in today's HFC networks have some limitations with regard to deploying targeted services. Most networks were designed to accommodate analog and digital forward signals, while managing return-path traffic based on limited knowledge of targeted service needs. Increased understanding of the return path and the rapidly approaching requirement for more return bandwidth drive the industry to seek bandwidth-efficient solutions for deploying advanced access services. A flexible node platform that supports both targeted forward digital services and return-path segmentation is one such solution.

Return-path segmentation

Return-path information capacity is determined by the diplex filter within the RF amplifier modules; serving area size and subscriber penetration; upstream data modulation schemes; and ultimately, the services being deployed. Typical nodes are designed to take four return legs and combine them in the RF domain. This 4-by-1 configuration represents a traffic bottleneck at the node that limits the bandwidth available per subscriber. Return-path segmentation is a concept that significantly changes this scenario.

One way to segment the system's return

Figure 1: Forward path narrowcasting implemented with one analog broadcast receiver and two digital narrowcast receivers



path is by changing the appropriate return interface assembly in the node and adding another return transmitter. This 2-by-2 configuration splits the serving area symmetrically into two independent return paths, effectively doubling the available bandwidth per subscriber. Other benefits to this approach include increased subscriber reliability in the return system and reduced noise funneling into a single transmitter. Upgrading the node to a 2-by-2 configuration is not costly if an extra dark fiber is already in place. It depends almost solely on the cost of the laser used. Also, changing the return interface assembly and adding a second return transmitter requires no plant reconstruction and does not interrupt forward path service.

Programmable switching

The second way to segment the return path is to use a programmable switching technique. A pre-configured, selectable switch, which is controlled and programmed remotely by the network's element management system, adds a new level of flexibility. Depending upon the bandwidth demand on each return leg, the configurable switch can direct return traffic to either transmitter. With the switch in place you can divide the return legs asymmetrically—for example, three return legs directed to one transmitter and one leg to the other. This configuration option is referred to as N-by-21. As the serving area grows and subscriber density increases, each return leg will demand different amounts of bandwidth. When this occurs, the ability to split the node asymmetrically may become an important advantage.

A configurable switch also has the ability to pre-set bandwidth allocation for different serving areas to accommodate changing usage patterns. One example might be to support the telephony requirements of a business district during the day and provide the necessary data throughput to the residential area for evening Internet use.

The N-by-2 configuration with a selectable switch offers techniques for return-path noise monitoring and control. The selectable switch can attenuate each return leg independently to isolate the one carrying noise ingress. This feature allows fast troubleshooting which maximizes service availability to the customer. In addition to improving service to return-path customers, modern optical nodes allow a system operator to offer interactive services at a reasonable cost.

Forward path narrowcasting

Forward path narrowcasting (where a narrow portion of bandwidth is used to direct cast targeted services to a specific portion of the population) also adds flexibility to the node. Typical nodes in HFC systems contain one optical receiver with 500 MHz (50-550 MHz) of bandwidth for analog broadcast programming, at least 200 MHz (550-750 MHz, or greater) dedicated to digital applications.

When a node is fed by only one receiver, analog and digital signals are sharing the same fiber. Dividing the node in half, by using two additional optical receivers, supplies at least 200 MHz of bandwidth to each side of the node, doubling the bandwidth available for targeted digital services. Forward path narrowcasting is used most effectively in nodes that contain at least three receivers (See Figure 1 on page 56). Forward path narrowcasting allows the use of lower grade, less expensive digital forward transmitters at the headend because digital signals are more noise-tolerant and do not require extra circuitry for linearization. Direct-cast digital signals will not undergo multiple splits like analog signals do. With direct casting, one headend transmitter targets one receiver in a node. Direct casting to

Figure 2: This 4-quadrant system design provisions the deployment of fiber deeper into the network

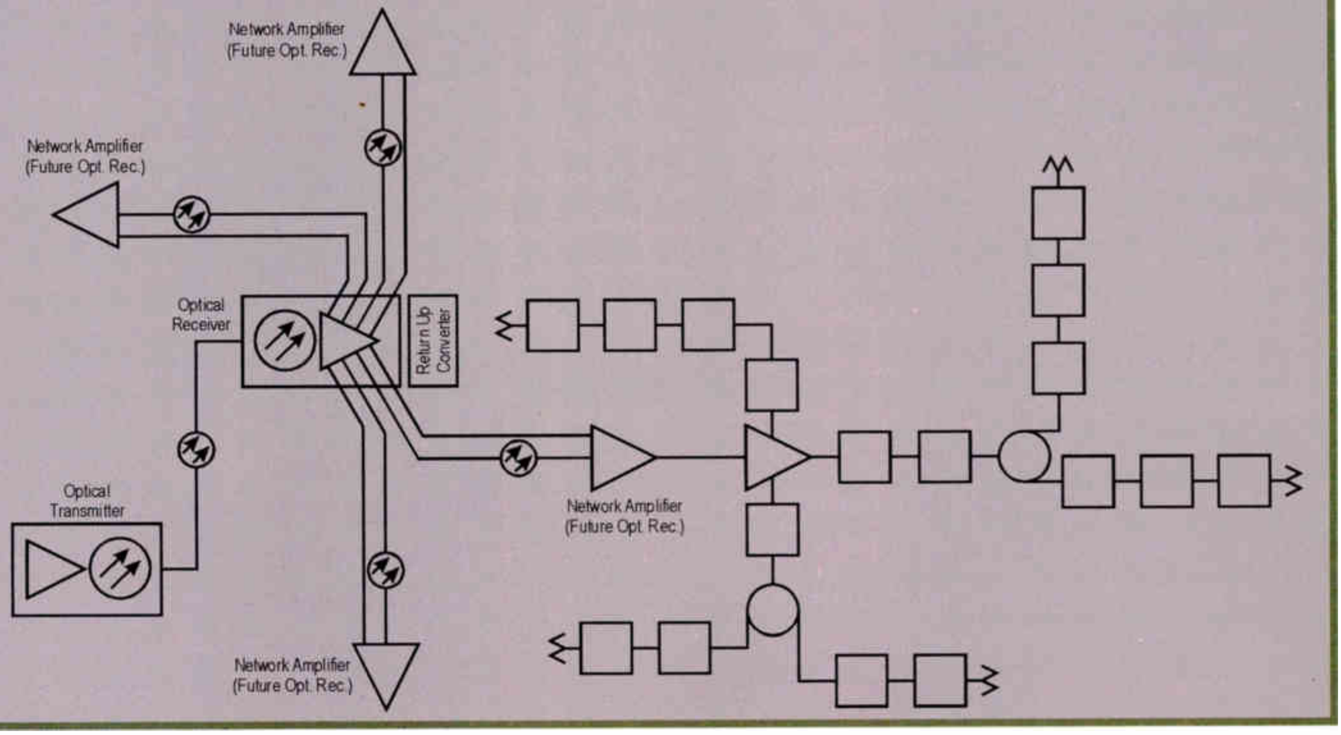
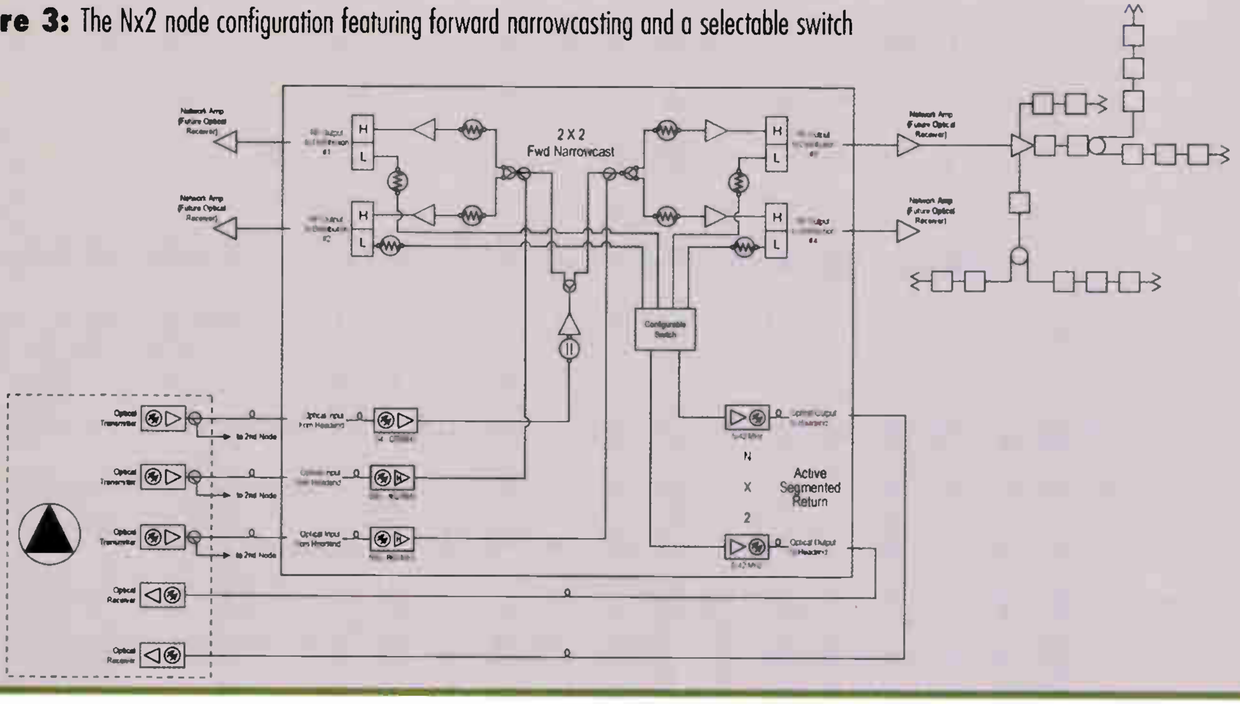


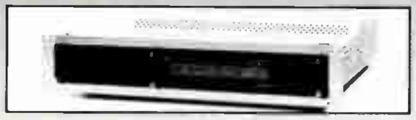
Figure 3: The Nx2 node configuration featuring forward narrowcasting and a selectable switch



two optical receivers instead of one (for the same size serving area) provides greater subscriber reliability.

Summary

Nodes that incorporate forward path narrowcast and reverse-path segmentation



BOTTOM LINE

Designing Nodes

The challenge: Designing nodes to accommodate the increasing demand for more return bandwidth and the requirements of advanced access services. Present node platforms have limitations such as return path traffic bottleneck, limited bandwidth per subscriber, and limited bandwidth for digital services.

The solution: A flexible node platform that supports both targeted forward digital services and return path segmentation. A user can even progress to the most advanced node platform one step at a time.

The benefits: The node configuration at cost-effectively optimizes the deployment of targeted services while increasing reliability is the N-by-2 node with a selectable switch and forward path narrowcasting.

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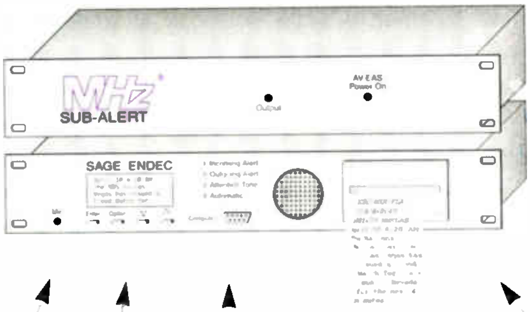

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techniques provide greater flexibility than the nodes of the past. Early nodes segmented the serving area into four equal sections, each with four RF legs. The first RF amplifier in each quadrant could be transformed into an additional optical node when more bandwidth was required. This would eventually result in the conversion of four RF amplifiers into nodes, and the addition of fiber, in order to provide additional bandwidth per subscriber. The construction costs associated with upgrading amplifiers to nodes can be minimized by today's node solutions. (See Figure 2 on page 57.)

Today's node platform provides system operators with many options. Typical node configurations are easy to upgrade. You can migrate to the N-by-2 node, one step at a time, as your system demands more bandwidth and functionality. Each step provides incremental benefits to both subscriber and operator. The node configuration that cost-effectively optimizes the deployment of targeted services while increasing reliability is the N-by-2 node with a selectable switch and forward path narrowcasting. This node platform increases the available return bandwidth, allows the operator to deploy advanced access services, saves on reconstruction costs, and provides added subscriber reliability. If bandwidth demands continue to increase, deploying additional fiber and upgrading amplifiers to nodes is still an option since the overall system design techniques have not changed. (See Figure 3 on page 58.) The cost savings, subscriber reliability, and additional bandwidth provided by modern node platforms allows operators to maximize customer satisfaction and system revenues while increasing shareholder value.

> "As the serving area grows and subscriber density increases, each return leg will demand different amounts of bandwidth."

Selectable switching is the first step towards a more sophisticated return router switch with dynamic switching capability based on bandwidth demand and hardware availability. Although this concept is appealing for return path monitoring and control, it is understood that implementation difficulties still need to be resolved. CT

[Editor's note: For an expanded version of this article, contact Philips Broadband Networks, Inc.]

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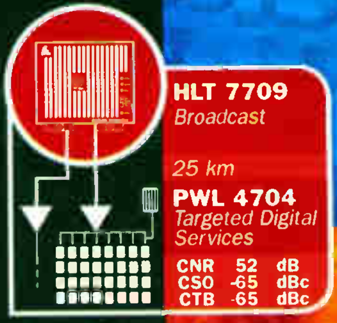

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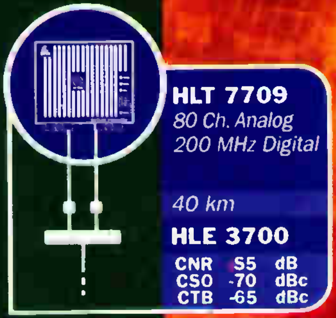

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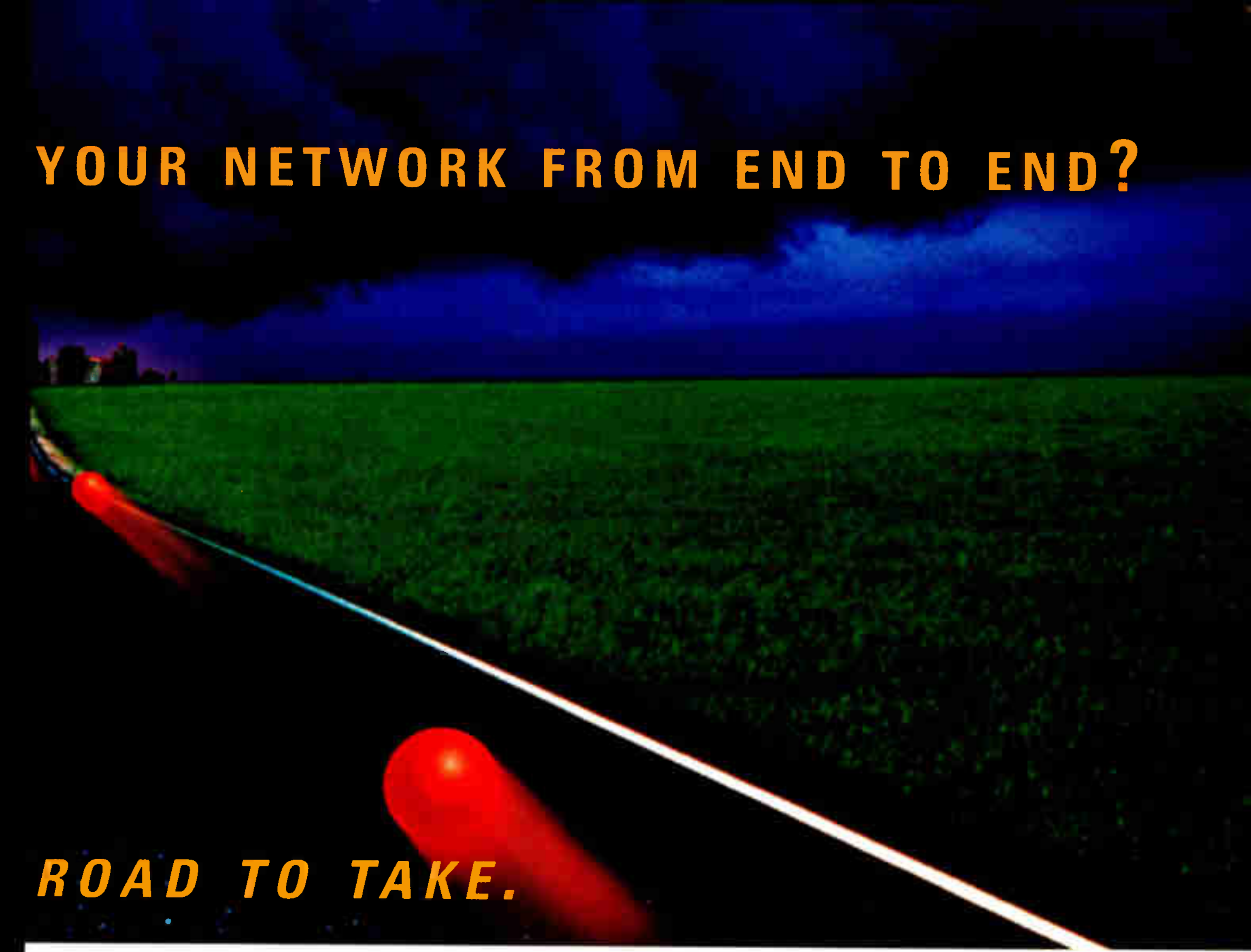

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The Need for Speed

The Case for Symmetrical Data Delivery on HFC

By Bruce McLeod

Beyond today's Internet super-consumers are tomorrow's fully active users who will expect high bandwidth, two-way data connections and, in effect, will reside in a virtual neighborhood.

Their usage patterns and expectations of Internet access and data bandwidth requirements have evolved and increased, bringing new challenges and opportunities for the hybrid fiber/coax (HFC) system operator. With symmetrical data delivery (SDD), the HFC operator can offer and deliver the flexibility and increased bandwidth to satisfy the appetites of the most bandwidth-hungry customers.

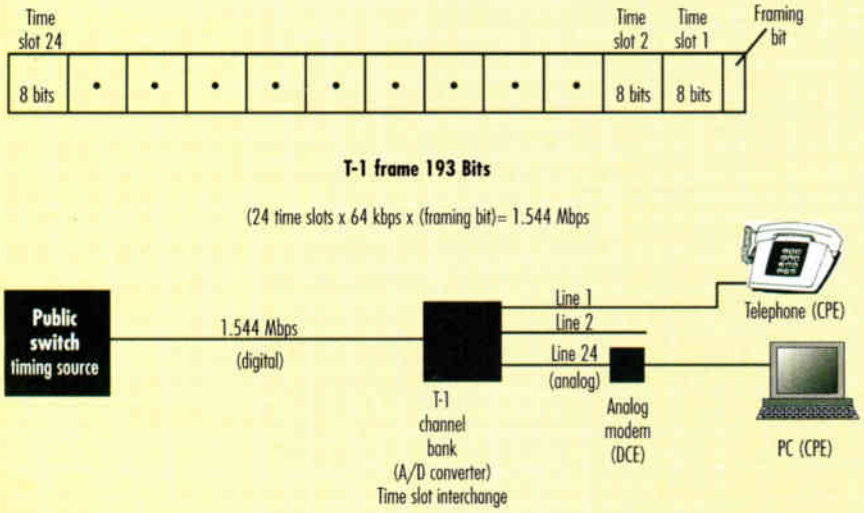
SDD is dedicated, two-way or duplex bandwidth over the HFC transport system located between the end-user modem and the network connection modem. (See Figure 1.)

Conventional high-speed symmetrical connections, such as T-1, employ time division multiplexing (TDM). With TDM, the data byte transmitted by the user is allocated a time slot in a telephony frame. In the basic T-1 frame, 24 64 kbps signals, or voice channels, are multiplexed to form a 1.544 Mbps data stream. The T-1 circuit from the switch and the data service unit (DSU), which converts computer data signals into switch compatible form at the user location, are synchronized to a timing source. The information contained in each time slot is then processed toward its final destination by the switch through the DSU to the Internet service provider's (ISP) router.

Symmetrical data connections

SDD, based on the telephony model (see Figure 2 on page 66), offers individual users dedicated, high-speed data capabilities that are not possible under shared media methods. This technology is implemented in an HFC system by

Figure 1: Symmetrical data/telephony transport on a telephone network



BOTTOM LINE

Feeding the Need for Speed

A new class of Internet user has emerged whose usage of the Internet exceeds that of the "super-consumer." This new class can be described as fully interactive participants residing in a virtual community.

Using the Internet to enhance and support their interests, and to share with and/or sell to others what can be volumes of information, the fully active participants crave more and more bandwidth to satisfy their Internet and Intranet needs.

Simply put, they want immediate data delivery, without saturated networks and sluggish bottlenecks impeding their process.

Hybrid fiber/coax (HFC) operators can be the new Internet service providers (ISPs) who are first in line to support and supply services to members of this virtual community—and in turn, reap profits and customer loyalty. ISPs can provide high-capacity, dedicated bandwidth by deploying symmetrical data delivery over an HFC system based on orthogonal frequency division multiplexing (OFDM) technology.

A symmetrical data delivery system offers users scaleable, high-speed, dedicated two-way bandwidth capabilities for telecommuters, home offices and small businesses.

demultiplexing the serial data streams and assigning the data from multiple time slots to a single user's modem.

Within a telephony and data delivery system, based on orthogonal frequency division multiplexing (OFDM), the data in each time slot can be modulated onto multiple radio frequency (RF) carriers and transmitted in parallel to the user's modem. The user's modem then demodulates and demultiplexes the data contained in the time slots back into a serial data stream. The amount of bandwidth provided to the user is a multiple of the number of 64 kbps voice channels allocated to the user's modem; the expression "Nx64k data" is derived from this concept. Permanent or "nailed-up" allocations can be 1, 2, 4, 8, 16, and 32 voice channels for data rates of 64, 128, 256, 512, 1,024, and 2,048 kbps, respectively.

An even more powerful utilization of available HFC bandwidth can be achieved using dynamic allocation of bandwidth to the end user. With this method, the user's modem generates an off-hook message as data is prepared for transmission. Available voice channels are allocated to meet the user demand and then de-allocated when the transmission is complete. For bursty traffic, this method allows concentration of available bandwidth that is transparent to the user.

Early ISPs

Consider the ISP's beginnings. The average ISP providing 14.4 kbps or 28.8 kbps dial-up service went into business in the early- to mid-1990s using a leased line from a telephone company for connection to the Internet. These leased line connections often started as only 56 kbps switched circuits or fractional T-1s.

The general rule of thumb at these user connection speeds is that a single T-1 can support 1,000 subscribers. This equates to only 1.544 kbps available per subscriber! To overcome this limitation, traffic is concentrated based on the number of modems at the ISP site. An 8:1 ratio of subscribers to modems allows 12.5% of users to be on-line at any given time. The ISP also offered business customers expensive, dedicated fractional T-1 data circuits (128, 256, 384, etc., up to 768 kbps) to the Internet, multiplexed onto the ISP T-1 Internet backbone connection.

Early dial-up ISP subscribers quickly noticed an increase in the number of busy signals and decreased performance as ISP analog modem and T-1 capacity became saturated. As the subscriber base grew, the ISPs added analog modems, incoming phone lines, and increased leased line capacity to the Internet, but these upgrades generally did not overcome the fundamental limitations of dial-up ISP systems.

Figure 2: Symmetrical data/telephony transport of an HFC network

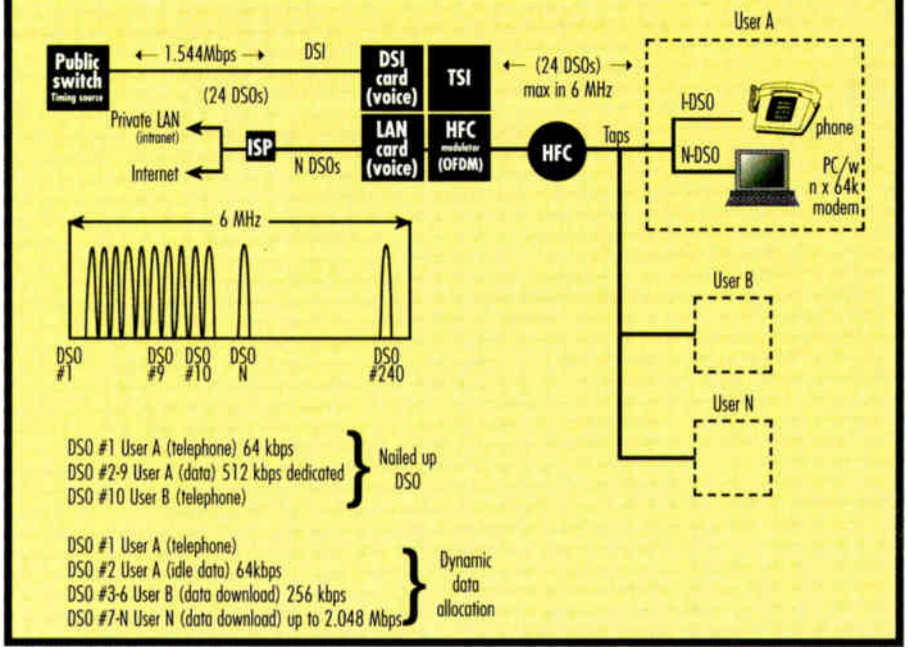
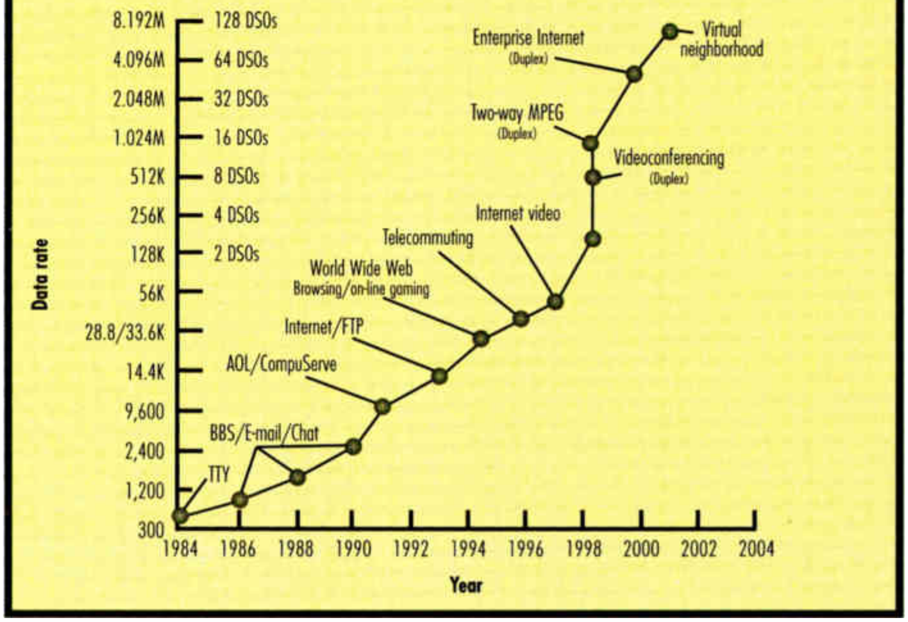


Figure 3: Evaluation of data applications and bandwidth requirements



In addition, many ISPs found it difficult to keep up with user demand as unlimited time and flat-fee subscriptions became common. Despite these drawbacks, most local ISPs still employ only T-1 or multiple T-1 connections to the Internet backbone because of the proportionally high cost of implementing advanced transport methods such as DS3 (45 Mbps), asynchronous transfer mode (ATM) or synchronous optical network (SONET).

Connection delays and service reliability caused many early dial-up subscribers to look for alternatives to the local ISP. This in

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turn opened the door for national ISPs, such as Sprint and AT&T, who have the financial and technical capability to provide local number service in most areas. National ISP service has been the standard for dial-up connections until the rollout of asymmetrical high-speed HFC cable data modems began in late 1996. Today, higher download speeds and a deluge of accessible information have fostered the development of an Internet "super-consumer." The evolution of the super consumer is an indicator of the next emerging market that must be satisfied.

Traffic jam

Many HFC operators follow the model of the early ISPs and employ only T-1 and multiple T-1 connections to the backbone. This creates a data throughput bottleneck that can prevent HFC data subscribers from realizing the full benefits of the 30 Mbps downstream bandwidth available from some of these systems. In traffic models with three or more users downloading high volume data (such as streaming video or videoconferencing), the user is lucky to have an effective downstream data rate of over 400 kbps. Internet backbone connections should have data rates that are equal to the maximum downstream demand. The HFC upstream is even more critical because cable data modem systems generally provide a reduced amount of shared bandwidth of 2 to 10 Mbps. In the case where a single user is transmitting a great deal of data, upstream congestion can slow downstream effectiveness, independent of the backbone connection rate. This is due to the requirements of acknowledgment messaging sent by the user under Internet protocols while downloading information. The effect of these two bottlenecks is to deny HFC operators the capability to provide service to the next wave of emerging customers.

> "Higher download speeds and a deluge of accessible information have fostered the development of an Internet 'super-consumer.'"

Two-way traffic

While Internet access subscriptions continue to grow at exponential rates, it is becoming apparent that Web browsing is merely a first step for many Internet subscribers. For others, it becomes a confusing and frustrating exercise of patience in a short-attention-span culture. When some subscribers' efforts are not met with immediate results, they quickly lose interest. The slow acceptance of WebTV

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illustrates this clearly. Some users will continue to use the Internet in a passive manner like the automatic downloading of the "push" concept from World Wide Web (WWW) services such as PointCast. But for many, it is the beginning of a new and changed lifestyle.

Arising from the user group that embraces the active capability of the Internet is a new class of on-line users. These new users will be information providers as well as information consumers. Many will desire to be fully active residents of virtual neighborhoods and seek to make data delivery activities the basis of their livelihood. They will require dedicated bandwidth to the Internet backbone equal to, or greater than, those of the early ISPs.

Here is an example of the type of application for which the capability of the Internet could be tapped. An HFC system operator was approached by a group of doctors who asked if his company could provide the transport capacity that would allow them the capability for flicker-free videoconferencing. The physicians' group wanted to demonstrate medical techniques, have multi-party discussions, and host on-line forums. The HFC system operator was frustrated as he realized his system's current upstream bandwidth could not provide the needed capacity to deliver this service. Consequently, the only option was for each doctor to lease his or her own T-1 service through an ISP/telephone company at a subscription rate of over $1,000 a month! A symmetrical cable data delivery system would allow dynamic allocation of Nx64 kbps channels as needed for each of the physicians' functions at a greatly reduced cost.

This is an example of new revenue sources that can be realized with HFC systems that offer scaleable, dedicated symmetrical data delivery. Other revenue opportunities include telecommuters, home offices, small businesses that need reliable intranets and extranets as they push into national and global markets, and the new Internet entrepreneur who has revenue opportunities we can only imagine. (See Figure 3 on page 66.) Emerging twisted-pair copper technologies such as high bit-rate digital subscriber line (HDSL) are symmetrical in their nature, and capable of meeting this market need. Symmetrical data delivery over an HFC transport system using OFDM technology is designed to give the HFC operator an edge in the integrated video, voice, and data marketplace.

For HFC system operators, a unique window of opportunity exists to provide users with high-capacity, dedicated bandwidth to and from the Internet, and to provide high capacity bandwidth intranet/extranet connectivity. The symmetrical data delivery platform can help HFC operators develop a large and loyal base of high-bandwidth subscription customers.

Bruce McLeod is senior systems engineer, broadband division for ADC Telecommunications Inc. He may be reached at (612) 946-2293 or by e-mail at: brucemcleod@adc.com.

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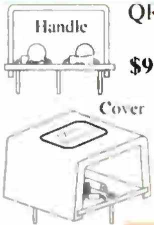

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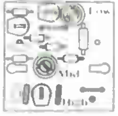

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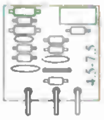

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SXP-T-Top Pads for Scientific Atlanta & *Augat*

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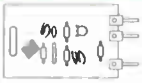

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Nominal Values are:

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330-400 MHz values: 4, 8, 12, 15, 18 dB

450 MHz - 4, 6, 8, 10, 12, 14, 16, 18, 20 dB

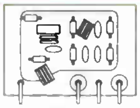
475 MHz - 4, 6, 8, 10, 12, 15 dB

TEXSCAN "T-SERIES" PADS - $5.00

0, 1, 2, 3, 4, 5, 6 dB

9, 12 and 15 dB

For Philips/Magnavox



QMAG-6 for 62E Series

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400 MHz - 2, 5, 8, 11, 14, 17, 20, 23, 26 dB

450 MHz - 2, 5, 8, 11, 14, 17, 20, 23, 26 dB

550 MHz - 2, 5, 8, 11, 14, 17, 20, 23, 26, 29 dB

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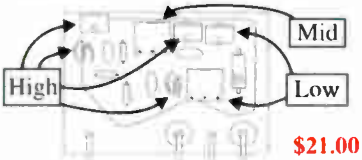

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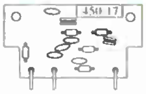

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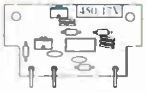

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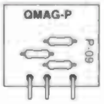

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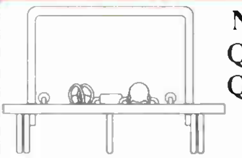

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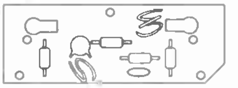

QAE top view, shown without #871 handle.

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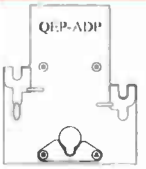

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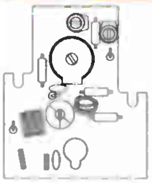

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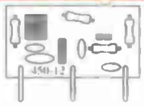

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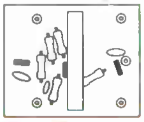

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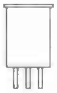

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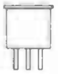
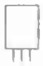


JXP-A-* 750 MHz **$2.90**



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data over cable

Headend to the Home

The SCTE Standard Data-Over-Cable RF Interface Specifications

By Ted Woo, Ph.D.

The State Department of the United States is submitting a contribution on the study of multimedia data transmission for nonhomogeneous cable transmission systems to the International Telecommunications Union.

The purpose is to advance the timely development of useful and standardized methods for data transmission over cable TV networks, according to Dr. Richard R. Green, president of CableLabs. This contribution represents a completed specification that satisfies the immediate needs of the United States industry. The following article summarizes this submitted specification. It introduces an all-coax or hybrid fiber/coax (HFC) two-way transmission network with the principal function of Internet protocol (IP) transmitted between the headend and the subscriber location. Discussed are the general functional assumptions, communications protocols, physical layer and media access control specifications, as well as the interaction between the cable modem and the cable modem termination system.

The newest Society of Cable Telecommunications Engineers standard seeks to add cohesion and polish to the already popular data transmission function of the cable telecommunications industry. It is called Data-Over-Cable Radio Frequency Interface Specifications.

This standard defines the internal and external network interface for a system that allows transparent two-way transport of IP traffic between the cable headend and the end-user customer premises, over a cable TV network of coaxial cable or hybrid fiber/coaxial (HFC) cable. Experience in high-speed data communications over cable systems today has shown that this technology works very well, and the end-users are quite satisfied with the high-speed connectionless service. The radio frequency specifications are part of the overall interim data-over-cable specifications, which are subject to improvement.

Advantages of this standard include the following: cable operators can get

BOTTOM LINE

What the Standard Means To Operators and End-Users

This standard specifies radio frequency (RF) interface data transmissions as they originate at cable TV headends and go into customers' homes and businesses. It defines the characteristic of the RF interface on the cable system and the signaling sequences between the headend and the subscriber's equipment as part of overall data-over-cable specifications.

The standard will enable the interoperability of cable modems from one cable system to another. By having a standard modem, cable customers may enjoy better prices and more choices in purchasing cable modems. The customer also will have some assurance that the cable modem will have access to a new family of services and options that may be enabled by high-speed access to the Internet.

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equipment from multiple suppliers; the interoperable products enable simpler maintenance and reduce inventory costs; the interchangeable specifications allow early modems developed to this specification to work on cable systems even though more advanced service capabilities may be added to new modems in the future; cable modems that work on a data-enabled cable system may be purchased by the end-user consumers from a retail store; and producers will minimize risks by designing and manufacturing to such specifications.

This specification enables the commercial availability of navigation devices, where the cable modem is a typical product. Products from multiple manufacturers with interoperability promote competition that benefits both cable operators and end-user consumers. The standard promotes investment savings since the early interoperable modems will not be lost when advanced modems are introduced.

The selection parameters for development of this specification were generated based on meeting basic performance, features, and cost for the first five years of service. These areas required:

1) IP transparency and support for various grades of service.
2) Minimized intellectual property issues and costs.
3) Technology to be tested and implemented.
4) Timely availability of prototypes for testing and high-volume deployment equipment.
5) Support for evolutionary aspects of the architecture, meaning the protocols are layered so as to be decoupled and include the ability to support the future upgrades and changes by negotiating the physical and higher-layer protocols.
6) Technology-based performance or feature benefits.
7) Support for additional supplier-specific features and added value.

In general, for this data-over-cable system, the cable modem termination system (CMTS) is located at the headend of the cable network, and the cable modem (CM) is located at the end-user customer premises. This document defines both the characteristics of the radio frequency interface on the cable system and the message sets and signaling sequences between the CMTS and the CM that are necessary to achieve interoperability.

In the future, new types of CMTSs and CMs with enhanced capabilities may be introduced that cannot be properly outlined today. These capabilities may include new physical-layer modulation encoding, new and improved configurations within the defined physical-layer encoding, and different traffic flows and classes of service. Future-proofing is provided, in the protocols, to permit new types of CMTSs and CMs to set up communication on an

enhanced basis. Meansalso are provided to download new software to cable modems over the cable network.

This document became an SCTE Data Standards Subcommittee (DSS) adopted standard on July 23, 1997, in Vail, CO, based on balloting within this standards developing subcommittee under the direction of DSS Chairman David Fellows. This standards document's designation is SCTE DSS-97-2. Following subcommittee adoption, the DSS standard was voted upon in the SCTE Engineering Committee on July 31, 1997, under the direction of Engineering Committee Chairman Dan Pike. Based on unanimous affirmative responses from all members of the Engineering Committee, DSS-97-2 became an SCTE standard on August 1, 1997, in Exton, PA.

CableLabs delivered this document to the U.S. State Department Study Group 9, from where it was then submitted to the International Telecommunications Union-Telecommunications (ITU-T) in August to be considered as an international standard. The SCTE Standards Department plans to submit this standards document to the American National Standards Institute for recognition as a new American national standard in the near future.

Ted Woo is the SCTE Director of Standards, and is responsible for the Society's standards development activities in the areas of interface practices and in-home cabling, data standards, digital video, emergency alert systems, maintenance practices, design and construction, and material management. He is an active member of SCTE and the Institute of Electrical and Electronic Engineers. He can be reached at (610) 363-6888, ext. 228, by fax at (610) 363-7133, and by e-mail at twoo@scte.org.

Secrets to Understanding Software Standards

By Bob Feather

Vendors of network and element management software often claim to be compliant with software "standards." Beware. "SNMP compliance" does not ensure that the software will be plug-and-play with other vendors' software.

And SNMP (simple network management protocol) is only one of dozens of "standards" that might be considered. The dilemma of planning for future operational support integration is confusing given the complexity of the integration process and the number of standards that need to be considered. This article describes what you should know about standards before making decisions on network management systems that will impact future software integrations.

Network management systems (NMSs) and information management systems (IMSs) have evolved through several generations, and each new evolution of technology is accompanied by a shift in software engineers' and developers' thought processes for design and problem resolution in architecting systems.

To maintain some sense of consistency through each evolution, programmers rely on software standards. Let's concentrate on a few of the application layer standards that are very important to the successful operation of an NMS. A simple NMS contains two entities that cooperate to gather network data and to conduct network analysis: managers and agents.

Managers

The NMS manager collects and manages fault information gathered from network elements (NEs) and delivers the collected data in the form of an alarm to the system operator. The operator then can decide which steps are required, if any, to eliminate the alarm. Network statistics and device attributes are collected from network device agents; the data is stored for later analysis or presented to other real-time applications for display and analysis.

A manager's role is to interface with many applications to provide the combined services offered by a NMS. A manager has several components where standards can be applied internally to produce external interfaces that assist in linking various software components together. Utilizing standard interfaces to other software applications provides the ability to modify the applications interfaced to the manager without changing the manager or compromising its architecture. This allows NMS maintenance to upgrade applications with new technology, correct bugs or add new applications without affecting other NMS services.

Agents

Network agents perform two basic services. First, they communicate with the manager utilizing the network management protocol. Second, agents execute requests from the manager and return an appropriate response. An agent's response can contain information including, but not limited to, status information, attribute data or even alarm information. (See Figure 2 on page 78.)

An agent that serves as a mediator between the network elements and the NMS manager is known as a proxy agent. Proxy

BOTTOM LINE

Software: Beyond the Alphabet Soup

From SNMP to SQL to CMIP—defining and understanding software standards is crucial when implementing a complete network monitoring system. Once you've decided to invest time and money in a network management system, you also should devote some time to learning about the many software standards you'll encounter.

But beware. While many vendors declare their products to be SNMP compliant, that does not necessarily mean they will be plug-and-play with other vendors' applications.

Remember, software standards are good. The key is determining which standards will most benefit your plant.

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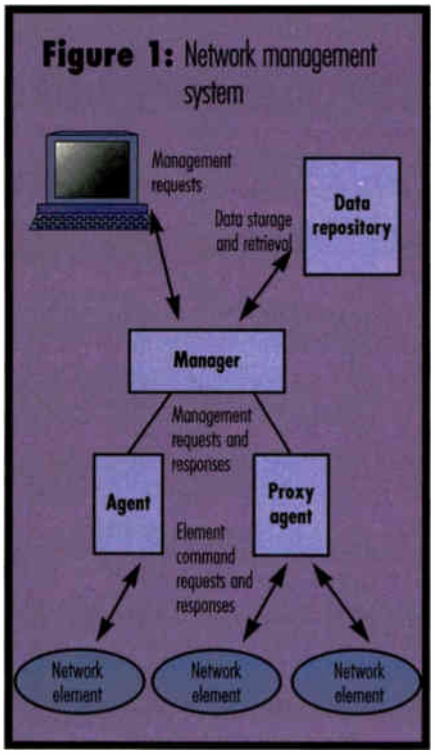


Figure 1: Network management system

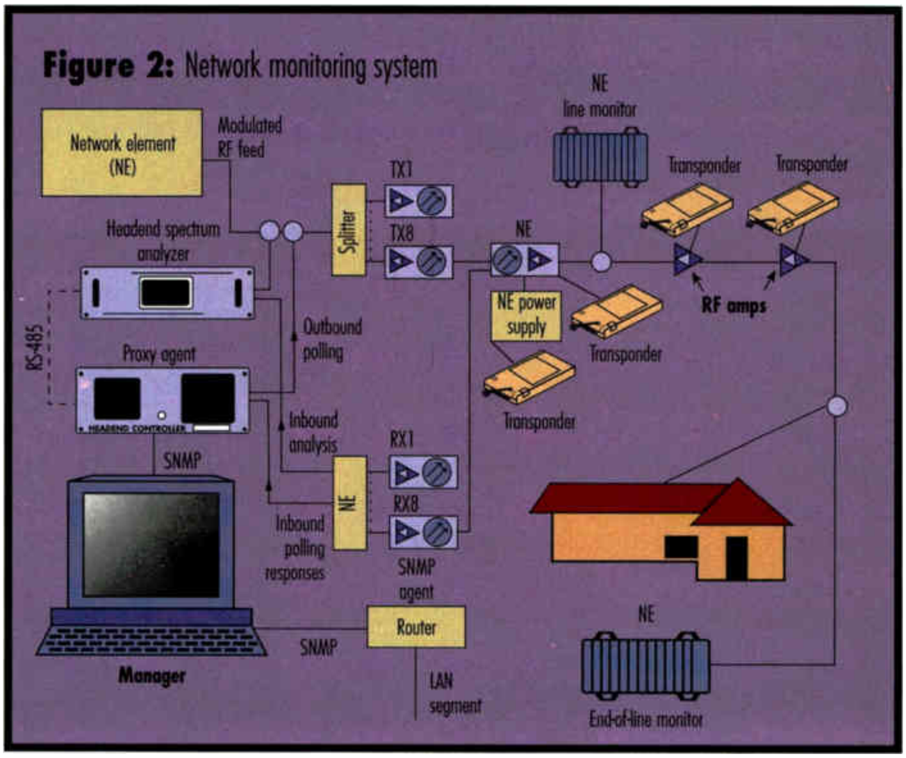


Figure 2: Network monitoring system

agents provide the traditional agent functionality and more—generally, proxy agents convert proprietary protocols required by the proxied network elements to the network management protocol in use.

Let's investigate a few of the categories and ask some questions of the NMS to determine whether our NMS is maintainable, expandable and state-of-the-art.

Client-server standards

Client-server standards are important for manager applications. The structured query language (SQL) standard specifies a mechanism for software applications to access data—regardless of location or storage format. SQL is a relational database access standard that specifies the syntax and functions of a relational database query. SQL also outlines query syntax for database accesses and syntax for defining, creating and updating relational database tables and table data—thus supporting standard report-generating tools.

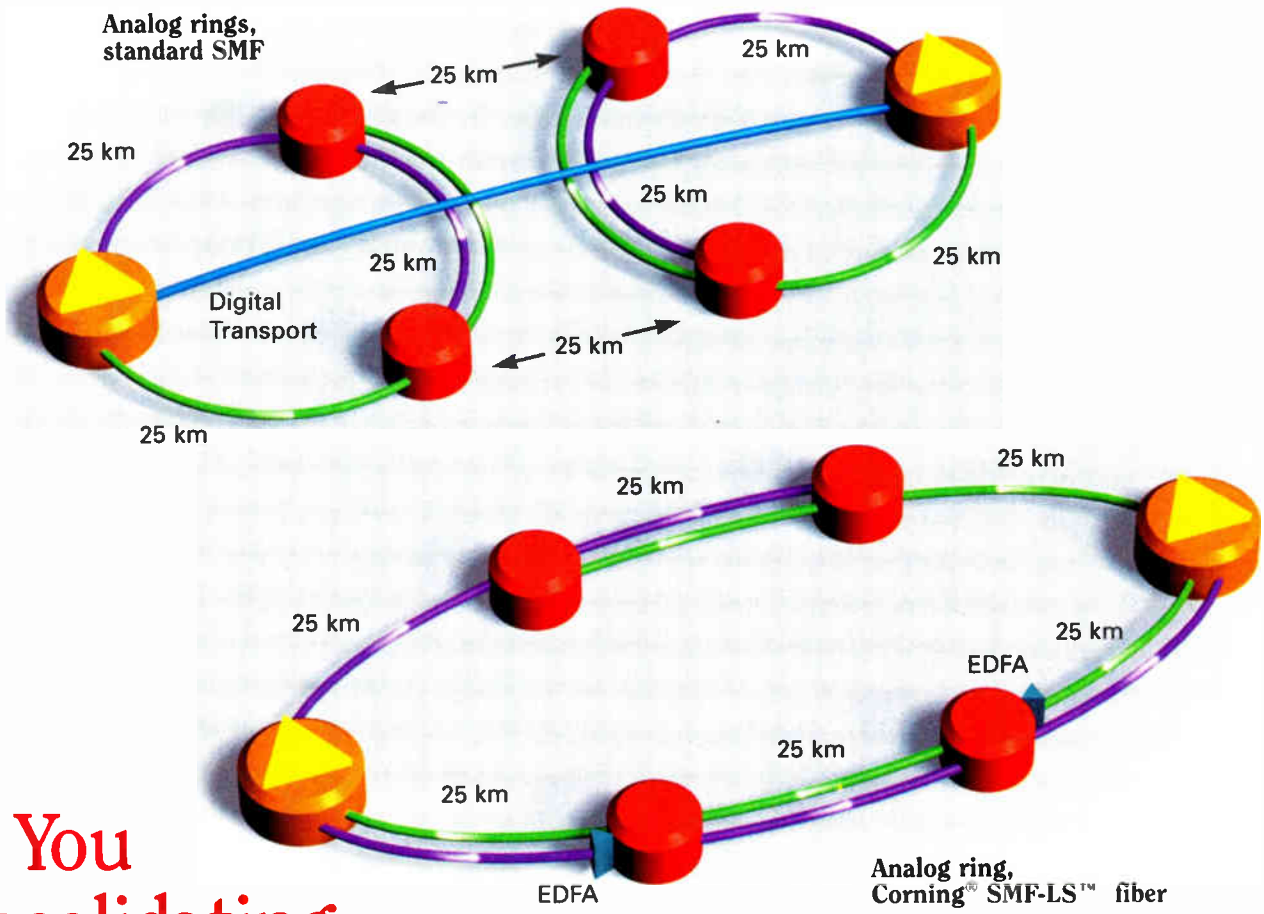
Programming language standards

I'm purchasing a turnkey NMS solution. Can the implementation language or languages impact my purchase decision?

Absolutely.

Languages such as C++ and Java are standards that help ensure the portability of an application from one computer vendor's hardware to another. Therefore, users can have a choice of which hardware platform to purchase.

For example, ANSI standards for the C/C++ languages are supported by many vendors. And while many companies develop using C/C++ compilers, many of these companies have proprietary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extensions to the language that are not portable across hardware vendors' platforms. Tapping into these proprietary extensions to the standard could lock you in to a particular vendor's maintenance support and even limit your current and future hardware upgrade choices.

Standard languages also are supported across many operating systems such as the many UNIX variants and Windows NT/95. With code portability across operating systems and hardware platforms, the make-up and configuration of your NMS solution can be configured to meet your needs.

Communications protocol

Managers communicate with agents to retrieve network data and statistics. To accomplish this, the manager and agents must use and understand the same communications protocol. Managers frequently support multiple protocols to different agents. The most common manager/agent protocols referenced today are the Common Management Interface Protocol (CMIP) and the SNMP. SNMP is the most widely deployed management protocol in use today.

Using an accepted standard protocol allows the manager to communicate with any vendor's agent or proxy agent that supports the selected standard protocol. Also, by purchasing network elements that support a standard communications protocol, any manager that supports the protocol can monitor the element.

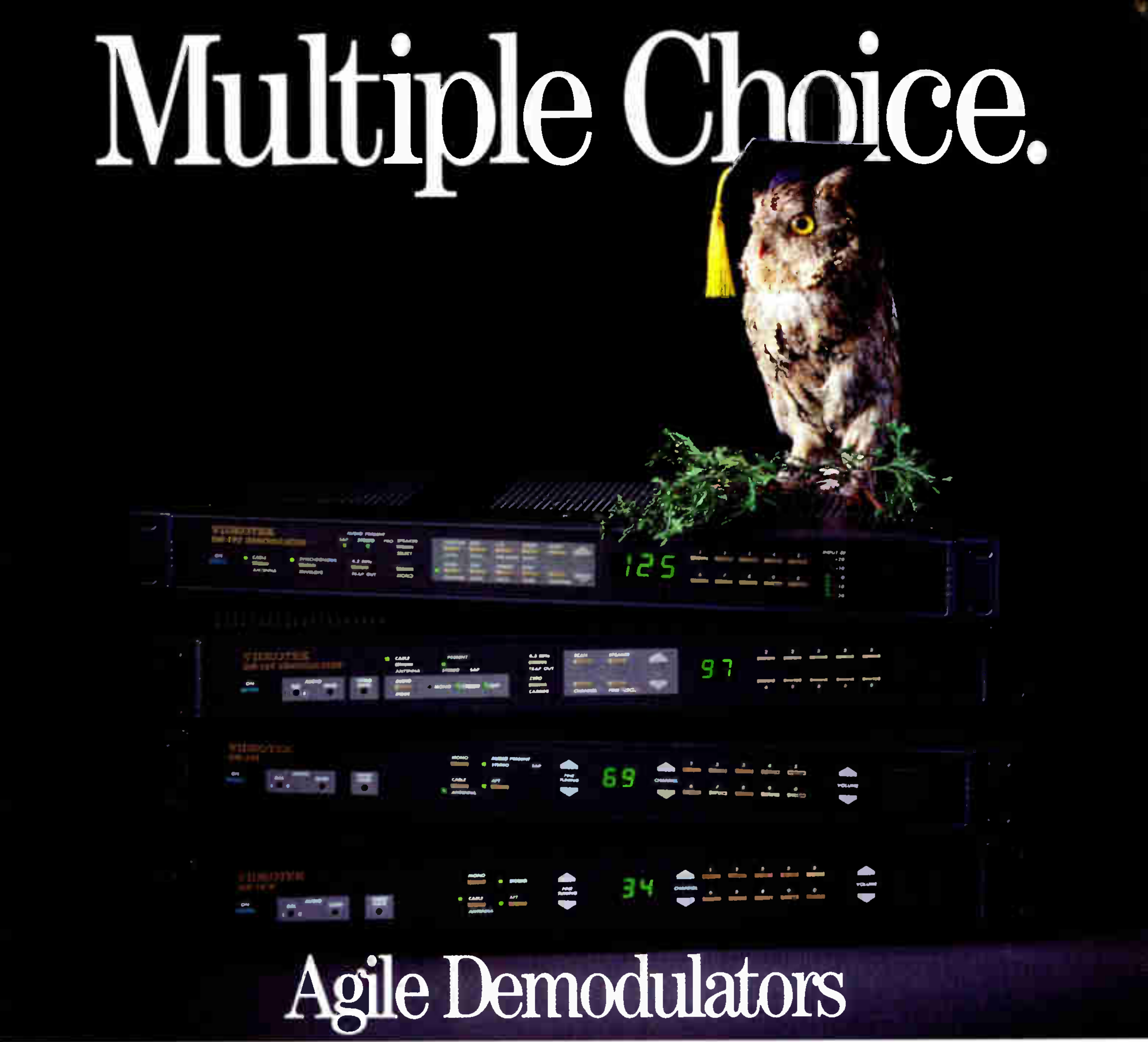
SNMP is the current standard for internetwork management. SNMP is simple in concept and is a management protocol that defines data types, formats and types of program data units (PDUs) used to communicate information between the manager and agents. While simple to implement and to use, SNMP is only a management protocol. It is only a specification of how the manager communicates its requests to agents. The manager and agents must agree upon a defined set of attributes for each different piece of network hardware to be managed. Each manageable attribute is known as an object and each object has a unique identifier referred to as its Object ID (OID).

The entire collection of OIDs for a device is referred to as the device's management information base (MIB). The MIB is the published list of attributes that are supported by the vendor's SNMP agent for a specific piece of hardware.

Controlling costs with standards

Simply because a manager and agents can communicate with the same protocol does not mean the manager can actually manage the network element. To manage a device, the NMS must understand what the device is doing and what impact it has in the network. SNMP managers basically can access data from any SNMP agent.

Great, I can retrieve attribute data from an SNMP agent, but what do I do with the data? How do I process it? Here is where the power and flexibility of the NMS design comes into play. Now some really tough questions need to be answered to ensure ongoing maintenance costs are controllable throughout the system's expected life cycle. ➤


Multiple Choice.
Agile Demodulators

Can a new Network Element with a new MIB be incorporated into my NMS at no additional cost? If the answer is yes, you have a good start. If the answer is no, then each time you add or replace an existing Network Element with a new type of element you will be paying the NMS vendor more money to incorporate support for the new element—or do the programming in-house.

If the answer is no, the next question should be: *Do you offer an SNMP API that my in-house programming staff can use?* Obviously, if the answer is no, this eliminates the possibility of your staff developing integrated applications with the NMS and you will end up paying the NMS vendor or a third-party developer to incorporate the new element support.

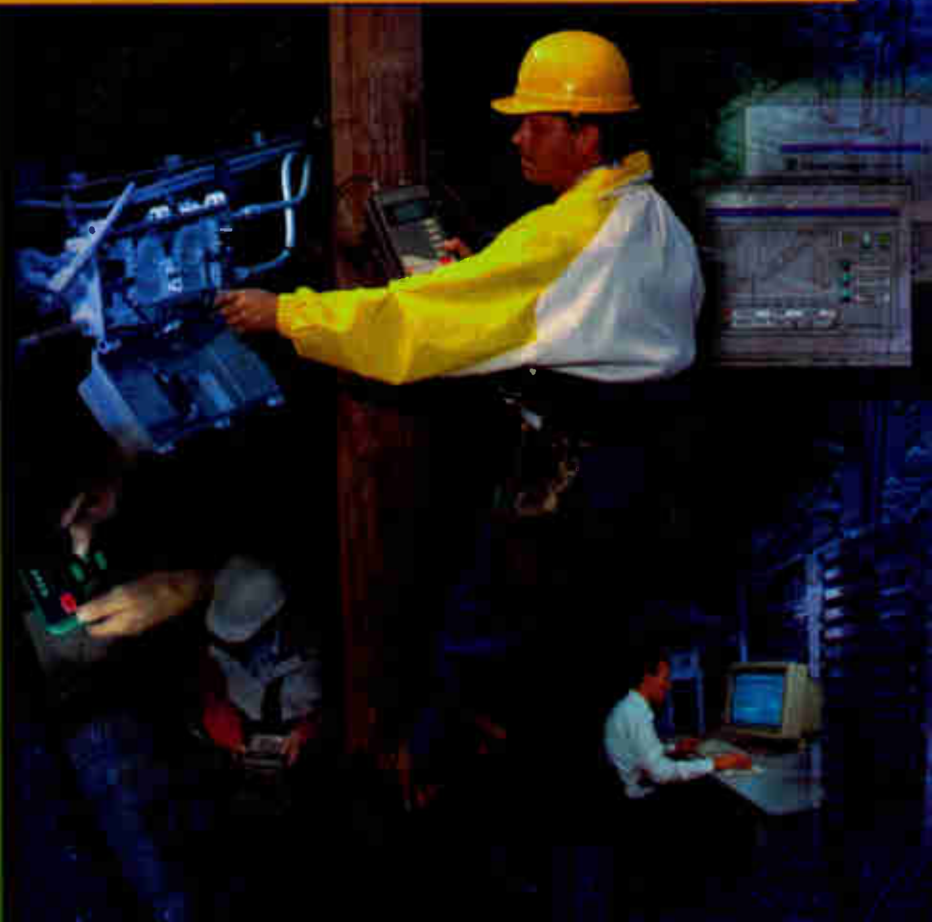
What functions of the NMS are supported for the new network element when I install the new element to be managed using only the tools provided with the NMS? The best answer is that all of the NMS functions apply to the management of Network Elements. Supported functions should include fault monitoring and acquisition; real-time display of element data; storage of element data in the data repository as it is collected; and recall, analysis and display of the archived data. Also, element control and configuration of parameters such as alarm limits, channels to be monitored, and the list of data attributes to monitor should be supported by the NMS with no additional development required.

Is the new element's attribute data available for processing by an Expert System and other support applications? If yes, you also need to ask whether the support applications require modification to process the new data. For example, is the new attribute data utilized by the Expert System application in the root-cause analysis processing when determining network failures, and if so, how? You also need to find out whether the Expert System tool sets allow modification of the rules while the system is executing. Will the monitoring system be required to be halted while new rules are installed to incorporate processing for the new network element?

These are some important questions you should feel comfortable asking of your current or prospective NMS vendor. CT

Bob Feather is senior principal engineer for Superior Electronics Group Inc. He can be reached at (941) 756-6000.

WHEN IT COMES TO RETURN PATH MAINTENANCE



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STOP INGRESS AT THE SOURCE

The Guardian RSVP Return Path Evaluator stops ingress where it starts: the subscriber's home. Up to 200 RSVPs can communicate with each Guardian 9580 SST in the headend to verify that the return path meets requirements. Working with a Guardian IsoMeter Reverse Leakage Detector, the RSVP verifies the shielding integrity of the home wiring, hardening your system against ingress with every installation and maintenance visit.

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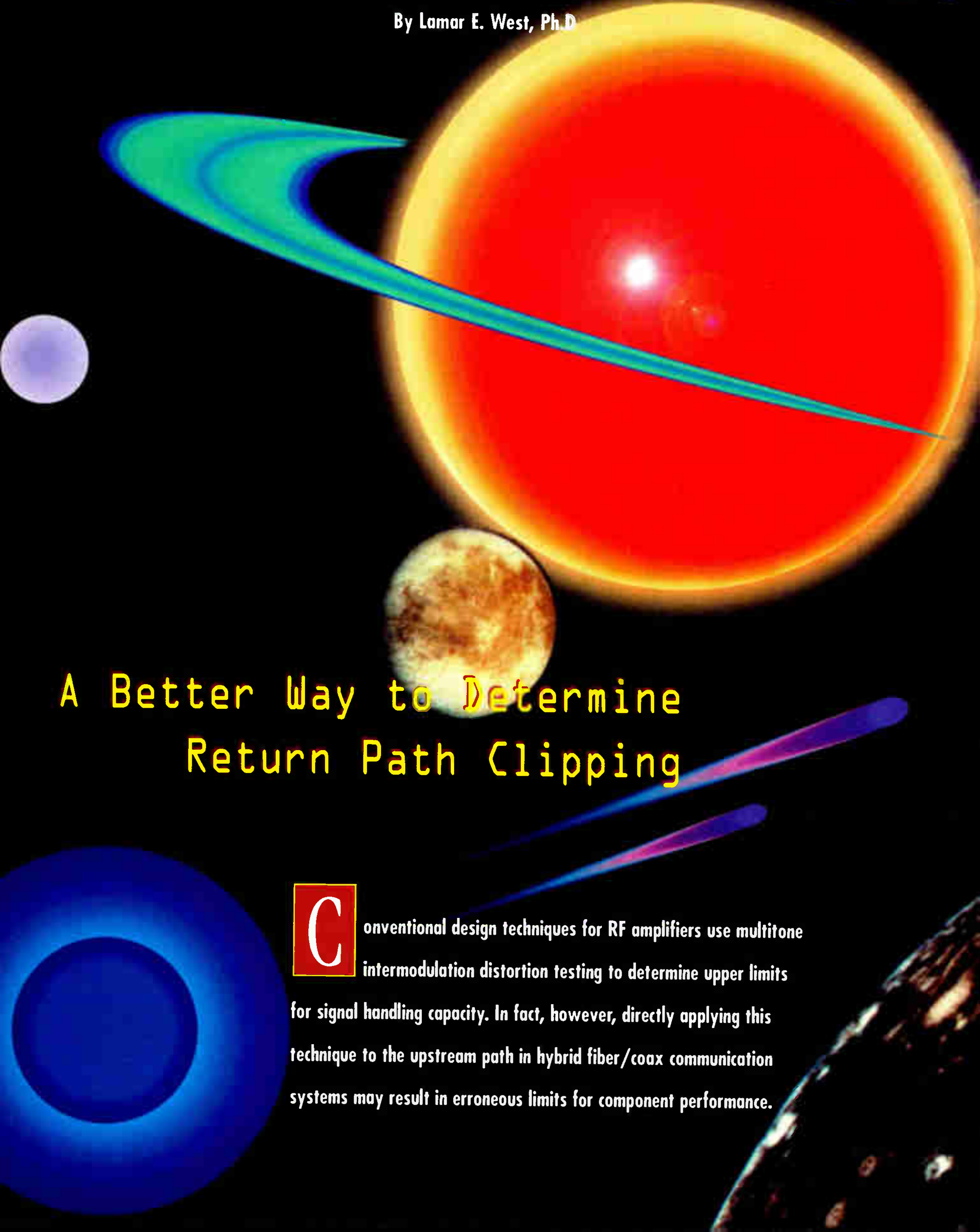
The Outer Limits

By Lamar E. West, Ph.D

A Better Way to Determine Return Path Clipping



Conventional design techniques for RF amplifiers use multitone intermodulation distortion testing to determine upper limits for signal handling capacity. In fact, however, directly applying this technique to the upstream path in hybrid fiber/coax communication systems may result in erroneous limits for component performance.

Later in this article, I'll describe some of the problems with this technique and suggest a more appropriate method. I'll also discuss several factors that discourage the "constant power-per-hertz" rule for assignment of subcarrier relative amplitudes on the reverse path.

RF amplifier techniques

Previous methods of characterizing RF amplifier distortion performance in broadband subcarrier multiplexed (SCM) networks have centered around intermodulation distortion (IMD) as the limiting factor for performance. This is clearly the case for downstream applications where up to 110 conventional analog video carriers may populate the spectrum. In this case, composite triple beat (CTB) and composite second order (CSO) dominate the distortion power spectrum.

RF amplifiers used in broadband CATV applications exhibit mild nonlinearities. Unfortunately, a frequency dependence exists in these nonlinearities that makes a full analytical treatment extremely challenging. In practice, we generally approximate the amplifier characteristic by means of a truncated Taylor series expansion and include the frequency dependence in the model by means of empirical measurement of CTB and CSO. As shown in Formula 1, which follows, beginning with input, V_I, and output, V_O, (equivalently, these could be currents) we have

Formula 1:

$$V_o(t) = a_1 V_I(t) + a_2 V_I^2 (t) + a_3 V_I^3(t)$$

where

a_1 = gain and a_2, a_3 = functions of the device to be characterized.

Over the normal range of signal amplitudes, terms of order higher than three are small enough that you can ignore them. Because of AC coupling, you also can ignore any DC terms. The a_2 term is associated with second order IMD (CSO) and the a_3 term is associated with third order IMD (CTB).

Amplifier distortion is characterized using a spectrum of unmodulated continuous wave carriers (CW) at a known power level. The distortion performance under power loading conditions may then be predicted based on the previous measurement. Power scaling for distortion performance using the "one-for-one" rule for CSO and the "two-for-one" rule for CTB has been described in detail in previous CATV literature.

This technique also has been used for characterizing RF amplifiers for the return (upstream) path for two-way RF CATV networks. In the case of reverse path RF amplifiers, as in the case of forward path RF amplifiers, IMD is usually the primary factor limiting system performance. CW tones are used to characterize IMD performance in a manner similar to that used on the downstream path. This characterization typically uses five or six tones, located at the picture carrier frequencies of the standard T-channels.

When these amplifiers are loaded with signals other than conventional analog video, it is possible to predict performance based on the number and magnitude of individual distortion products measured during the characterization. Quite often the design guidelines are simplified to indicate that IMD performance may be predicted based solely on the composite RF power in any given 6 MHz T-channel band. In such a case, additional IMD products generated by replacing a single carrier with multiple carriers are ignored due to their small amplitude as predicted by the truncated Taylor series expansion given in Formula 1, in the preceding column.

Laser characteristics

In the case of an optical link carrying broadband subcarrier multiplexed signals, system performance also is limited by distortion. In most reverse path optical links, the laser dynamic range is so small that this distortion is due to laser clipping.

In a transfer characteristic for a typical laser, the laser optical output power is a function of the laser current. The laser is given a DC bias I_B. The signal current is summed with this DC bias current. Laser clipping occurs when the instantaneous laser drive current drops below the laser threshold current, I_{TH}. In such conditions, laser optical output power goes to zero. Think of the laser optical output as the sum of an ideal, linear term and a clipping noise term.

Unlike the conventional CATV broadband RF amplifier, the laser diode is essentially a memoryless (frequency-independent) device over the frequency range of interest to the broadband hybrid fiber/coax (HFC) network designer. Therefore, it is completely appropriate to use the Taylor series expansion of the transfer characteristic to describe the laser. Unfortunately, due to the severe nonlinearity around I_{TH}, it is inappropriate to truncate the Taylor series representation of the laser after the third order term. Many higher order terms become quite significant in the transfer characteristic. A typical transfer characteristic is given in Formula 2, as follows:

Formula 2:

$$V_o(t) = a_1 V_I(t) + a_2 V_I^2(t) + a_3 V_I^3(t) + a_4 V_I^4 + \Lambda$$

If we examine the laser drive signal for a laser in an upstream optical link, that current will be made up of the sum of the carriers to be sent over that link. In the case of the downstream path, we make measurements using a multitone generator (typically a Matrix generator). This multitone generator simulates the individual channel carriers with a CW signal (that is, a sine wave). In such a case, the mathematical equivalent of our model would be:

$$I = A \cos(2\pi\ f_1 t + \phi_1) + A \cos(2\pi\ f_2 t + \phi_2) + \cos(2p\ f_3 t + \phi_3) + \Lambda$$

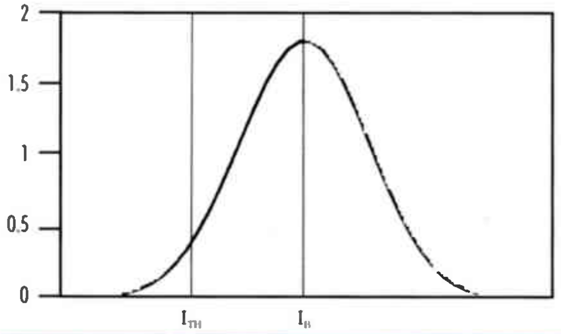
where

A is the amplitude of all of the carriers (we assume a flat spectrum), f_1 is the frequency of the first carrier (for example 55.25 MHz), ϕ_1 is the phase of the first carrier, f_2 is the frequency of the second carrier (for example 61.25 MHz), ϕ_2 is the phase of the second carrier, etc.

We can make a similar model for signals in the upstream path. As a simple example, consider an upstream link that is carrying 250 narrowband (49.5 kHz) quadrature phase shift keying (QPSK) telephony carriers centered at 20 MHz. As in the case of the downstream path, we will model the carriers as CW (sine waves). Our upstream model becomes

$$I = A_1 \cos(2\pi\ f_1 t + \phi_1) + A_2 \cos(2\pi\ f_2 t + \phi_2) + \Lambda + A_{250}(2\pi\ f_{250} t + \phi_{250})$$

Figure 1: A sample probability density function for the laser input signal current



where

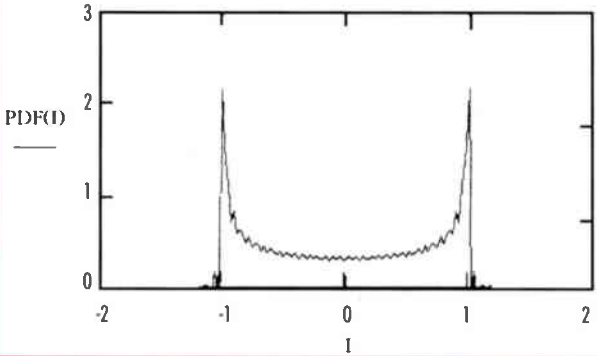
A_n is the amplitude of the *nth* carrier, f_n is the frequency of the *nth* carrier, and ϕ_I is the phase of the RF IPPV carrier, ϕ_n is the phase of the *nth* carrier.

Plugging this equation for I into the Taylor series expansion shown in Formula 2 would be a real mess. What we need is a modeling technique that will facilitate predictions of clipping performance with arbitrary signal loading.

Five tone method results

To make the analysis of laser clipping easier, one simulation tool accurately models the laser transfer characteristic and determines the optical link output for a given input signal. We carried out a simulation of laser clipping effects. The laser was loaded with 250 narrowband (49.5 kHz) QPSK carriers centered at 20 MHz. The resulting carrier to clipping distortion ratio is approximately 47 dB. The simulation was repeated with the carrier amplitudes increased by 6 dB. The carrier to clipping distortion ratio is reduced to approximately 24 dB—a decrease of 23 dB! Clearly, the distortion does not follow the conventional one-for-one or two-for-one CSO/CTB rules. Higher order terms of the Taylor series expansion must be considered.

Figure 2: PDF of a single CW tone



The inclusion of the higher order terms makes it impossible to ignore the effect resulting when a single carrier is replaced with multiple carriers, even if the average power remains constant. One must consider the instantaneous peak power, or equivalently, the instantaneous peak current.

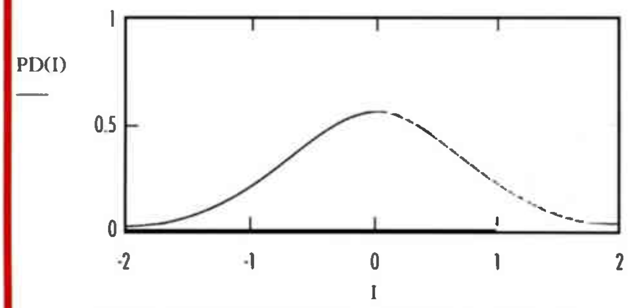
As an example, let us consider the simple case of a laser that was characterized for distortion using the five tone method. Assume that five equal amplitude CW carriers at 6 MHz spacing are applied to a laser. Their amplitude is increased until the onset of clipping distortion is obtained. At the onset of clipping, the peak signal current, I_{peak}, would be:

$$I_{peak} = I_B - I_{TH} = 5 \times I_N$$

where

I_N is the peak current of each carrier individually.

Figure 3: PDF for 100 CW tones



Each tone is -20 dB with respect to the tone with PDF as shown in Figure 2

Now let's assume that one of these carriers is to be replaced with 100 lower level narrowband telephony carriers. If the constant power design rule is applied, the level of each of these carriers should be 20 dB below the level of each of the five tones used to characterize the laser. This would result in the same average composite power applied to the laser.

If we assume a system RF characteristic impedance of 75 ohms, the power associated with each of the test tones, P_N, is given by:

$$P_N = \frac{I_N^2}{2} x\ 75$$

The power associated with each of the telephony carriers, P_T, will be given by:

$$P_T = \frac{P_N}{100}$$

And the peak current associated with each telephony carrier, I_T, will be given by:

$$I_T = \sqrt{\frac{P_T \text{ x } 2}{75}} = \sqrt{\left(\frac{I_N^2}{2 \text{ x } 100} \text{ x } 75\right) \text{x } \frac{2}{75}} = \frac{I_N}{10}$$

Based on this technique, the total peak signal current will be given by:

$$I_{peak} = (4 \text{ x } I_n) + \left(100 \text{ x } \frac{I_n}{10}\right) = 14 \text{ x } I_N > I_0 - I_{TH}$$

Clearly the laser will be clipping if the constant power technique is employed, despite the fact that the laser power loading is identical in the two cases! An increase in distortion will result.

A better approach utilizes probabilistic methods to determine the likelihood of the laser current dropping below I_{TH}. This technique allows the system designer to predict the levels of clipping distortion and adjust the input level such that this distortion is reduced to acceptable levels.

You can describe the amount of time that the input signal current stays at any one value using a probability density function (PDF). The PDF is a kind of histogram that indicates how often something happens. Each different input to the laser will have its own unique PDF. The height of the curve at any point is proportional to the amount of time that is spent at that value.

It requires some extremely sophisticated (and *difficult*) mathematics in order to determine the PDF from a given set of input carriers to be applied to a laser. It requires even more tough math to get to the clipping distortion power levels and its effect on the signals. But before you get too discouraged, remember that it takes equally difficult mathematics to create a fully analytical description of a CATV RF amplifier. In the case of the RF amplifier, a series of measurements using a multitone signal generator (typically a Matrix generator) can simplify the problem into something practical.

Determining a PDF is simply a matter of determining how often a given signal takes on a given value. It is much like keeping a history of a signal and counting how often it crosses a particular value. Repeat this process for all of the values of interest and you have a PDF!

Let's consider one of the five original test tones described in the previous example. We may calculate the normalized PDF for that tone as shown in Figure 2 on page 86. The PDF can be thought of as a histogram, indicating the time spent at any given current level.

The peak excursion of the current of this single tone has been normalized to unity. Consider now the the PDF of a group of 100 that result in a composite average power equal to the single carrier previously shown. The PDF for this group of carriers is shown in Figure 3. Clearly, the peak current excursions have dramatically increased with respect to that shown in Figure 1, despite the fact that the average power in the two cases is identical.

Other factors

There are other factors that might result in a desire to violate the constant power-per-hertz rule. An initial problem results from the frequency dependence of the ingress noise accumulated from the coaxial portion of the network. Studies of ingress have indicated that the amplitude of the ingress is typically larger at the low end of the reverse band. There also is a relationship with the frequencies of broadcast services, ham and CB services. This ingress noise tends to color the overall noise characteristic of the reverse plant. Consequently the subcarrier amplitudes should be appropriately adjusted.

Several types of services are expected to be carried on the HFC reverse path. Among these services are analog video back-haul, RF IPPV telemetry, telephony, high-speed data, video telephony, home communication terminal (HCT) control and status monitoring. Different services may employ different modulation techniques, such as AM-vestigial sideband, frequency shift keying (FSK,) QPSK, offset QPSK, and quadrature amplitude modulation (QAM.) Each of these modulation types has its own sensitivity to noise, above and beyond any differences that might result from bandwidth considerations. Each service may have its own unique Quality of Service (QoS) requirement. Adjust subcarrier amplitudes to allocate the available dynamic range with these factors in mind.

Well-established techniques have been developed to determine the effect of Gaussian (thermal) noise on the bit error rate (BER) of digital modulated subcarriers. However, it has been shown that it is inappropriate to use these methods when the noise results from clipping.

Finally, headend considerations may impact subcarrier amplitudes. Certain reverse services are demodulated on an optical node-by-node basis. Typically, a separate telephony demodulator is supplied for the reverse output from each optical node.

The reverse output of several nodes may be combined before demodulation for services such as RF IPPV. Noise funneling that results from this combining may cause you to operate the subcarriers at a substantially higher level than services that are demodulated on a node-by-node basis.

Lamar E. West, Ph.D. is an optoelectronics engineer for Scientific-Atlanta. He can be reached at (770) 236-7354 or via e-mail at lamar.west@sciatl.com. This article was adapted from the proceedings of the SCTE 1997 Emerging Technology Conference.

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Compiled by Toni Bornett

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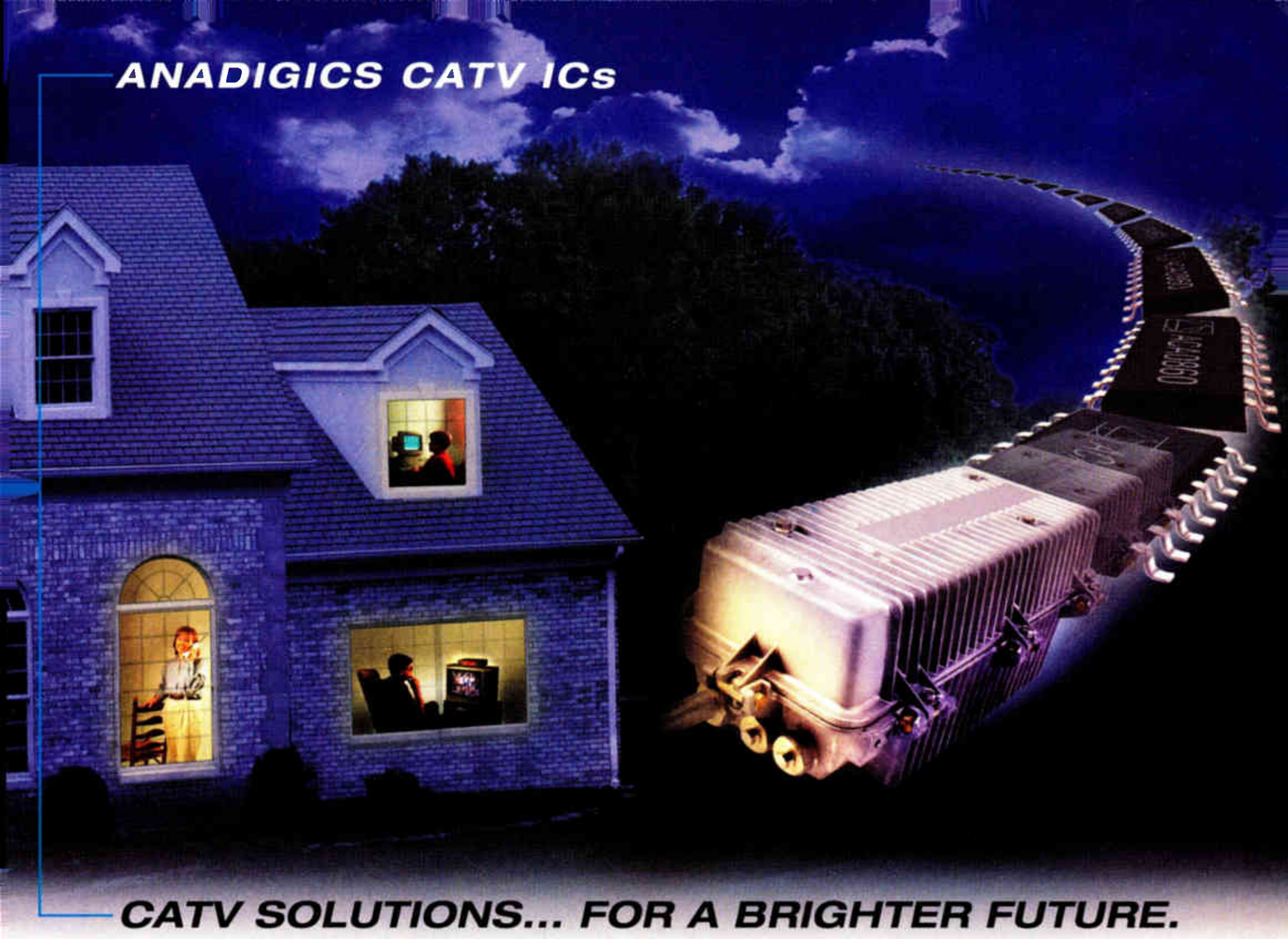

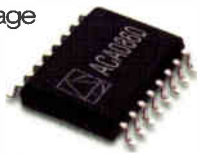

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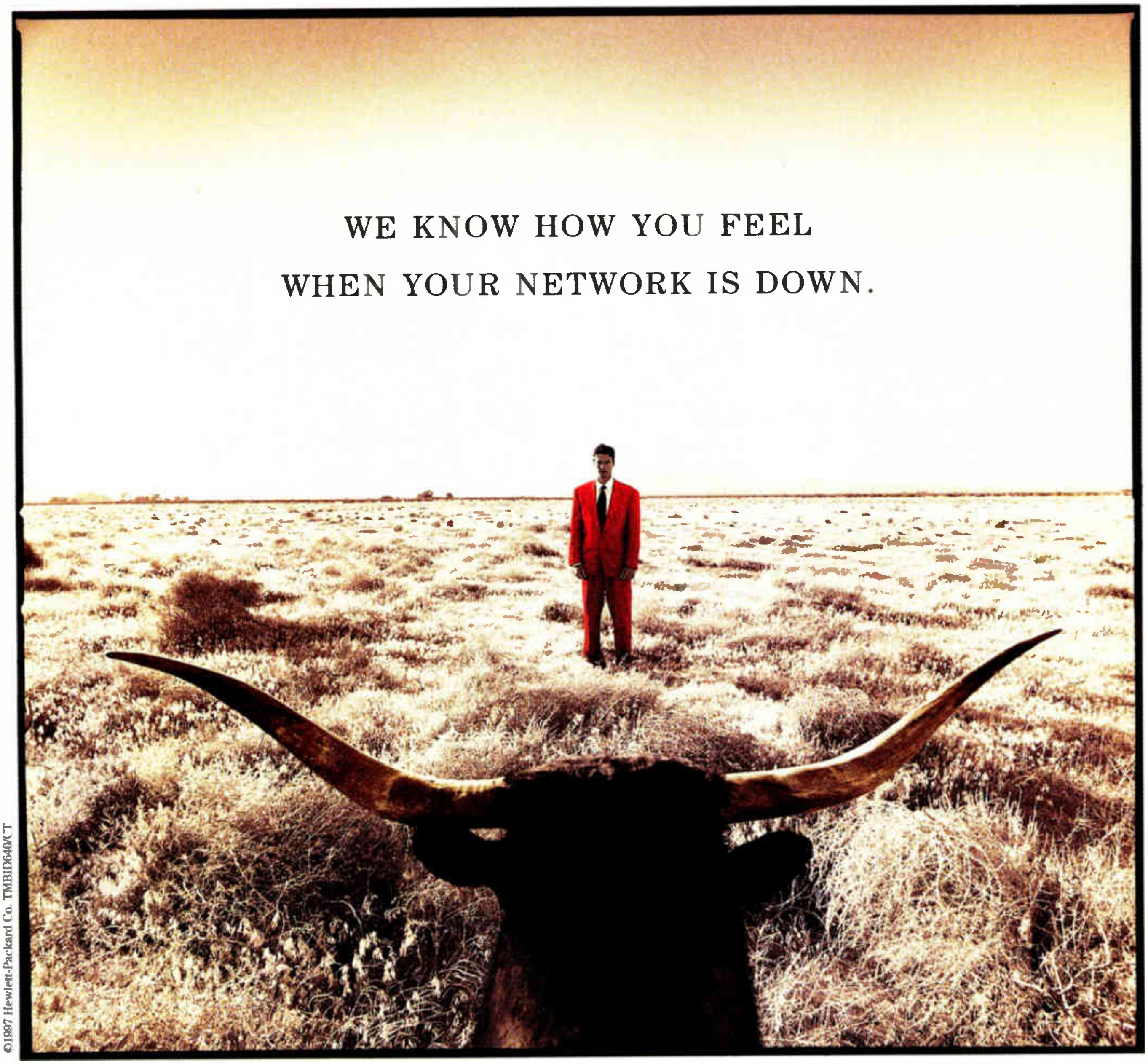

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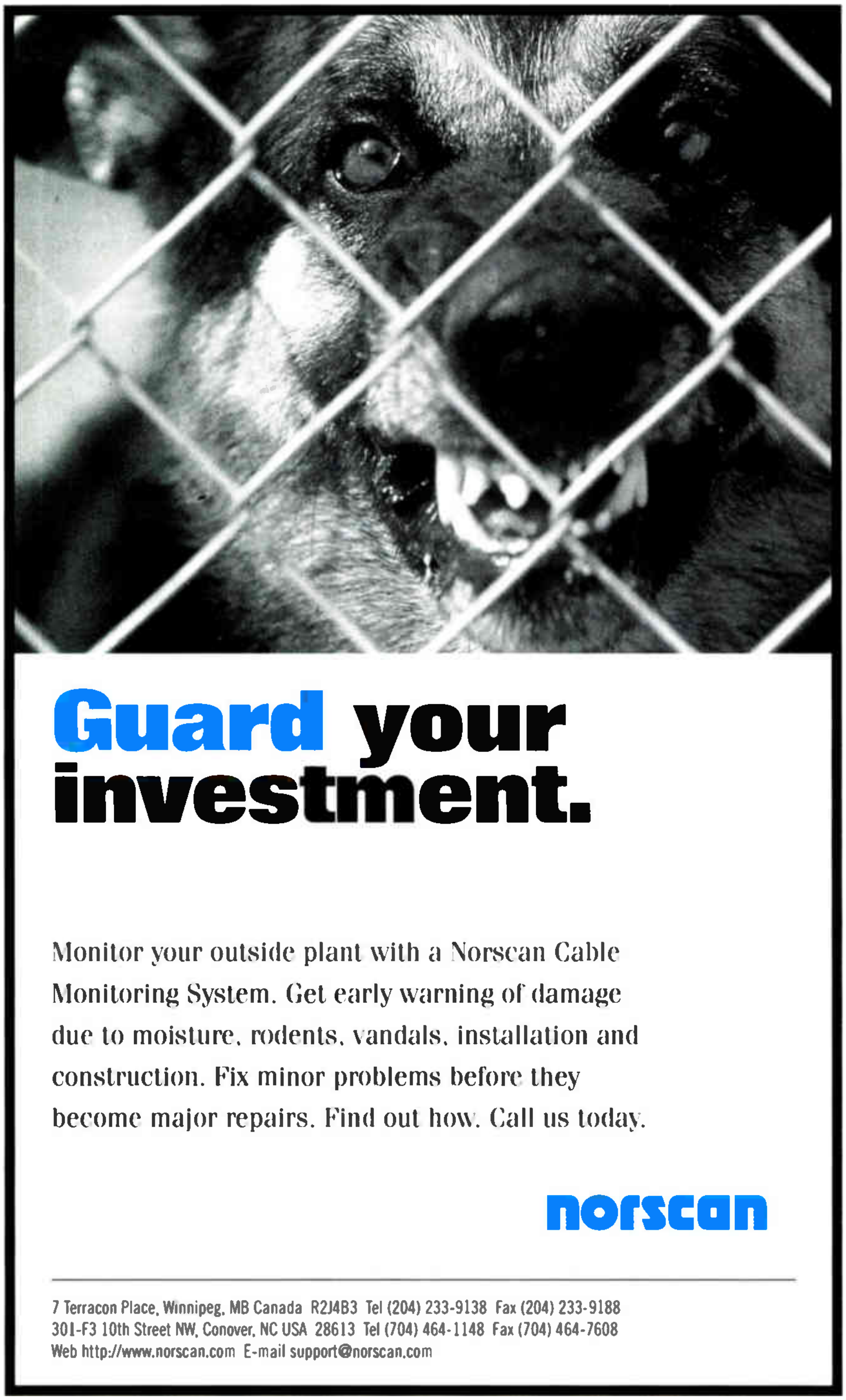

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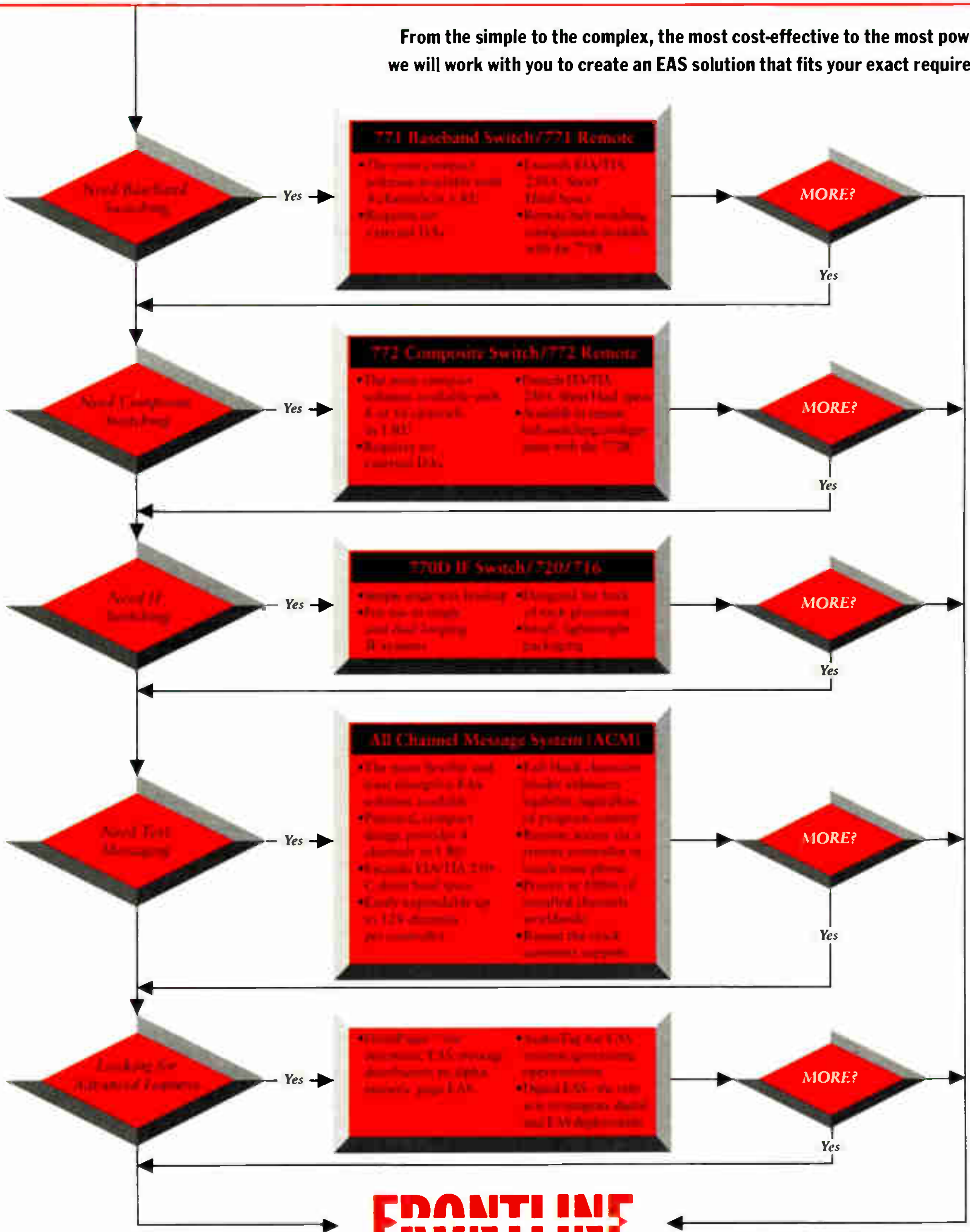

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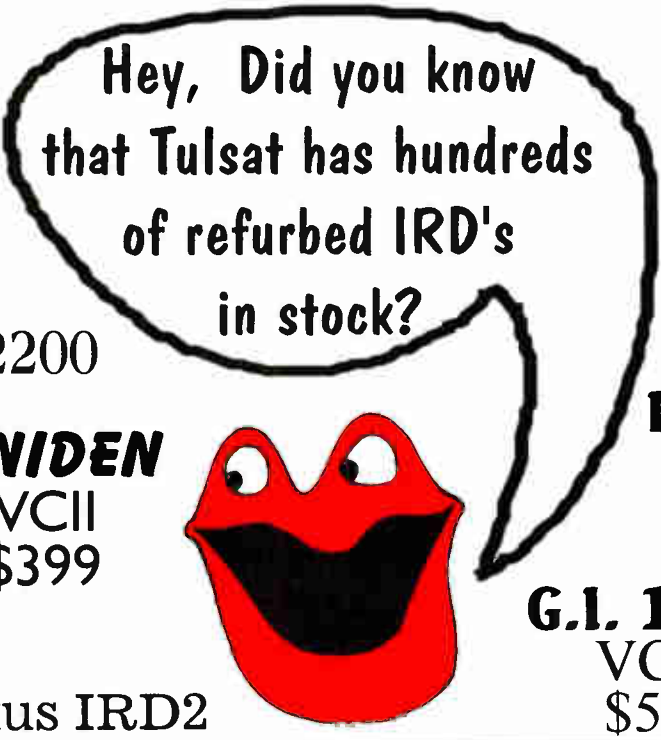

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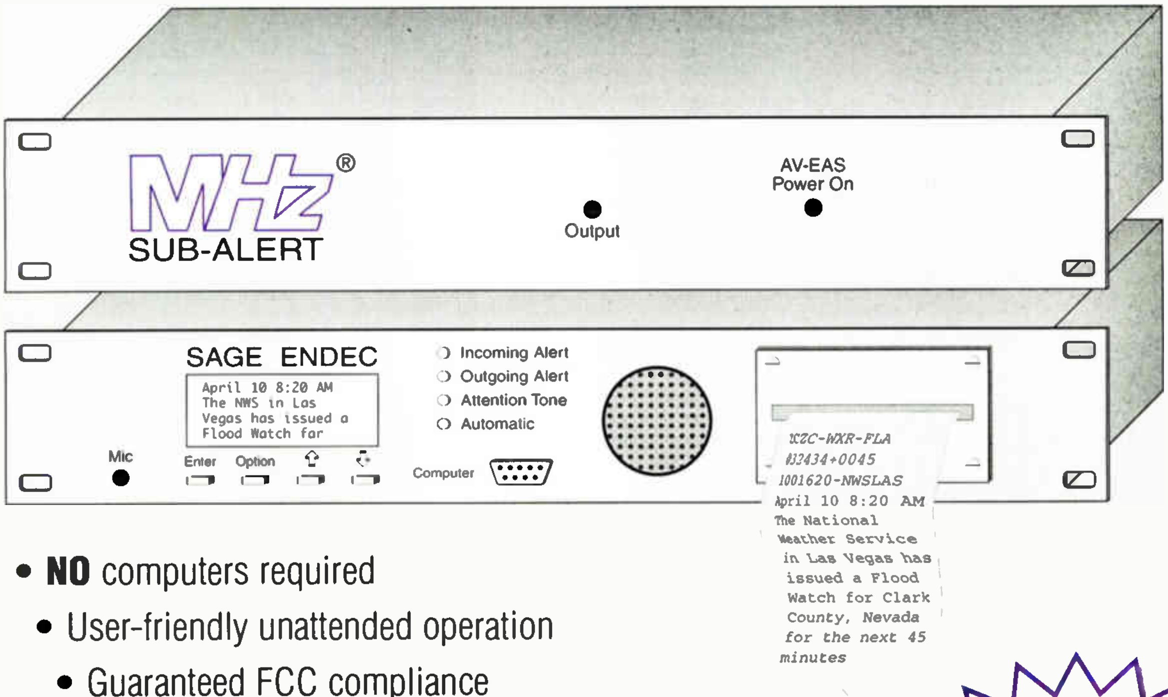

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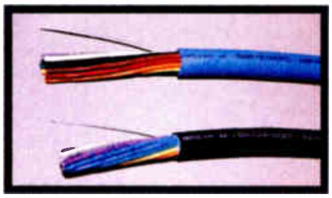

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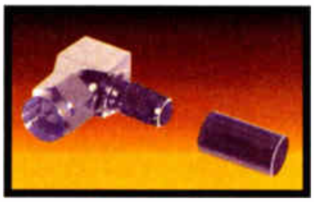

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This right-angle SMA male crimp plug for RG-58/U cable features Teflon insulation, gold contact and nickel plated body. The product is designed for simple assembly and installation. It can be used with the following coaxial cables: RG-58, -141 and -400/U; Belden 8219, 8240, 8259, 8262, 9201, 9203 and 9311; Comm/Scope 0268; Cushcraft Ultralink TL92463 and TL92887; Intercomp 4585A; and Time Microwave LMR-195.

Reader service #312

Two-Way Video System

Fiber Options' series 2255D system features simultaneous two-way transmission of video, audio and control data plus an additional channel of two-way audio over one or two single-mode optical fibers. Supporting TTL, RS232, RS422, or Manchester (biphase) control formats, the 2255D operates over distances greater than 50,000 feet. Providing diagnostic indicators for level/loss, audio, video and data, this system is available in either standalone units or rack card.

Reader service #309

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☐ A check or money order in U.S. funds for the appropriate amount shown above and made payable to the Society of Cable Telecommunications Engineers is attached.

☐ I wish to pay by credit card (please check one). ☐ MasterCard ☐ VISA ☐ American Express

CT198

Video Hum Eliminator

TecNec, a division of Tower Products, has developed a video hum solution for video, the Humzinger hum eliminator. The product uses active, high-speed, solid state multi-stage differential amplifiers coupled to an exclusive processing circuit, which removes any residual hum/noise. The Humzinger employs an equalizer/driver module that eliminates signal losses in either luminance or chrominance. The unit is equipped with a cable driver, which can push video signals up to an additional 100 feet. These features allow the Humzinger to eliminate hum caused by AC ground differential and induced signal hum.

Reader service #310

Transmission Link

The new Model 2792 ExcelLinx FM fiber-optic transmission link was developed by Force, Inc. The link provides contribution distribution quality baseband video and unbalanced stereo audio transmission. These links are available for use with either single-mode or multimode fiber.

This universal link transmits video and stereo audio more than 90 km over single-mode and 1550 km over multimode fiber. The product comes in 850 nm, 1300 nm and 1550 nm wavelengths.

Reader service #308

Analog Oscilloscopes

Leader Instruments Corp. announces the addition of two new oscilloscopes to the 8000 series, Models 8106 and 8105. Both feature 100 MHz bandwidth and three-channel operation and have the same technical specifications. The 8106 adds operational refinements such as auto setup and on-screen displays that include continuous readout of Channel 1 signal frequency or period and average DC level (DC coupling) or peak-to-peak signal amplitude (AC coupling), all independent of sensitivity settings. Additional operational features include solid-state attenuator switching and LEDs (electronic displays) that show H mode, trigger sourcing, coupling and mode at a glance.

Both scopes feature a boost in Channel 1/Channel 2 input withstand voltage to 400V (DC+AC peak) and an accuracy improvement to 2%. Standard operating features include calibrated delayed sweep with alternate sweep so that the main and delayed traces may be viewed simultaneously. Six traces are displayed in the ALT sweep mode when the three channels are active.

Reader service #307

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- Digital Compression: Expanding Channel Capacity While Enhancing Video and Audio Quality—Thomas Elliot (moderator), H. Allen Ecker Ph.D., Richard Prodan, Ph.D. and Geoff Roman discuss how cost-effective digital video compression is closer than ever and will provide new opportunities for services and revenue. (80 min.) Order# T-1111, $45.
- Technical Compliance: How FCC Reregulation Will Impact Your System Operations and Maintenance Practices—Steve Ross (moderator), Wendell Bailey, Jonathan Kramer and John Wong are featured in this video. With FCC reregulation a reality, this presentation seeks to provide an overview of the new regulations, as well as define key parameters including classes of signals covered, channel boundaries, aural standards, visual signal levels, signal-to-noise, signal-to-coherent disturbances ratio, hum modulations, color signals, testing requirements and when tests are to be conducted. (85 min.) Order # T-1112, $45.
- Cable System Technology Meeting Subscriber Expectations—Margaret Combs (moderator), Jonathan Kramer and Thomas Robinson explore the issue of what the cities want and need to deal with cable operators properly. (45 min.) Order #T-1113, $30.
- *Current Events in Cable TV Technology: Fiber Optics, HDTV, PCN and Outage Reduction*—Thomas Jokerst (moderator), Edward Callahan, James Chiddix and Thomas Elliot discuss comparisons between the new Star Star Buss (SSB 500) and fiber-to-feeder architectures, and factors that will drive advances in fiber-optic technology. This program offers a unique vision of how we will use our increased bandwidth in the future, including HDTV, personal computer networks, possible 16:9 NTSC and how new consumer equipment may drive the services we must provide. (78 min.) Order #T-1114, $45. CT

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

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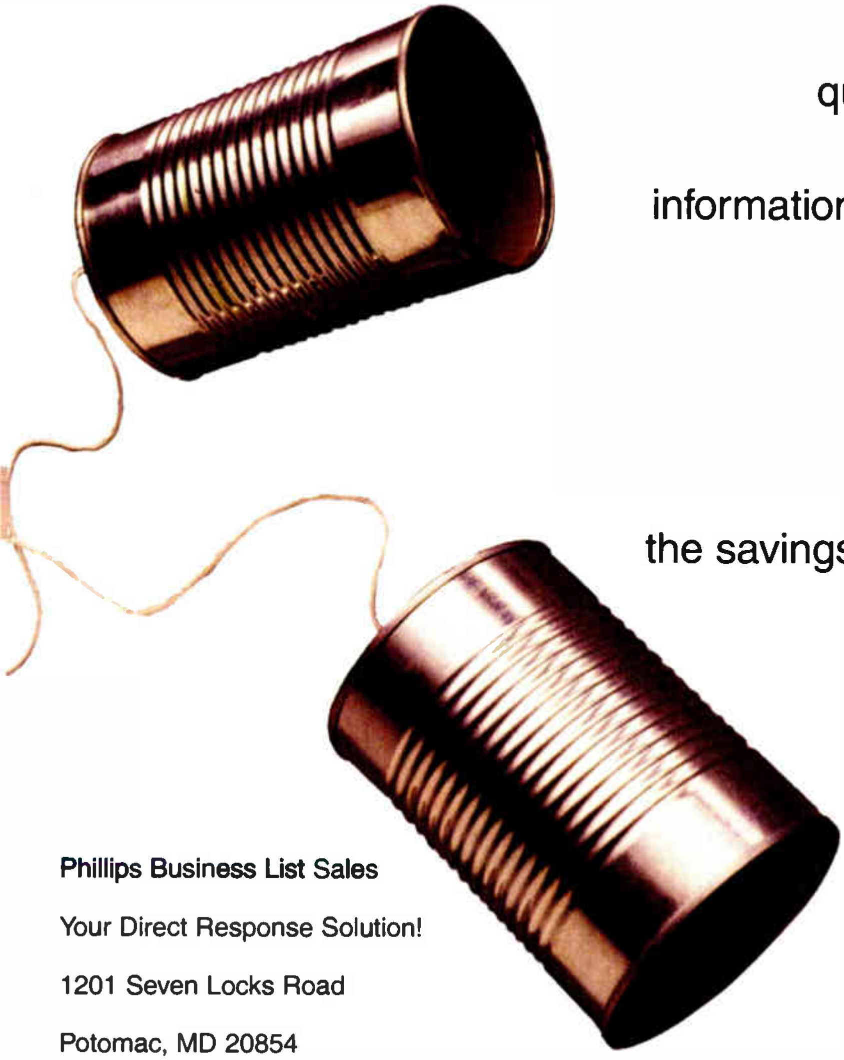

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Vendor Connection is *Communications Technology's* resource for up-to-date information on the industry's leading technology suppliers. These vendors have advertised in this issue. Check their ads for products and services that will improve your cable system's reliability, efficiency and capacity.

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Reader Service #10

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David L. DeLane; (215) 538-8703
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Planning Ahead

March 4-6: Global TMN Summit '98 and Vendor Showcase, sponsored by Vertel and HP OpenView Telecom, Orlando, FL. Contact www.vertel.com or www.hp.com/go/ovtelcom.

April 21-23: Digital Signal Processing design conference, Santa Clara, CA. Contact Liz Austin, (415) 538-3848.

April 27-29: Internet & Electronic Commerce & Exposition, sponsored by the Gartner Group Inc. and Advanstar Communications Inc. Contact (203) 256-4700.

May 12-14: Pacific Equipment & Technology Expo, Orlando, FL. Contact Robert Morock, (800) 525-7383.

June 10-13: SCTE Cable-Tec Expo, Denver. Contact (610) 363-6888.

September 13-16: ICSPAT & DSP World Expo '98, Toronto, Ontario, Canada. Contact Liz Austin, (415) 538-3848.

January

8: SCTE Satellite Tele-Seminar Program, "Data Over Cable (Part Two)," Galaxy 1R, Transponder 14, 2:30-3:30 p.m. ET. Contact SCTE national headquarters, Janene Martin, (610) 363-6888, ext. 220.

13-16: Siecor Corp. fiber-optic training course, "Passive Fiber Optic System Design for Local Area Networks," Keller, TX. Contact (800) 743-2671.

15: SCTE Penn-Ohio Chapter, technical seminar, "Maintaining and Troubleshooting an HFC Network," Pittsburgh. Contact Marianne McClain, (412) 531-5710.

21: SCTE Lincoln Land Chapter technical seminar, "Fiber Installation and Restoration." Contact (815) 433-1163.

22: SCTE New Jersey Chapter technical seminar, "Emergency Alert System," Kenilworth, NJ. Contact Earl Bennett, (908) 665-0133.

28-30: SCTE Conference on Emerging Technologies, San Antonio. Contact SCTE national headquarters, (610) 363-6888.

February

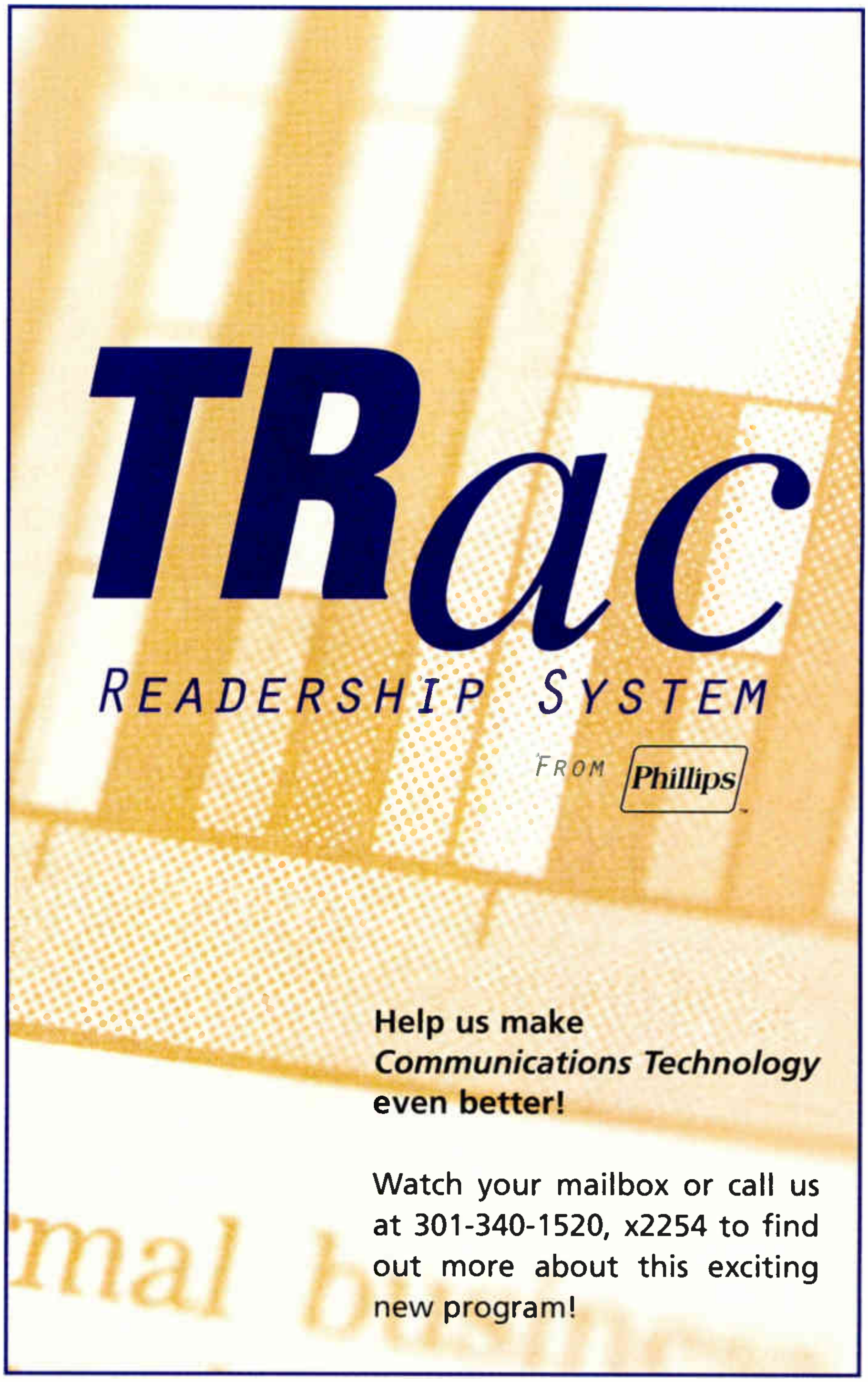
3: SCTE Cactus Chapter Cable-Tec Games, Phoenix, AZ. Contact Bill Nolanl, (602) 870-4977.

4: SCTE North Country Chapter, technical seminar, "Transportation and Distribution Systems," via an interactive link between Anoka and Wadena Technical Colleges, MN. Contact Dan Shea, (612) 572-9290.

11: SCTE Delaware Valley Chapter technical seminar, "Competitive Access and Business Meeting," Horsham, PA. Contact Chuck Tolton, (215) 961-3882.

14: SCTE Llano Estacado Chapter technical seminar, Lubbock, TX. Contact David Fieldler, (806) 793-7475, ext. 4518.

18: SCTE West Virginia Mountaineer Chapter technical seminar, "Fiber Fundamentals," Charleston, WV. Contact Steven Johnson, (740) 894-3886.



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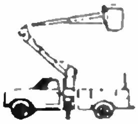

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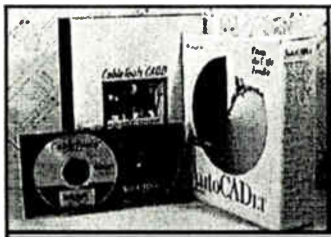

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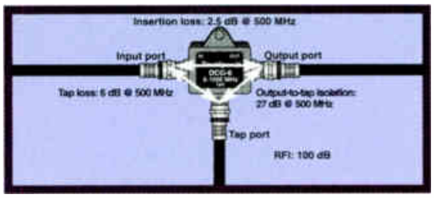
TRAINING

By the NCTI

Troubleshooting the drop system: Part 5

This month's installment begins a series on troubleshooting directional couplers. The material is adapted from NCTI's Installer Technician Course, complemented by performance training suggestions to reinforce the material in a hands-on classroom setting. © NCTI.



Typical DC-6 specifications @ 500 MHz

An important aspect of maintaining the drop system is knowing how to troubleshoot passive devices. Although not as commonly used as splitters, directional couplers are frequently encountered, especially in homes and MDUs where loop-through wiring was installed to feed multiple TV sets. As well, DCs are commonly used when providing personal computer access through cable systems. To successfully troubleshoot DCs, you must first understand how they operate and what signal level should be available at the various ports.

Unlike splitters, directional couplers divide the broadband cable input signal unequally (see accompanying figure). However, like splitters, the typical problems associated with DCs include wrong cable connections, internal defects, inadequate RFI shielding, insufficient port-to-port isolation and wrong coupler selection.

The directional coupler has an input port, a tap port (or down leg) and an output port (or through leg). The amount of signal available at the tap and output ports depends upon the manufacturer's specifications and value selected. The accompanying table lists a typical manufacturer's specifications for its directional couplers.

Next month's installment will continue this series on troubleshooting directional couplers.

Hands-on performance training

Proficiency objective: Describe operation and identify specifications of directional couplers.

Provide each student with several DCs (different values) and specification table(s) for the directional couplers used in your system.

While describing how directional couplers operate, also discuss the applications where and why they are used.

Using the specification table, explain what the different specs mean and why they're important.

Verify that each student can correctly describe the operation and identify specifications of the directional couplers used in your system. CT

Typical DC manufacturer specifications

DC values:		6	9	12	16	20	24	27	30
Output port insertion loss (max.)	5 MHz	3.0	1.7	2.5	0.8	0.7	0.8	0.90.	8 dB
	50 MHz	2.6	1.4	0.5	0.6	0.6	0.6	0.7	0.6 dB
	300 MHz	2.5	1.3	0.5	0.6	0.6	0.6	0.7	0.5 dB
	500 MHz	2.5	1.3	0.7	0.5	0.5	0.6	0.6	0.9 dB
	750 MHz	3.0	1.8	1.5	1.1	1.1	1.0	1.3	0.9 dB
	1,000 MHz	3.2	2.0	1.8	1.5	1.5	1.5	1.6	1.1 dB
Tap port-to-output port isolation (min.)	5 MHz	23	30	36	32	36	55	55	60 dB
	50 MHz	31	30	36	32	36	55	55	60 dB
	300 MHz	25	33	33	32	33	45	52	50 dB
	500 MHz	27	33	30	29	31	43	43	43 dB
	750 MHz	28	30	25	27	28	39	40	40 dB
	1,000 MHz	27	28	23	28	27	38	38	38 dB
Tap loss (tolerance in-tap) (max. ±dB variation from DC value)	5 MHz	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5 dB
	50 MHz	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5 dB
	300 MHz	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5 dB
	500 MHz	0.5	0.5	0.5	1.0	1.0	1.0	1.5	1.5 dB
	750 MHz	0.5	1.0	0.5	1.5	2.0	1.5	2.5	1.5 dB
	1,000 MHz	0.5	1.0	0.5	1.5	2.0	2.5	2.5	2.5 dB

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By Bill Riker

Training for Tomorrow

It's that time again—the fresh start of a brand-new year. Twelve months of endless possibilities lie ahead of you, and it's time to start planning the ritual commitment known as a New Year's resolution.

What are you going to do this year that will firmly establish you and your organization on the forefront of the telecommunications industry? I suggest one thing: join the Society of Cable Telecommunications Engineers.

Here at national headquarters, we're making exciting plans for 1998. We're beginning the new year committed to self-improvement so that we can better serve our members. Each January, we identify new skills we want to develop, re-dedicate ourselves to improving our responsiveness and find more ways to interact with the membership. This year, the Society resolves to introduce some of the best technical training opportunities in the business.

I encourage you to take advantage of the quality training that distinguishes SCTE from other educational organizations in this industry. Your Society offers a wide range of options for broadband professionals to select the information they need in a format compatible to their own learning styles.

SCTE will soon offer computer-based training supporting the "Troubleshooting" level of the Service Technician Certification Program. Leader guides and student workbooks, including a guide to Bill Grant's *Cable Television* textbook, will soon be available to enhance and improve in-house training programs everywhere.

On a larger scale, more than 1,400 engineering professionals are expected to converge in San Antonio, TX, this month for the broadband telecommunications industry's top technical program, the annual Conference on Emerging Technologies.

This year's event, titled "Building the Digital Platform," will be held at the San Antonio Convention Center on Jan. 28-30, 1998, and will feature presentations focusing on data transmission networks and digital TV technologies.

Another outstanding training opportunity is Cable-Tec Expo. Recognized as our industry's leading annual hardware trade show, Expo provides valuable information on the latest technological advancements and applications through groundbreaking technical workshops and hands-on hardware exhibits. More than 8,200 attendees took advantage of this invaluable learning experience last year in Orlando, FL.

SCTE's Annual Engineering Conference, held during the opening day of Expo, is dedicated to the discussion of current engineering issues, technical and regulatory concerns, and converging industries. Here, engineering and operations leaders worldwide can stay abreast of this dynamic industry. In September, a valuable training opportunity will be available to you once again, this year in Florida. The Third Annual SCTE/IEEE (Institute of Electrical and Electronic Engineers) Communications Society Joint Workshop on High-Integrity Hybrid Fiber/Coax Telecommunication Networks will bring together leading industry experts to assess the future of HFC technology as it fits into the scope of telecommunications in the next millennium. HFC '98, which attracted more than 1,300 attendees last year, will include groundbreaking workshops on the many facets of this progressive technology.

As always, the Society will be offering learning opportunities at three other industry trade shows this year. We are hosting technical sessions at the Texas Show (February), Atlantic Show (October) and Western Show (December).

SCTE's 1998 agenda of regional educational seminars includes 12 practical seminars held in cooperation with our 75 local chapters and meeting groups dedicated to training industry employees and supporting broadband's stronghold in the next millennium.

Our training availability extends throughout North and Central America. Our chapters and meeting groups regularly host technical meetings featuring well-informed speakers, and many local groups also sponsor annual Vendor Days, which focus on education rather than sales and provide a wide variety of learning experiences that allow attendees to enhance their professional knowledge with intensive training that's both cutting-edge and cost-effective.

Another economical way of getting the technical training you need is through our Satellite Tele-Seminar Programs. At no cost, anyone with satellite downlink capability can access one-hour instructional presentations on a variety of critical topics.

To encourage technical training even more, the SCTE Technical Tuition Assistance Program provides financial support to forward-thinking members who wish to further their education, and their careers, through industry training. We also are honored to participate in two additional scholarship programs, the Milton Jerrold Shapp and Ken Foster Memorial Scholarships.

So, as you consider your New Year's resolution, I urge you to incorporate SCTE into your training future. Whether you want to educate yourself on vital information from thousands of industry professionals in a trade show setting, or prefer to learn the latest data from a book or videotape in the privacy of your own facility, we have the tools and resources to help you reach your goals in 1998 and beyond.

Bill Riker is president of the Society of Cable Telecommunications Engineers.

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