Communications Technology

30th 1969-1999

Official Trade Journal of the Society of Cable Telecommunications Engineers

May 1999

Service in Technology Winners

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Photo courtesy of The National Cable Television Center and Museum

In November 1965, early industry pioneers install cable at the Prudential Bache building.

1968: Charles Tepfer and William Karnes seek greater recognition for cable engineers.

1969: Seventy-nine people attend SCTE's inaugural meeting at the NCTA convention in San Francisco.

1974: Membership reaches 1,000.

1983: Cable-Tec Expo premiers in Dallas.

1984: *Communications Technology* becomes the SCTE's official trade journal.

1985: Ninety engineers become candidates for BCT/E certification.

1987: SCTE purchases its first national headquarters building.

1989: Ron Hranac earns the first BCT/E certificate at the technician level. Les Read earns the first certificate at the engineering level.

1992: SCTE membership tops 10,000.

1995: SCTE changes name from "Cable Television" to "Cable Telecommunications."

1996: ANSI recognizes SCTE as an official standards development organization.

1998: ANSI adopts three SCTE proposals as new national standards:

- "F" Port Physical Dimensions
- Coaxial Cable Structural Return Loss
- "F" Port Return Loss

The ITU approves the Data-Over-Cable RF Interface Specification.

1999: Membership climbs to 14,500.

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Cover
Design by Maureen Gately; Photography by Rod Reilly

Cover Photo:
The Cox Team, clockwise from left: Hugh McCarley, Richard Wallace, Christopher Bowick, Richard Mueller, Mark Davis, Alex Best

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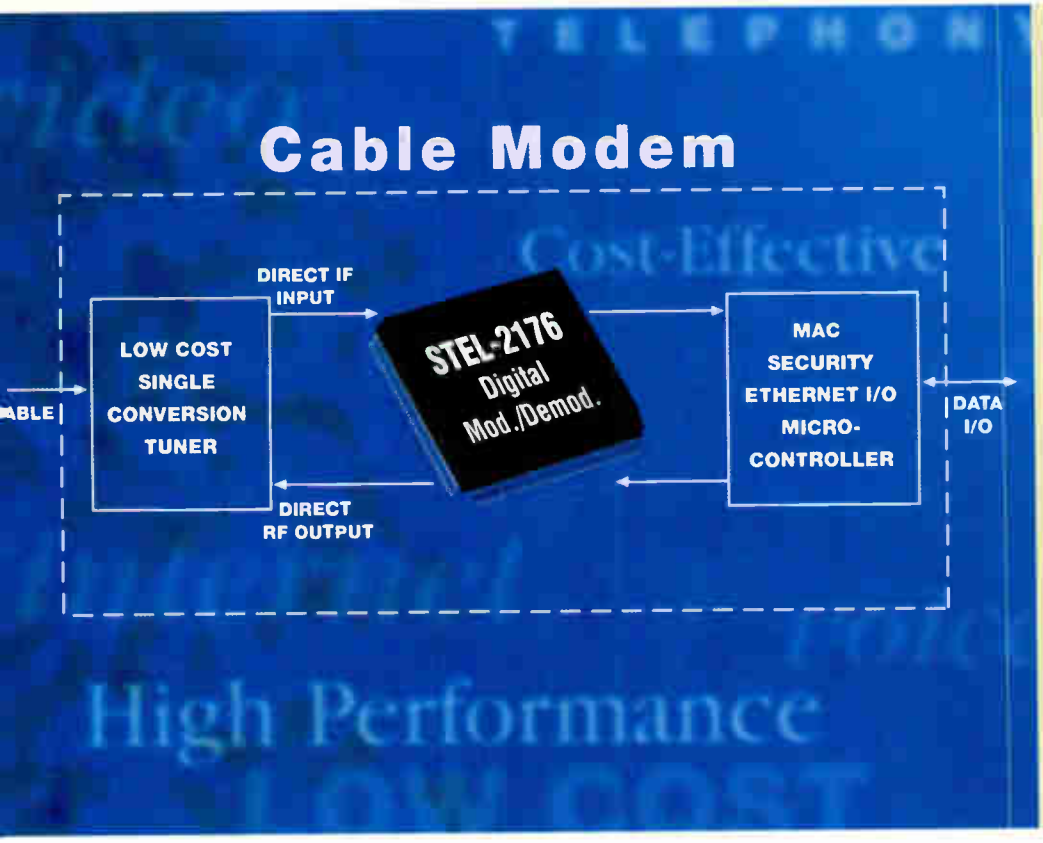

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Reader Service Number 3

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DEPARTMENTS

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Finally. A Cable Modem That Can Be Self-Installed.

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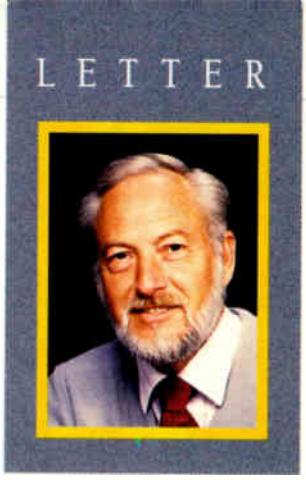
Reader Service Number 4

By Rex Porter



A Deal for Everyone?

The AT&T/TCI merger is complete. Charter acquired Rifkin and Interlink, only to be swallowed up by Allen. Century is now owned by Adelphia. And then Comcast acquired MediaOne through a $60 billion stock deal.

Lots of money is changing hands daily. Owners are making fortunes. I'm pleased that people who were willing to take risks when there seemed no future for cable are now reaping these rewards. But I worry about the future of good technicians and engineers in the wake of these deals.

I hope the new owners will listen to their chief technical officers when deciding who stays employed. It's too easy to consider dollars only. CTOs know who has worked hard in the past. They know the value of Society of Cable Telecommunications Engineers Broadband Communications Technician/Engineer certification and Installer certification.

I have seen engineers and technicians work for years in a given system, only to see their past performance and dedication overlooked when the company merged with another. I have seen engineers and technicians come into newly acquired companies based not on performance or skills but because they satisfied some obligation from the new owners.

Technicians and engineers need to protect their own interests. You never know when a merger can threaten your job. The new owners won't know your abilities and training, so you need to keep your résumé current at all times, not just to find a new job—it could help save your existing one.

You must be prepared to present your case to the new company, to document your story. What is your formal education? What training do you have? Are you a member of the SCTE? Have you been active in your local chapter, perhaps as an officer or member of its board of directors? What certifications do you have? Are you a senior member of the Society? Have you been involved in activities outside of your own system or company? Have you spoken or presented papers at industry events? What cable jobs have you had?

In short, be ready to show how valuable you are. If your résumé looks slim to you, it certainly will look slim to your new bosses. Get involved in SCTE programs. Speak to groups, and get involved in training. If you neglect your future, you could very well be a target for the falling ax.

Rex Porter
Editor-in-Chief

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Reader Service Number 7

LETTERS TO THE EDITOR

Keep up the Good Work

Rex:

Hey, ol' man! I just read your Editor's Letter in March *CT*. I don't know what prompted it, and I suspect it was not done for just the hell of it (although knowing you, it may have been), but let me compliment you on it.

Again, knowing you, it wasn't a surprise; it reflected the integrity you have demonstrated and respect you have earned these many years we have been friends in this industry.

And by reflecting your philosophy, you may just have reminded some of us about ours. You said some things that a lot of us live by (or try to, anyway), but that we don't always take the time to express.

It's good advice to live by, and I hope some of the younger members of this telecommunications community take the time to read and think about it, as should a lot of us veterans.

Keep reminding us of why we do what we do, thanks for saying what you said, and keep *CT* a shining source of industry info.

Par G. Peterson
ADC Communications

A Worthy Cause

Dear Rex:

My name is Jane Whitley. I am a member of the Cardiac Care Center Advisory Board at The Children's Hospital in Denver. You may be aware of how fortunate we are to have one of the premier pediatric cardiac programs located in Denver. Everett Hirsh, of LORAND, recommended I write to you regarding our special event.

Last year on Aug. 31, I chaired the First Annual From The Heart Golf Tournament and Auction. We are very pleased that the proceeds from this tournament netted over $40,000 for the Cardiac Care Center. The cable TV industry was our target audience for this event. Companies such as Cablexpress, Antec and General Instrument stepped up to our cause with Gold sponsorships. Scientific-Atlanta and Argus Communication Group helped our cause with Silver Sponsorships, and 18 other industry companies supported us at the Bronze sponsorship level. Our host for this fun evening was Tony Werner, TCI's senior vice president of engineering.

This year we will be holding our Second Annual From the Heart Golf Tournament and Auction on Friday, June 11. The outing will take place at the Canterberry Golf Course in Parker, Colo. Currently, we are in the process of planning this fun-filled event. Our committee consists of several industry people, including Matt Endsley of Antec, Everett Hirsh of LORAND, Jack Joynt of CableCom, and Mike McNeil and Joe Whitley of Cablexpress. The proceeds this year will be used for a developmental research fund to begin hypoplastic palliative research. The hypoplastic left heart is a congenital heart defect.

My husband Joe and I experienced the heartaches of this terrible defect with our daughter Caitlin. She was born on March 6, 1997, with a hypoplastic left heart. At our original diagnosis when I was 7 months pregnant, we were told by one doctor that when she is born we should take her home to let her die. We, however,

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Reader Service Number 9

decided to do whatever we could to help our daughter, which is how we came to The Children's Hospital in Denver. They recommend heart transplants for children born with the hypoplastic left heart. They have a very high success rate and are the second busiest in pediatric heart transplants in the country. Caitlin waited for three months for her new heart. We were able to bring her home for 1-1/2 months while she waited. She was only the fourth baby with a hypoplastic left heart ever to leave the hospital and live at home while waiting for a heart transplant. Caitlin received her heart on June 2, 1997. It was very successful. She returned home on June 10. However, that weekend complications developed causing her to return to Children's. Caitlin passed away on June 16, 1997.

Though we are truly saddened by the loss of our daughter, we are grateful to TCH for its procedures that allowed us to share in our daughter's life for three months. Since then, it has become my goal to assist TCH Cardiac Care Center in any way I can so it may continue to provide the best possible care to children with heart defects, as well as continuing the research programs, especially within the transplant and hypoplast areas.

The cable industry has been extremely supportive to us and this cause. We appreciate their support and generosity so much. I hope you can help us spread the word about this great event. If I can answer any questions you might have, please call me at (303) 699-5071.

Thank you in advance for any help you might be able to give us.

Jane Whitley

Alphabet Soup

Mr. Porter:

I am a new reader of your *Communications Technology* magazine. I started reading the articles on voice over Internet protocol (VoIP), "Cable Makes a Play for Voice," on page 50 in the March issue, a topic I'm very interested in. But I became very frustrated when I could not find out what "MSO" stood for.

I hadn't ever encountered the term before, and I have worked in voice communications for some time, with experience in the U.S. Air Force and now as a contractor to the Air Force.

I think any profession does extreme disservice to itself when it makes any assumptions about its readers. The editors of *Communications Technology* appear to assume that all your readers know what MSO means. In addition to the article referenced above, your "Editor's Letter" also uses MSO with no explanation.

I quote from paragraph 6 of your letter: "During the past 50 years, our industry has matured because MSO management required operations managers to improve the bottom line by adding programming, improving customer relations, clustering and many other new ideas." Earlier in your letter, you expanded the abbreviation for HDTV (high definition TV). Why not MSO?

Please help me to understand the cable industry better—expand all abbreviations and acronyms you use in your TJ. (Oops, that's tech journal.)

Jon Selken
Communications Engineer
System Technology Associates

Editor's response: Hi, Jon—sorry if we confused our readers. The acronym "MSO" stands for multiple system operator, as opposed to those cable operators that own a single system only. MSOs are companies such as TCI, Time Warner, Cox and so forth.

I suppose this term has been used within the industry for the past 30 or 40 years, and we sometimes forget that we have readers who are new to the industry or who simply aren't familiar with the term. Because other acronyms, such as HDTV or MPEG (Moving Pictures Experts Group), are relatively new, we (perhaps wrongly) think that everyone already knows what an old expression such as MSO means.

My apologies to you and any other readers if we assume too much at any time. I hope you continue to read and enjoy "Communications Technology" magazine.—RP

Write to Us

You can contact the *Communications Technology* editorial staff at 1900 Grant St., Suite 720, Denver, CO 80203, or fax (303) 839-1564.

CT reserves the right to edit letters for clarity and space.

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Reader Service Number 11

Modem Certification In With DOCSIS Tide

In the first wave of anticipated cable modem certifications, Thomson Consumer Electronics and Toshiba washed ashore with the initial CableLabs' endorsement. Cisco Systems also stormed the beach by being the first vendor to win certification for cable modem termination systems (CMTS) used in headends.

No longer going by the moniker Data Over Cable Service Interface Specification (DOCSIS)-certified, the more consumer-friendly titled "CableLabs-certified" modems are based on the specification's 1.0 version. The new, green stickers indicate that the products have passed CableLabs tests and are ready for the retail market.

Other modem makers are hot on the heels of Thomson and Toshiba. Askey Computer, Philips Consumer Electronics, Motorola and Sony are participating in CableLabs' current wave of DOCSIS testing, joining past participants Nortel, Samsung, 3Com, Zenith, Cisco, Com21 and General Instrument.

3Com, in addition to submitting an external modem, entered the first internal cable-modem card for DOCSIS testing. Meanwhile, Nortel, 3Com and Motorola submitted headend equipment for the DOCSIS seal. Tests results are expected by the end of April.

Jones Digitizes System's Future

Jones Intercable is serious about digital. The cable operator now offers digital services in two U.S. systems.

By launching Jones-branded ImpacTV in its Augusta, Ga., and North Augusta, S.C., systems, Jones delivers enhanced services to an estimated 91,000 customers. The digital rollout follows extensive testing in more than 600 customer homes, according to the company. Upgrades and additions to the operator's fiber network made the launch possible.

"In the last four years, we've added 200 nodes and 200 miles of fiber to our system, bringing the total strand miles of fiber to about 650," reports Jones Intercable Regional Engineering Manager George Stickler.

Jones tested digital cable TV in Augusta for about six months and achieved high grades from the customers who participated in the tests, Digital Project Manager Sam Schwartzman explains, adding, "More than 95 percent of the respondents said that the digital service either met or exceeded their expectations."

Those who worked to make the launch happen say that the testing process is an integral part of a smooth overall deployment throughout the system.

ImpacTV in Augusta and North Augusta delivers Headend in the Sky (HITS) programming via a General Instrument platform—combined with TV Guide's on-screen menu. Jones is working on extending the service to more of its systems, which serve nearly 1.3 million customers in 14 states.

Road Runner Picks Qwest For New Backbone

Qwest won a three-year, $10 million contract to provide Road Runner with leased access to the Qwest nationwide fiber-optic backbone. The agreement gives the cable Internet access provider bandwidth sufficient to reach speeds up to optical carrier (OC)-48 or 2.4 Gb per second. The process, says Qwest, will involve interconnecting its network with Road Runner affiliates and delivering content and applications over cable modems.

Road Runner officials say that the deal will help the company to accommodate its rapidly expanding market for

New Era in Field Portable Spectrum Analyzers

The AT-2000R is said to be the best investment in field portable spectrum analyzers because of its technical merit, quality, weight and price. It's designed from the ground up specifically for CATV field applications. This unit from Avantron Technologies Inc. is 100% non-interfering for CATV measurements and addresses all FCC proof-of-performance RF measurements.

On a performance issue, the AT-2000R's absolute amplitude accuracy is +/- 0.75 dB and meets all specifications within 1 minute after it is turned on, across entire operating temperature range.

Some key elements that distinguishes the AT-2000R from other field portable units is that it weighs only 19 lb. (including the battery which lasts 2.5 hours). Avantron's unique AutoCal feature assures accuracy by periodically self-testing itself and automatically triggering a non-obstructive background calibration, as required. In addition, the AT-2000R is fully upgradeable and less expensive than all other spectrum analyzers in its class.

The 9 top MSOs use the AT-2000R.

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high-bandwidth online services. Road Runner plans to aggressively deploy service and add more content in 1999. Slated '99 rollouts include Orange County, Calif.; central Florida; Wichita, Kan.; central and western Massachusetts; Kansas City, Mo.; Cincinnati; Oklahoma City; and Fairfax County, Va.

Qwest is in the process of completing its 18,500-route-mile fiber network, which is up and running in 10 cities including Chicago; Cleveland; Dallas; Boston; New York; Philadelphia; Sacramento and San Jose, Calif.; Seattle; and Washington, D.C.

The nine remaining cities awaiting network completion are Albany, N.Y.; Austin, Texas; Baltimore; Houston; Indianapolis; Los Angeles; San Antonio; Newark, N.J.; and White Plains, N.Y. Qwest expects to announce a more comprehensive plan for local connectivity by mid-year.

Ciena Raises Fiber-Optic Stakes

Ciena, an innovator in dense wavelength division multiplexing (DWDM), plans to spend $980 million to acquire Lightera Networks and Omnia Communications. The two privately held companies will provide Ciena with technology to deliver a new generation of high-capacity optical transport and switching systems. The deals also will enable Ciena to provide a suite of protection and restoration capabilities that it says will allow carriers to build mesh, ring or hybrid mesh-ring optical cores without legacy synchronous optical network (SONET) equipment.

The move to buy Lightera signals a bold entry into a new market for Ciena. Lightera is launching a product in the fourth quarter, the LightWorks optical switching platform, which switches individual wavelengths of light among DWDM nodes in fiber-optic networks. The new platform makes a meshed DWDM network possible, whereas to date, DWDM mostly has been deployed in point-to-point applications. Meshed networks would enable service providers to establish different DWDM service levels—each dependent on the number of nodes through which data traffic passed. Service providers could charge premium prices for networks with fewer hops.

Redundancy also can be enhanced using meshed networks because multiple backup paths for traffic can be configured through a network. Service providers could offer different levels of redundancy and charge more for the most highly redundant services.

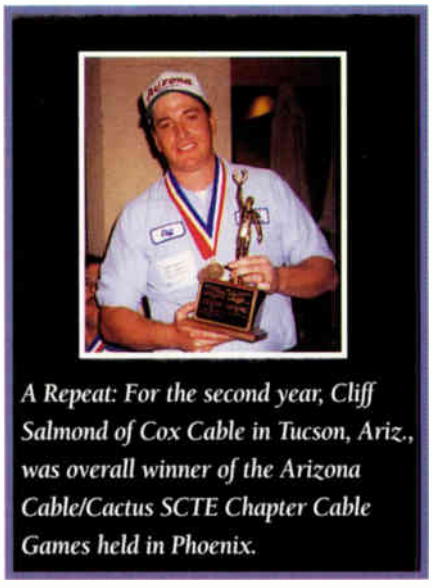
"As we put more and more bandwidth in, the existing technology in the network wasn't able to manage it," says Steve Chaddick, Ciena senior vice president of strategy and development. "We couldn't use TDM (time division multiplexing) technologies or SONET (add/drop multiplexers) or anything else. We needed a product like the LightWorks platform to manage the bandwidth."

Ciena's other purchase is no small milestone for the company. Omnia Communications' AXR 500 integrated access platform will give Ciena the ability to provision any service from the DS-0 level up to the 100BaseT Ethernet level to carriers. When combined with Ciena's existing DWDM multiplexers, this means Ciena can provide equipment that supports services from the DS-0 level to the OC-48 level.

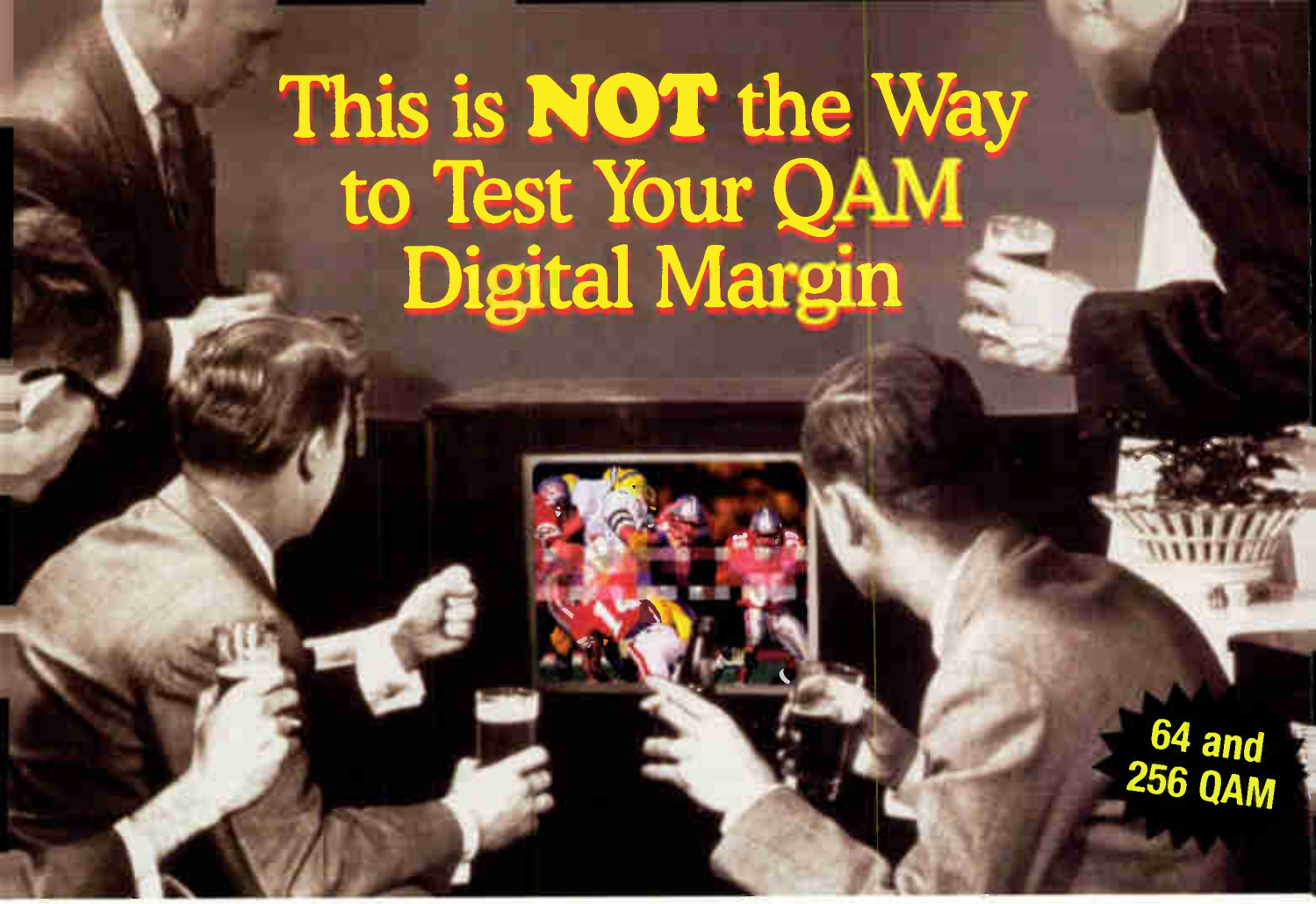
NEWS BITES

News Bites

- AT&T has broadened its purchasing agreement with Arris Interactive by ordering an additional $100 million in host digital terminal (HDT) equipment. In a previously announced deal, which Arris says has a potential value of $900 million, AT&T committed to using the Cornerstone network for initial telephony provisioning over upgraded TCI plant.
- Adelphia has a $5.2 billion deal to acquire Century Communications. The deal will make Adelphia the fifth largest cable operator in the United States.
- After March announcement of a two-for-one stock split, Comcast has sold 8.7 million of its subordinated debentures for an aggregate public offering price of $718 million. Maturity of the debentures can extend to 2059, Comcast says.
- The National Digital Television Center, the National Cable Television Cooperative and TCI's Headend In the Sky (HITS) digital programming arm have agreements with General Instrument for digital equipment. Under the deals, small cable operators will be eligible to receive a combination of volume-driven discounts on GI headend equipment along with rebates on HITS launch support and digital front-line training.
- MediaOne's Express service is available to an estimated 1 million New England homes in 123 Massachusetts and New Hampshire communities. Based on its four-year, $1.3 billion effort to deploy digital TV (DTV), high-speed Internet access and telephony services in New England, the company estimates that it has upgraded more than 20,000 miles of plant.
- Set-top boxes will continue to dominate the home entertainment market for years to come, despite the imminent arrival of integrated digital TVs (IDTVs) into retail stores. According to a report from Strategy Analytics, by 2005 only 6 percent of U.S. households will own IDTVs, compared to 63 percent with digital set-tops
- RCN's Boston cluster will receive a boost. The company will begin providing telephony, cable and Internet services over its synchronous optical network (SONET) in the Burlington, Mass., area by 2000. RCN currently is providing local and long distance telephony, cable and Internet services in several northeastern markets. RCN says its next target is the San Francisco-to-San Diego corridor.
- DIVA plans to deliver a third-generation video server during the second quarter of this year. The company says that the server, geared for more than two terabytes of disk storage, will allow DIVA to expand its programming mix for on-demand services to include more than 1,000 titles. CT



A Repeat: For the second year, Cliff Salmond of Cox Cable in Tucson, Ariz., was overall winner of the Arizona Cable/Cactus SCTE Chapter Cable Games held in Phoenix.



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Reader Service Number 13

DEPLOYMENTWATCH

By Greta Durr

Although the Data Over Cable Service Interface Specification (DOCSIS) certification process is gaining momentum with CableLabs' first-round certification announcements, the uncertified broadband industry favorites already are speeding down rapid deployment's fast track with Internet service superpowers @Home and Road Runner.

Surveys Indicate ...

A new round of studies indicates that the market for the cable industry's high-speed service delivery is reaching new peaks and finding growth in broadband valleys.

A recent Strategis Group study has found that world shipments of two-way cable modems last year reached 955,000. Of these, half were destined for the exploding U.S. market. The report further shows that Motorola, with a 42-percent market share, has so far been the industry's clear favorite.

According to the study, Nortel has a 29-percent share of the market, while Com21 and Terayon trail with just under 10 percent in their folds racing to the high-speed Internet access arena.

Meanwhile, Kinetic Strategies estimates that the number of cable modem subscribers has surpassed 500,000. According to a study, 85 percent of these subscribers are using two-way cable modems while the remaining 15 percent are using telco-return products. Kinetic's study indicates that with North American operators attracting approximately 2,000 cable modem subscribers daily, the toll will pass 1 million before 2000.

Not Just for Analysts

Kinetic also reports that @Home's network affiliates served an estimated 330,000 subscribers at the beginning of the year. Since it was founded by TCI in 1995, the service provider has reported cable partnerships with Bresnan, Cablevision Systems, Century, Comcast, Cox, Garden State Cable, Insight, InterMedia Partners, Jones Intercable, Lenfest, Marcus Cable and Midcontinent Cable Co.

Road Runner also has flourished to meet consumer demand for enhanced services. Its affiliates include sibling Time Warner Cable and MediaOne. The company says that it also is attracting the interest of third-party cable operations, a notion reinforced by deployment deals with Multimedia, Media General, Greater Media and Fanch Communications.

Time Warner Cable and MediaOne project that, by 2000, all of their cable plant will be upgraded and capable of delivering the high-speed Internet service to their 27 million homes passed by cable. At the beginning of this year, the two operators, busy merging Internet operations, were serving 170,000 subscribers. More than 250,000 customers now buy Road Runner service.

According to the company, the majority of Time Warner's initial cable modem deployments have taken place over Motorola devices. Toshiba, one of the first cable modem vendors to earn the DOCSIS-certified stamp from CableLabs, has been in the mix all along. MediaOne, however, has favored two-way cable modems from Nortel and telco-return devices from General Instrument for its pre-DOCSIS-certification deployments.

Turnkey Unlocks Two-Way Markets

High-speed Internet access provider High Speed Access recently signed with Com21 for 40,000 cable modems and associated headend and the networking gear to be purchased over the next year.

Turnkey provider HSA has been working with Com21 for two years as its primary source of devices for Internet services over cable. HSA says it has found success in targeting small to mid-sized markets.

HSA's model provides cable operators with network operating center (NOC) and headend equipment, plus integration, Internet backbone connectivity and technical management. Additional services include customer and technical support as well as sales and marketing at the local level.

Marcus Cable already has deployed HSA's service over Com21 modems in west-central Wisconsin and has more deployments in progress throughout the operator's reach in the state.

Com21 modems have been deployed over a number of domestic systems with cable operators TCI, Charter and Prime Cable as well, but a slew of international launches also has helped to keep the vendor in deployment's top ranks.

A Gartner Group survey ranked Com21 the No. 3 worldwide cable modem supplier in the first six months of 1998. CT

Greta Durr is assistant editor at "Communications Technology" in Denver. E-mail deployment information or comments to gdurr@phillips.com.

Deployment Spotlight

MindSpring, a turnkey provider, has made its first in a planned series of cable modem deployments. The launch in the Montgomery, Ala., area signifies the Internet service provider's (ISP's) first cable modem effort. Additional deployments over **Knology's** plant in Augusta, Ga.; Charleston, S.C.; Columbus, Ga.; and Panama City, Fla.; are scheduled to continue as the operator completes its system upgrades. Last autumn, Knology signed with **Hybrid** for up to 100,000 cable modems slated for use in the systems.

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Expo '99: It's All Here

From fun to education, if it has to do with cable, you'll find it at the Society of Cable Telecommunications Engineers Cable-Tec Expo '99.

Be sure and attend the Annual Membership Meeting on May 24, from 4:30 to 5:30 p.m. at the Orange County Convention Center in Orlando, Fla. This meeting is your opportunity for in-person discussions with other members, SCTE staff and the board of directors. Chairman of the Board of Directors Hugh McCarley will open the meeting, followed by reports from the chairs of each standing committee. SCTE President John Clark will make opening remarks and then take questions from the floor for members of the board of directors and headquarters staff.

Certification testing will be held on May 26 and 27, from 10 a.m. to 2 p.m. and on May 28, from 9 a.m. to noon. Available exams include the Installer Certification written exam, all seven categories of the Broadband Communications Technician/Engineer program (BCT/E), the Broadband Service Technician (BST) Technical Foundation exam and the Telephony associate-level exam.

Expo Evening, featuring the 1999 national Cable-Tec Games event, will be at Disney's Pleasure Island from 7 to 9 p.m. on May 25. Sponsors for this event include Antec, CommScope, General Instrument, Philips Broadband Networks, Scientific-Atlanta and SCTE. A 30th Anniversary fireworks display and cake-cutting ceremony will top off the evening.

The Annual Awards Luncheon, to be held May 25 from noon to 1:45 p.m., will highlight member and organization contributions to the industry. Immediately afterward, from 1:45 to 2 p.m., a 30th Anniversary ribbon-cutting ceremony will open the exhibit hall.

For more information about the participatory events at Expo, call the hotline at (610) 363-3822 or visit the SCTE Web site at www.scte.org.

Changes in Vermont

The SCTE has revitalized the Vermont Meeting Group.

The new leaders are President Jim Kelly of Telewire Supply; Vice President George Goodrich III of Trans Video; Secretary Mike Reilly of Adelphia Cable; and Directors Roland Phillips of Gilbert Engineering and Frank Quinby of FrontierVision. Kelly describes the last meeting as igniting a "renewed sense of purpose."

With renewed support from one of Vermont's largest cable operators, Adelphia Cable, and the core of original chapter leaders, Kelly feels confident that the group "will be able to successfully meet the training objectives of SCTE."

The meeting group already has begun planning various technical sessions for 1999. BCT/E-certified members of the New England Chapter have agreed to assist with setting BCT/E testing schedules and proctoring exams. Kelly says, "This support will greatly enhance our progress in providing this avenue of training and certification for SCTE members in Vermont, northern New Hampshire and northeast New York state."

For information about starting an SCTE meeting group or to learn more about volunteer opportunities within local groups, contact Paula M. Jones, membership services manager, at pjones@scte.org, or call (610) 363-6888, ext. 209.

Satellite Tele-Seminars Fix Ignorance

The SCTE 1999 Satellite Tele-Seminar series has attracted more than 100 participants in the three months since its debut. Designed to support candidates enrolled in the BCT/E certification program, the program combines information with study and resource materials to guide participants in their preparation for exams.

Satellite Tele-Seminar programs are one-hour instructional presentations that are broadcast via Galaxy 1R, Transponder 14, on the second Thursday of each month from 2:30 to 3:30 p.m. Eastern Time. Anyone with downlinking capability can participate in the program at no cost. SCTE encourages viewers to videotape the program for personal reference or for use as a company training tool.

The Satellite Tele-Seminar program offers technical training in the latest technologies available to the broadband community. Greg L. Morley, applications engineer for Tellabs Operations Inc. says: "I have been promoting the program ever since I first learned about it in 1992. The Satellite Tele-Seminar program is a powerful tool for fixing ignorance. It's a part of any general manager's solution to a training budget problem and a chief technician's smart choice for supplemental training."

Remaining 1999 seminars include:
May 13: Transportation Systems
June 10: Distribution Systems and Broadband Course Tutorial
July 8: Telephony 101
Aug. 12: Data Networking and Architecture
Sept. 9: Terminal Devices
Oct. 14: Engineering Management and Professionalism
Nov. 11: Excellence Through Customer Service
Dec. 9: A Review of Upcoming Satellite Tele-Seminars in 2000

To register for the program, send your name, postal mailing and e-mail addresses, plus telephone and fax numbers to Janene Martin, SCTE marketing implementation coordinator. Fax to (610) 363-5898, call (800) 542-5040, ext. 226, or e-mail jmartin@scte.org.

SCTE is a nonprofit professional organization serving the broadband industry's technical community. SCTE currently has more than 14,000 members from the United States and 70 foreign countries and offers a variety of programs and services for the industry's educational benefit. SCTE has 73 chapters and meeting groups and has technically certified more than 3,000 employees of the cable telecommunications industry. CT

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Reader Service Number 15

Interview with a Leader

By Rex Porter

SCTE Hall-of-Famer Dave Willis

Dave Willis

Editor's Note: For the Society of Cable Telecommunications Engineers' 30th anniversary issue, we wanted to interview an engineer whom everyone would recognize as a pioneer. I could picture only a very few with as much background as Dave Willis. Here is an engineer who designed and constructed systems without the benefit of the modern equipment or technology we enjoy today. With tube equipment, basic test equipment such as 704s, a volt-ohm meter (VOM) and a diddle-stick, Dave built and engineered the cable operator known until recently as TCI, now owned by AT&T. Let's take a look back through the years.

Communications Technology: *Tell us about your days before cable.*
Dave Willis: I was born in Nebraska, only 165 miles from Denver. In the early years, right after high school, I went to work in the oil fields. Then the Korean War broke out, so in December 1950, I enlisted in the Air Force to get an electronics background.

I was assigned duties as an electrician at an Air Base Group. I had applied for a tech school for almost a year before I got into airborne electronics. The Air Force sent me to Keesler in Biloxi, Miss., for a year. There I studied specific sets and wound up flying in-flight maintenance for bomb navigation systems on B-36s.

Discharged in December 1954, I worked briefly for Boeing Aircraft Co. in a flight test center at Moses Lake, Wash., flight testing B-52s. But I thought it miserable, so after about eight months I moved back to Nebraska.

Communications Technology: *So, how did you get into cable?*
Dave Willis: A company from Denver, Collier Electric Co., was building a cable system in Sydney, Neb., so I went to the engineer to see if I could get a technician job. He hired me, gave me the plans for the system, and went back to Denver. So within the next few months, I completed the system.

I hooked up a lot of subscribers; we had about 80-percent penetration the first year. The first 30 days I spent on top of a 750-foot tower installing antennas. We picked up Denver, over-the-air, on that 750-foot tower from about 165 miles.

Collier expanded, and we built systems in Scottsbluff, Gering, and Alliance, Neb., ending up with seven systems, which included Laramie, Wyo., and Sterling, Colo. We were just building Scottsbluff when Collier had problems with the Federal Communications Commission concerning a microwave system we had built, microwaving channels from Fort Morgan, Colo., to Alliance and Scottsbluff.

In 1962, Collier and Bob Magness got together, and Magness made an offer, ultimately buying out the Collier systems.

By then, I believe Bob Magness owned 12 systems, and Collier had seven, with a total subscriber base of about 20,000. That's when I went to work for Magness. It was Community TV then, not TCI.

Bob was living in Bozeman, Mont. Shortly thereafter, he moved to Scottsbluff, that year consolidating the company and buying out a partner. He had to decide whether to move the company to Denver or Salt Lake City. His partner, George Hatch, was really in favor of moving the headquarters to Salt Lake City, but Magness held out, and the company moved to Denver.

I was in Sydney as manager, doing engineering for a little district encompassing seven systems. I remained in this position for several years.

Communications Technology: *Tell us what it was like to be a cable tech in those days.*
Dave Willis: Cable was such a remarkable development, and people didn't seem to understand television. I was overseas during the last two years of my enlistment and had never actually seen television until I came home in 1954. This was in western Nebraska, and there wasn't a lot of television around.

My Dad had a TV set and a big rooftop antenna. You could occasionally, in the evening, get 30 minutes of something that

looked like a picture. I hired on with the cable TV company thinking I would see where all this would go.

I immediately enrolled in an RCA electronics correspondence course. I took courses for electronics and television (later, color TV), and in the midst of taking the courses, I took the exam for the First Class Radiotelephone License in Denver and received my first class license. This was a major career step in those days.

I always encouraged my guys to get FCC licenses, and most of them were reasonably successful because most of the guys coming into cable were ex-GIs with military electronics experience.

All of the amplifiers were tube-type. Soon we did have aluminum cable, but the secondary was RG-11. To attach a subscriber to the RG-11, we would install a round aluminum box that was hollow and had a tin lid. The lid had a rubber washer to keep the water out, and the thumbscrew that closed the lid had a lead washer.

Inside this box, the RG-11 cable would be cut and soldered. The solid copper center conductor was soldered to a post, and the copper shield was soldered to a retaining clip. Then, when you put in a subscriber drop, you again soldered the shield to the retaining clip. The center conductor went to a post. Between that post and the post of the secondary cable, a proper size capacitor-resistor would be soldered.

Needless to say, soldering on a Nebraska pole in winter was extremely difficult. I mentioned putting the antennas on the tower; we did all tower work. We installed antennas, down lines, and if a light needed replacing, replaced it. If the tower needed painting, we painted it.

Within the towns, we mostly climbed the poles. We had ladders, but they were the most dangerous things we used to get up to the lines. It seemed like every time someone got really, really hurt, it was on a ladder. We had very few serious injuries when the workers were climbing poles, so cable was pretty much a climbing industry.

We also used a messenger support wire for the house drops. There was a unique way of lashing it. We would put the end of the strand, at the end of the drop, through a 0.045 lashing wire set-up and simply slide it down the line to the house. As it came off the inside of the reel, it would wrap itself, and then you would tighten it and fasten it to the house.

The interior wiring was similar to today's except that we faced a lot of walls. We would put the outlet anywhere the customer wanted it. We wouldn't discourage them, no matter where they wanted it or how difficult it was to get there. There was no way you wanted to lose a subscriber over anything.

Headend equipment and even microwave was then all tube-type. My first engineering boss insisted that we check all tubes monthly, and I argued with him, but he was insistent. It turned out we had more problems with loose sockets than we did with tubes. Eventually, I convinced him we needed to check operation parameters and then change tubes if necessary. That eliminated a ton of our problems.

But we had a 10-mile run from the headend to town, and that long trunk run was always a source of problems in many systems because virtually all systems had relatively long runs. Towns were built in valleys with signal available at higher elevations.

Communications Technology: *But how did you get to TCI's headquarters in Denver?*
Dave Willis: Jerry Shield, director of engineering for Community TV, invited me to Denver to work for him. This was shortly after I completed the system in Vail, Colo. I had activated that system and installed a microwave system with Jerry. Everyone said the system wouldn't work, but Jerry made it work, and I knew he would.

I moved to Denver with the family in about 1968. We were still known as Community TV and located in the upper floors of a Post Office building in the Cherry Creek area. We were in that building long enough that Jerry left and I replaced him.

My engineering department grew to such size that I didn't have enough room for them, so we moved across the street to the second floor above a bar. It was a great location, and on the same floor there was a beauty shop and a travel agency with women only. They were very nice to us guys, so that was a pretty nice location.

Communications Technology: *When did you move to the Tech Center?*
Dave Willis: In 1971. We moved to the Denver Tech Center and started to expand dramatically. In 1972, John Malone joined the company. The decision was made to pursue growth very aggressively. Perhaps it would be interesting to talk about some of the things we did in the very early days, and then I'll return to the point where Malone joined the company.

We started a tremendous expansion, but we were not very good franchisers. TCI was actually known as the Boy Scouts of franchising because we wouldn't promise anything we didn't intend to do or weren't really sure was feasible to do.

Therefore we were outstandingly unsuccessful at franchising because most of the franchise applicants would promise anything, project anything or do whatever they felt they had to do to get the franchise, then let the chips fall where they may. As they became unable to meet their commitments, we wound up buying a lot of those systems and companies. We made some extremely fortuitous acquisitions.

With Athena's purchase, unknowingly we acquired the Mandel patent covering all converters, and we made a lot of money off that patent. It would be very difficult to list all of the acquisitions. Athena, Horizon, Heritage, and the list goes on and on. Each of these acquisitions had its own unique problems.

One such unique acquisition was Pittsburgh Cable. This was some years after we had acquired CentreVideo, earlier Jim Palmer's company, in the suburbs of Pittsburgh. We bought them and had turned the company into a very good operating system or group of systems by the time we

bought Pittsburgh.

Pittsburgh was extremely overstaffed and terribly complex. The QUBE system was installed there. It had tons of monitoring and switching, so we decided to take out all of the QUBE equipment and convert it to a straightforward addressable converter system.

Pittsburgh viewers thought we had installed an all-new system. They were overjoyed because the programming was dependable, actually showed up at the right place and was extremely reliable. So the people were very happy.

The manager sent in to take over was Art Lee. Art called all of the employees together and fired everybody. Then he said, "I'm taking job applications first thing in the morning," and he rehired those he believed to be the best people, and through this process we cut the staff by about one-third.

Communications Technology: *It must have been fun being a part of such a changing industry as you worked to help build such a major operator as TCI.*

Dave Willis: Among the great things I remember was the continuous progression of equipment. Every aspect of cable TV improved year by year by year. There was a constant improvement in amplifiers, one product after another. Cable improved, studio equipment and especially in-home equipment, tap devices—tremendous advances in such a short period of time.

The other thing is how this was truly a grass-roots industry. It was never subsidized by any government entity that I know of. We received far more harassment than subsidies.

Early FCC-imposed technical specifications were, I think, proper and needed. In fact, I think that some of the stringent rules placed on us, with operational and electronic requirements, were very good for the industry, so I greeted them with open arms.

But when the government imposed the Cumulative Leakage Index (CLI), I think it was a travesty and a burden, which was simply harassment. There had never been an airline accident caused by cable interference—never was at that time and has never been to this date. The FCC's insistence that we inspect every foot of plant every year was to me totally unconscionable, a burden that was ridiculous.

I wrote to the Federal Aviation Administration, having researched their radio frequencies, suggesting that if they would abandon seven specific frequencies, it would be impossible to have any interference from a cable system. This would have been seven of about 5,000 frequencies.

Their response was they were not about to abandon anything and that if we had any brains at all, we would replace every stitch of coaxial cable with fiber. That was when we had literally millions of feet of cable out there in the systems. It illustrates how well they understood a cable system. They imposed rules very stringently and yet had absolutely no understanding of how systems operated.

The loss of seven frequencies would have been absolutely unnoticed to them. I also went on to say that if they had to retune any radios or modify them to eliminate those seven frequencies, TCI would pay the bill. It made no impression whatever. They simply did not understand and did not want to cooperate with our industry to any degree.

Over the years, franchising obviously got a lot of people into trouble because they would promise a

lot of things and not be able to deliver. One of the big problems we had in acquiring some of these systems and companies was we would have to go meet with the city and renegotiate, trying to get a reasonable franchise worked out.

One example was the city of Boulder, Colo. We purchased the company that had the franchise. When we went in to renegotiate it (straighten it out), citizens announced to the city council and us right up front that they thought there should be no charge for cable TV. It should be totally free except for presentations of tremendous value and interest, such as ballets, symphonies and concerts. That was their concept of the real value of cable.

I can't think of any other city that extreme. That shows the gamut of the cities with which we had to deal. Some cities felt they would be happy if we gave them 12 good channels of cable, and others wanted us to promise the moon. When we wouldn't concede, we really had a difficult time convincing them what they were asking would have been a totally empty promise.

Communications Technology: *Although I started my career as an engineer and system operator, I became a vendor during the '60s. I remember calling on you to sell TCI cable or connectors. Talk a little about your TCI purchasing days.*

Dave Willis: After I became the director of engineering in 1971, I wore many hats. I was purchasing agent, director of engineering, in charge of facilities and training. I don't think I had to do windows, but I did just about everything else. Because of that, I got a very broad view of all the things involved in the technical department and facilities. This put me in contact with many, many vendors.

I remember fondly the many vendor relationships I had with all of the various people. Now they weren't all good, but there were very few that I would say were bad. In general, I had a lot of respect because of a tremendous amount of cooperation and good camaraderie with an awful lot of people who were vendors to the operating companies.

It wouldn't do for me to pass the opportunity to say how much I enjoyed and appreciated the operation of the SCTE. In the earlier years, I frankly had a lot of problems with it. I had a very difficult

time agreeing with one early head of the SCTE on almost anything. After that era, however, I saw the true value of what the SCTE could be and then supported it wholeheartedly.

I served on the board of directors and spent a lot of time supporting the Society. I was rewarded very nicely for that at the end of my career when I was voted into the SCTE Hall of Fame, an honor I cherish to this day. I think it was a tremendous honor to join this group. I still maintain my membership in the SCTE today and am active on at least one committee, occasionally doing other committee work for them. The SCTE will always have a warm place in my heart.

Communications Technology: *Since your retirement, is there anyone you really miss from the old days?*

Dave Willis: I cherish the memories of some of the guys I got to work with. I never had a real enemy within my own camp, or at least if I did, I wasn't aware of it. The guys I worked with closely were just extremely good guys, very conscientious and hardworking. We worked so hard that we didn't have a lot of time to raise our heads and look around.

> "My engineering department grew to such size that I didn't have enough room for them, so we moved across the street to the second floor above a bar."

From the top of our company on down, one of the guys that I have extremely fond memories of is Bob Magness. Magness was a "good old boy" in every sense of the term. He was a guy so honest that if he shook your hand and said, "This is the way it is," you could bet the homestead that was the way it was.

He brought in John Malone in 1972, and Malone took much of his operating persona from Bob. He was very close to Bob, and I think Malone admired him a great deal, as I know Bob Magness admired John Malone.

John was, to me, a financial genius, and I think he has done a fantastic job over the years to nurture, develop and make TCI into a real entity to be reckoned with. With TCI's sale to AT&T, I don't look at that as the death of TCI. I look at it as further development for it to continue to incorporate the heart and soul of TCI.

When I was in charge of purchasing, I got to operate quite closely with guys like Gary Bracken and Don Fisher. These guys were extremely competent and conscientious. I worked almost my entire career at

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Reader Service Number 20

TCI for J.C. Sparkman, really about 25 years. J.C. was kind of a "shoot-from-the-hip" kind of guy; actually, I guess he always was that way.

Before he came aboard, we had been kind of hung up on getting decisions made. It seemed really tough getting a final decision on things out of upper management, so J.C. was exactly the medicine we needed. When you took a problem to J.C., he had an answer or decision immediately. Now, he wasn't always right. But every time you struggle with a decision, it seems almost any decision is better than no decision at all. He had no problem with making them or making them quickly, and I've got to say he was right an awful lot more than he was wrong.

Communications Technology: *Looking back, are there some things that you think amazing?*

Dave Willis: It was amazing that the years flew by so quickly. It seems only yesterday I was climbing poles, soldering taps and doing all the things I did. And now here, all of a sudden, I'm 68 years old and retired. How quickly it went.

And what a wonderful experience it was being a part of this unbelievably dynamic industry that was really just a bootstrap operation that I think everyone in the industry should be proud of. Whenever I hold a class or give a talk, I always emphasize that cable TV made some contributions not immediately apparent.

Without cable TV carrying adjacent channels on cable systems, the TV set manufacturers would have been much slower in cleaning up their adjacent reception so adjacent channel carriage could improve. In the over-the-air world, it simply didn't happen that you had side-by-side channels authorized. So the manufacturer vastly improved the TV set as a direct result of adjacent channel carriage on cable TV systems.

Another thing is significant. The first video delivery by satellite was HBO, and that was enabled because some cable TV systems had foresight, guts and wherewithal to belly up and put in some of those $100,000 earth stations. If you can remember, some of the very early earth stations were 10 meters, and those things were expensive. The first one TCI put in was about a hundred grand, and the second one was, as I recall, about 85.

Because of this activity, there was suddenly a terrestrial part of the satellite story, so the next video service went up and on and on. I think that had the cable industry not taken the steps install those initial earth stations, it would have been a long time (maybe as long as 20 years) before we would have seen significant video delivery by satellite. But because the cable systems did it in 1976, it's old hat today.

I remember the initial low noise amplifiers (LNAs) we bought cost in the neighborhood of $2,500 apiece. I saw an advertisement the other day, and LNAs were selling for $69. They are probably better LNAs than those we first bought. But with the expanded use of LNAs, the price has plummeted as competition made

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each version just a little better. This has put the satellite industry where it is today. But they wouldn't have been near there today without the cable TV industry.

Communications Technology: *Well, now you get to relax, fish and travel. How do you think cable has impacted your family over the years?*

Dave Willis: I was single when I entered the cable industry, and I think I had been in cable for three years before I got married. It always kind of galls me when I hear people today saying, "Well, it's this television that makes these kids go wrong and do bad things." I have three kids, and they are wonderful kids. They never knew a day in their lives without cable TV, and I've got to say my kids never got into any serious trouble. They've lived pretty good lives, and they've turned out to be excellent individuals. I have four grandkids now, of whom I am very proud. When they get older, they may disown Old Pappy, but right now I just love them.

After my retirement, you and Marlowe Froke met with me. You asked if I would be interested in participating in some of the activities of the National Cable Television Center and Museum. It was in the process of moving from State College, Pa., to Denver. I typically will jump at any opportunity to maintain contact with the industry, so of course I agreed. Marlowe then appointed me an Industry Fellow of the Museum and named me Curator of Artifacts for the museum. I have worked at that for the last several years. It's been rewarding, and I've enjoyed doing it.

We are breaking ground this spring for the new Center and Museum building. I think when it gets built and we get all of the artifacts settled into that building, I will leave the museum, simply because I don't want it to turn into an eight-hour-a-day job. That's what it's going to require. In the meantime, I love the opportunity to contact people looking for old artifacts.

I used to do a five-year prognostication for one of the trade magazines where I would say what I thought would be going five years out. Like all forecasts of the future, I had some hits, and I had some misses. But in the last one I did, I predicted by the year 2000, 20 percent of the cable industry would be owned by a telephone company. I'm anxious to see how close to the mark I am going to be. I think that is one of the forecasts I will hit pretty close.

In closing, I would like to say I am looking forward to the next year or year and a half as I work with the Cable Center and Museum and the SCTE. And I especially look forward to hearing from the many, many cable people I have known throughout the years. I've never ever had occasion to regret my involvement in the industry, and I've always been extremely proud of those people who have been in the industry during the years with me. CT

Rex Porter is editor-in-chief of "Communications Technology" in Denver. He can be reached via e-mail at tvrex@earthlink.net.

By Ron Hranac

Work Together to Beat Over-the-Air Interference

A couple months ago, I discussed RFI—radio frequency interference—from the perspective of signal leakage and ingress. But did you know that a cable operator can be responsible for RFI from devices that aren't even connected directly to the system? The culprit is certain Part 15 devices.

Part 15 devices are electronic devices such as cordless telephones, wireless modems and garage door openers that share over-the-air radio frequencies with licensed users of the same spectrum.

The Part 15 devices do not require a license to operate, and they fall under the Federal Communications Commission's rules and regulations, specifically Part 15. If you've ever read some of the fine print in a Part 15 device's instruction manual or perhaps on a sticker affixed to the device, you've probably seen something like this wording from a sticker on the bottom of my cordless phone's base unit:

"This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation."

What's the cable impact?

What does this have to do with cable systems? Not much, unless you're using Part 15 devices such as wireless modem jacks to connect a digital set-top to an existing phone jack located in another part of a subscriber's home.

In addition to the cable connection, digital set-top boxes often require a phone line connection to facilitate pay-per-view (PPV) and other features. Phone jacks seldom are located near TV sets, so if you can't install one there, you can use wireless modem jacks instead.

A specific example

Several months ago, the American Radio Relay League (ARRL) received reports of local interference from carriers in the vicinity of 3.52 MHz, which is near the bottom end of the 80-meter amateur band.

> If your wireless modem jacks are causing interference, then you are responsible for resolving the problem.

The ham radio operators reporting the interference commented that the interfering carriers in many instances were noisy and somewhat drifty. A few appeared to be frequency modulated with voice signals that sounded like telephone conversations. The interfering carriers ranged from S7 to 60 dB over S9 on amateur transceiver signal strength meters, strong enough to make two-way radio communication impossible on the affected frequencies.

It turned out that the interference was caused by wireless modem jacks that had been installed by the local cable company, in this case TCI. The wireless modem jacks are Part 15 devices and technically are "carrier current" devices; they use a home's electrical wiring to transmit signals. They are full duplex transceivers that use FM signals conducted by the home's electrical wires.

A wireless modem jack includes a pair of modules. One is connected to an existing phone line and plugged into a convenient electrical outlet. The second connects to the digital set-top's rear panel phone jack and another electrical outlet.

Early designs of the module installed at the wired phone outlet transmitted on 8.27 MHz and received on 3.52 MHz, and the module installed near the digital set-top transmitted on 3.52 MHz and received on 8.27 MHz. The 3.52 MHz signal was on continuously, even when data was not being transmitted. It was this signal, some of which was being radiated by the home's electrical wiring, that was causing interference to nearby ham operators.

The wireless modem jacks in question are manufactured by Phonex Corp., located at 6952 High Tech Drive, Midvale, UT 84047, (801) 566-0100. The company also makes wireless telephone jacks marketed by GE, RCA/Thomson and Radio Shack. The wireless telephone jacks are similar to the wireless modem jacks, but they operate on different frequencies (3.025 MHz and 6.436 MHz). ➤

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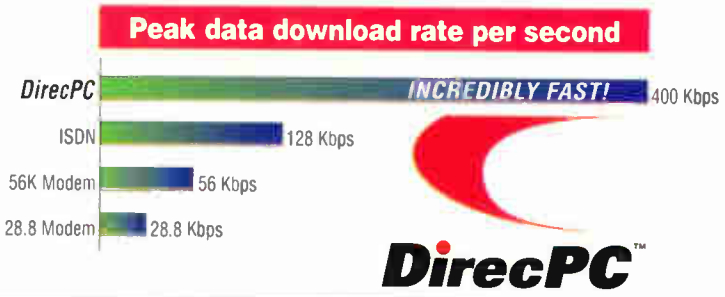

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EDITOR'S LETTER

By Rex Porter

New Services for A New Century

Say goodbye to the 20th Century and engineering practices based solely on what we learned during the past 50 years. Technology has spawned a new industry for us: Cable networking.

Job security in broadband communications will depend not only on design and maintenance of hybrid fiber/coax (HFC) networks but also on understanding the influx of new equipment and services over these HFC architectures. An end-to-end solution is more than a term; it must be incorporated into the system in such a manner that customers will appreciate our service into their homes.

Headends will be eclipsed by NOCs (network operation centers). The need for multiple servers, routers, telephony switching and various other new equipment will require spacious buildings unlike any traditional headend. If the modems must be Data Over Cable Service Interface Specification (DOCSIS)-compliant, then the headend network equipment must be DOCSIS-compliant. Equipment must work in concert, or else our efforts at standardization have been for naught. And the NOC should provide status monitoring for the complete network, unlike headends of old.

Moving outside the NOC, a concern of the engineer/technician must be to protect the integrity of the HFC network so that other services can be added as changing technology dictates. While it may seem digital TV (DTV), Internet data, commercial data and telephony are old technologies, it was only a few years ago that we had none of these services. It is interesting that while each service was unique, the HFC architecture needed for each was the same.

Because we recognize the important cash flow potential of Internet protocol (IP) telephony, ensure the end-to-end solution highlights this service. If nodes designed for DTV and Internet service are questionable for IP telephony service, your end-to-end solution company should be able to discuss this with you. And they should discuss how solutions might change as more subscribers use each service. In short, do they understand your business as well as their own?

There surely will be a number of new services added to our cable networks in the near future. Research is ongoing toward providing software for equipment monitoring to decrease system downtime to zero. This may be accomplished by remote sensing and switching equipment prior to failure. Video streaming advanced commercial data and a host of new ideas are on the horizon.

This brings us back to the responsibility of the system engineers. Do not base your buying decisions on the present only. Do not buy the cheapest gear available. You must balance today's requirements against future needs. When choosing end-to-end solutions, consider companies that have experience dealing with local area networks (LANs) and wide area networks (WANs) designed for businesses and universities. Consider their business alliances with other major equipment vendors in the networking arena. Smart end-to-end solution suppliers will ask the right questions before they successfully deploy the services or equipment. And those questions will develop the right answers for your deployments.

You have engineered the right HFC architecture for the cable network's future. Now protect the architecture by demanding the best end-to-end solutions for that architecture.

Rex Porter
Editor-in-Chief
Communications Technology

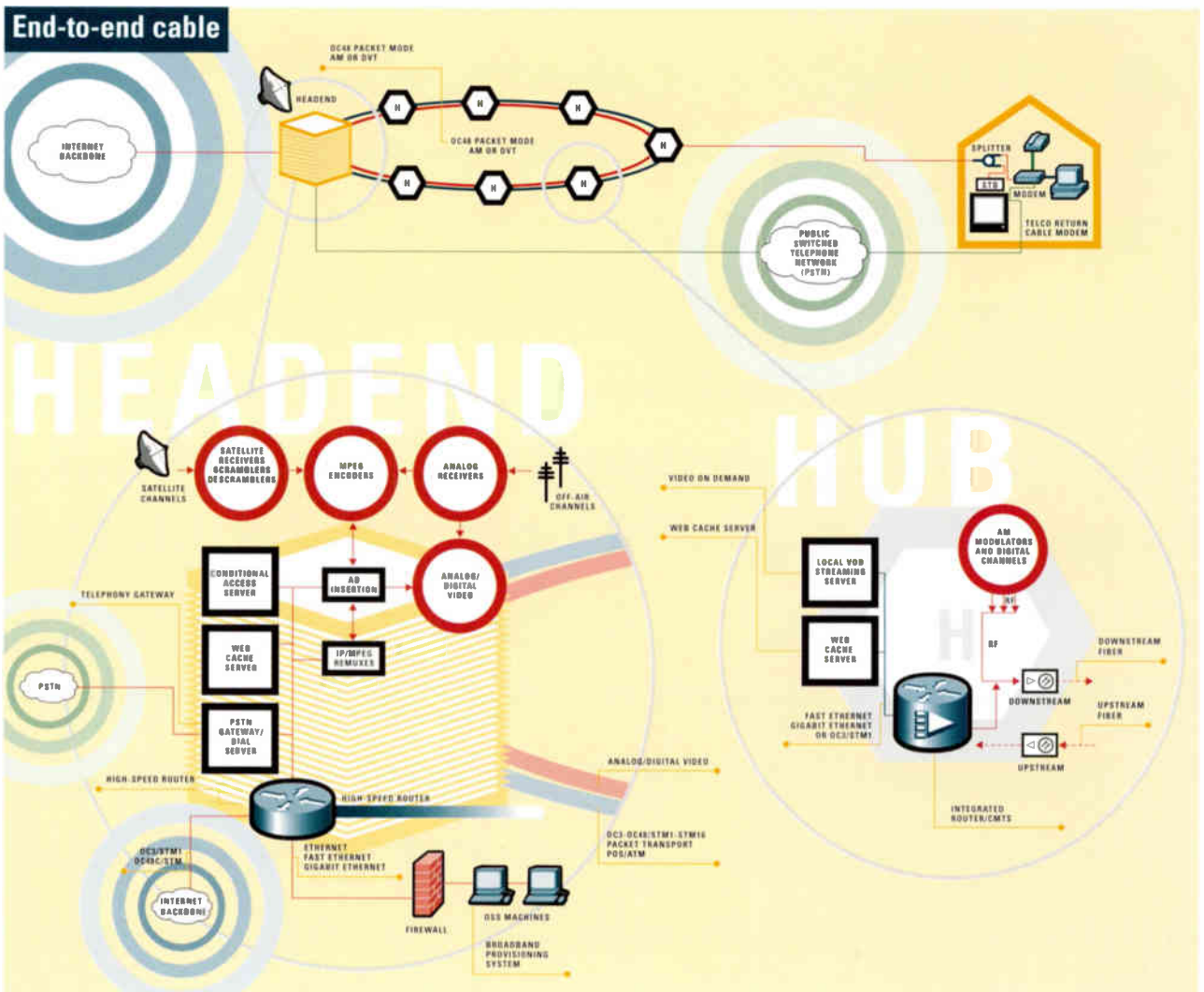
Deploying IP Services Over Cable:

Success = Planning, Planning, Planning

Cable companies that successfully deploy digital IP services expect and plan for change.

It may be impossible to completely predict future business directions and needs, but you can design and implement a digital infrastructure that will effectively accommodate whatever market shifts or growth your company experiences. Essential to success is the development and maintenance of a deployment plan that outlines strategies for digital equipment rollout. Whether you are just beginning to evaluate digital IP opportunities or have already begun the deployment process, planning will ensure that over time you can profitably deliver whatever types of services make sense for your business.

During the planning process, leverage the experience of others. Partnerships with systems and network equipment vendors give you direct access to technology and product information, business support programs, and real-world deployment experience. Use their expertise to help develop a plan that not only lets you evaluate startup needs, but



Capacity calculation example

Calculating the total amount of bandwidth required for each hub on your network is not a difficult process. Your network equipment vendor should provide financial models that use capacity planning data to automatically determine the networking equipment needed for each type (for example, residential or commercial, voice or data) and level of service.

In the following example, see how a simple six-step process helps determine bandwidth requirements for each data service on a plant. Note that this example specifically estimates requirements for data services. Any other service model (such as voice) would also include self-provisioning for the unique features (such as call blocking) of that particular IP service.

Step 1. Select a particular hub and calculate the total number of homes passed (HP) on that hub. For example:

Hub A - 50,000 HP
Hub B - 43,000 HP
Hub C - 61,000 HP
Hub D - 32,000 HP

Step 2. Build a quarter-by-quarter estimate of the market penetration you expect to achieve for each individual service to be enabled on your plant. For example:

Y1, Q1 - 0.2%
Y1, Q2 - 0.5%
Y1, Q3 - 1.0%
Y1, Q4 - 1.7%
Y2, Q1 - 2.5%
Y2, Q2 - 3.3%
Y2, Q3 - 4.5%
Y2, Q4 - 6.0%
Y3, Q1 - 8.0%

Step 3. For each service, describe the total upstream and downstream bandwidth allocated per user. For example:

Residential data service:
Upstream = 300 kbps;
Downstream = 1 Mbps

Step 4. Estimate the maximum percentage of subscribers simultaneously using each service. For example:

Residential data service:
Maximum peak usage = 25%

Step 5. Estimate the percentage of time active subscribers on each service will actually be transmitting or receiving information.

Residential data service: Residential users typically download no more than 20 percent of their online time; users typically upload 10 percent of their online time. The rest of the time, users are reading or using downloaded information.

Step 6. Apply the following formula to estimate peak downstream usage for each service at each hub for each quarter:

Total peak usage for this service at this hub =

(Hub HP) · (Market penetration) · (Downstream bandwidth allocated per user) · (Maximum peak usage) · (Percentage of time user is downloading)

For example:

Y2, Q1 usage of residential data service at Hub A =

Total peak usage downstream =

(50,000 HP) · (2.5% penetration) · (1 Mbps per user) · (Maximum of 25% of users on line at any time) · (20% of time spent downloading) = 64 Mbps

Calculate the total traffic generated at a specific hub by adding the traffic generated by each service. By completing these calculations across quarters, you can predict the downstream bandwidth required to meet your service needs over a designated period of time (see graph on page 6). These totals, plus the information derived in the configuration planning stage, will help you determine the appropriate type and numbers of network equipment products required for your business.

also helps you anticipate system requirements that will support expansions or modification of services. As you build a plan, include strategies for the three critical stages—capacity planning, configuration considerations and ongoing maintenance.

Calculating capacity requirements

Step one in deployment planning requires you to evaluate the networking equipment that will be needed to support your offered business services. Specifically, by performing a few simple calculations, you can determine approximately how many routers and cable modem termination system (CMTS) products (including modem cards) will be required for each network hub. The most important items to consider include:

Number of subscribers over time. Assess your geographic coverage, including the initial number of homes passed (HP) and expected subscribers. Then estimate these numbers, by quarter, for the next three to five years. Few companies have the financial resources to start up with a network equipped for long-term capacities, but every business should design its infrastructure with an eye on future requirements. Making the right equipment decisions early maximizes your returns on capital investments. Consider, for example, equipment racks. It may be more cost-effective to set aside adequate space for expansion in your headends now, rather than try

to reconfigure your headends when your service grows.

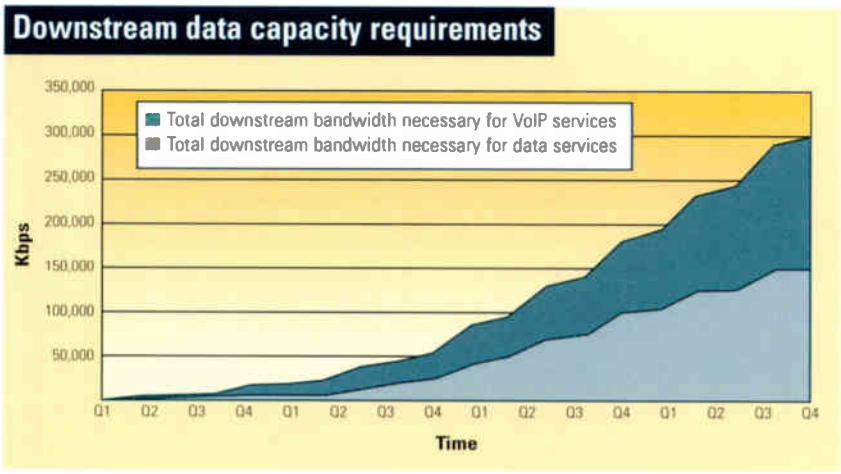
Type and level of services to be provided. After you have determined the types of services to be offered—data, voice or integrated data and voice—you need to choose the levels of service that the customer will accept. For example, to support your data service, you may offer 256 kbps, 512 kbps or 1 Mbps, depending on your customers and their expectations.

Customer usage profiles. Gather information about your users. You'll need to find the answers to several questions. When are your subscribers online, and what are they doing? Are they commercial users with heaviest access during business hours? Or are you mainly serving residential users whose favorite times will be early evenings? What will be the most popular activities—casual Internet access, media streaming or interactive gaming? Taken together with the type and level of services to be provided, the usage profiles that you gather will help you accurately predict overall network bandwidth requirements. Furthermore, this information will be crucial in helping you and your company maximize the revenue from your customer base. Make sure that your equipment vendor has a solution for gathering and analyzing this data.

Configuration issues

After you have defined capacity requirements, evaluate the existing equipment environment—the physical configuration of cable plants, hubs and headends. The goal is to determine what modifications or additions will be necessary in order to deliver the bandwidth to support the peak usage levels outlined in the capacity plan. The most important items to consider are state of the plant, IP address management and supporting servers.

State of the plant. How many of the homes passed already are connected via the high-quality plant required for voice/data service? How many must be upgraded? The geographical layout of nodes and the quality of the associated plant will determine how many nodes can be integrated into each router or CMTS. Assuming geographic proximity, four to eight nodes per router would be typical for a plant in good condition. The better the condition of the plant, the more nodes you can connect to a single router before noise becomes a problem. Plant condition, geographic coverage and bandwidth directly affect the number of required routers. At some point in service scale-up, bandwidth will become the determining factor in node combining.



IP address management. It is critical to develop an addressing allocation scheme, as well as to determine in advance how you will change that plan to respond to actual usage patterns. IP addresses are scarce commodities. The inefficient use of IP addresses has caused some cable companies to halt customer installations while the technical staff either reallocated the existing pool of IP addresses or petitioned the centralized authority (Internet Assigned Numbers Authority, or IANA) for more.

Your network equipment vendors can help you implement a plan that is simultaneously effective and flexible. Vendors are also a good source of useful configuration hints. For example, an experienced network equipment vendor would tell you to avoid assigning all your IP addresses up front. Rather, you should keep a pool in reserve. Also, do not necessarily hard-code routing infrastructures with address prefixes matched to specific geographies. The reserve pool of addresses and a flexible addressing scheme will help you accommodate growth and set up your system software and routers for optimal responsiveness. The use of private addresses (unregistered 10.x.x.x class A addresses) for local devices that do not need routing over the public backbone also can conserve your address space.

Supporting servers. Select servers (both hardware and software components) that can handle all of the volume and protocol requirements of your business. Wherever possible, select products that support industry standards. Make sure the server systems—which reside at both hubs and headends—support dynamic host configuration protocol (DHCP)/domain name system (DNS), time of day and trivial file transfer protocol (TFTP), all of which are required for DOCSIS devices. Also, though it may seem obvious, carefully estimate your physical space requirements—computer systems, routers, switches and racks take up space that is generally very limited at the hub or headend.

Maintenance

The planning does not end when your installation is complete. Internet-based businesses and services grow explosively and unpredictably. To stay competitive, you must be vigilant in monitoring network operations. Information about the performance at every level—from equipment to topology to application—should be detailed and easily accessible. The more accurately you can monitor what is going on in your network, the more readily you can avoid operational problems, as well as identify opportunities for enhanced services. Be sure to consider traffic profiling, trend analysis and support logistics.

Traffic profiling (bandwidth usage) and composition. Routine plant traffic measurement is essential for ongoing capacity planning. As you evaluate networking products, make sure they include robust traffic monitoring and analysis tools. Can you remotely meter traffic at key network points, including the cable plant and links? You should be able to easily identify the specific composition of all network traffic—for example, Web, file transfer protocol and streaming media.

Traffic profiling, by telling you exactly how much bandwidth each service is consuming, can help you predict when you might run out of bandwidth at a particular hub. Ideally, to avoid service blockage or customer complaints, equipment should be ordered three to six months before you actually need it. You also can minimize plant rewiring if you order enough equipment to support one-year's worth of expected traffic growth.

Trend analysis. Check that available reports provide detailed information in highly readable formats, letting you quickly and easily spot trends. Good maintenance planning requires more than reports of byte counts.

Support logistics. Plan for routine maintenance of your network equipment. What will you do in the event of a failure? Does your support plan identify all necessary resources? How quickly do you need response to equipment service requests? Who will be responsible for diagnosing unidentified problems? The more details you work out in advance, the more seamless your delivery of customer services will be—no matter what may be happening behind the scenes.

Information sources

A wealth of information is available to help you effectively plan your deployment. Check out vendor programs and business models, relevant industry publications, and Web sites. The following sites can help you get started:

- www.cisco.com/warp/public/728/ubr/mdcab_pl.htm
- www.cablemodem.com ■

Cisco Cable Solutions for the MSO

Cisco Systems offers an end-to-end suite of products to fit practically any multiple system operator (MSO) need in networking data, voice and video over cable. In fact, Cisco solutions can support everything from high-speed backbones in the largest cable systems to self-contained systems in very small cable installations.

For example, Cisco is able to solve the problems MSOs face interconnecting headends and distribution hubs via optical internetworking using Cisco GSR12000 gigabit routers and uBR7246 Universal Broadband Routers. Cisco's powerful line of access servers is the solution for providers doing telco return with cable downstream and dialup modems upstream because these solutions are modular enough to be able to support both one-way telco-return systems and two-way cable-return networks in the same, easily upgradable system.

Cisco's complete, end-to-end solutions feature DOCSIS-based cable modems and equipment for your headend, as well as powerful provisioning software.

An end-to-end solution

Specifically, the Cisco Universal Broadband Router family delivers an attractive choice of two headend solutions. The Cisco uBR7246 is the most powerful, scalable and feature-rich interface between subscriber cable modems and the backbone data network. As a lower-cost solution, the Cisco uBR7223 provides everything needed to run data services over cable by combining the power of a Cisco 7200 series router with the high-speed network access of a cable modem shelf, all in one solution bundle.

The two cable modem products that Cisco offers include full-featured router functionality and can support 20 or more personal computers (PCs). The uBR904 offers four data ports, and the new uBR924 provides four data ports plus two voice ports for IP telephony services. These products are ideal for the small office, home office and small business markets, including the high end of the telecommuter market.

For complete telecommuter and residential market coverage, Cisco has leveraged the retail power and brand recognition of consumer vendors Sony, Samsung, Thomson, General Instrument, Askey, Pace and Com21 for a wide range of residential cable modems and set-top boxes that include cable modem functionality.

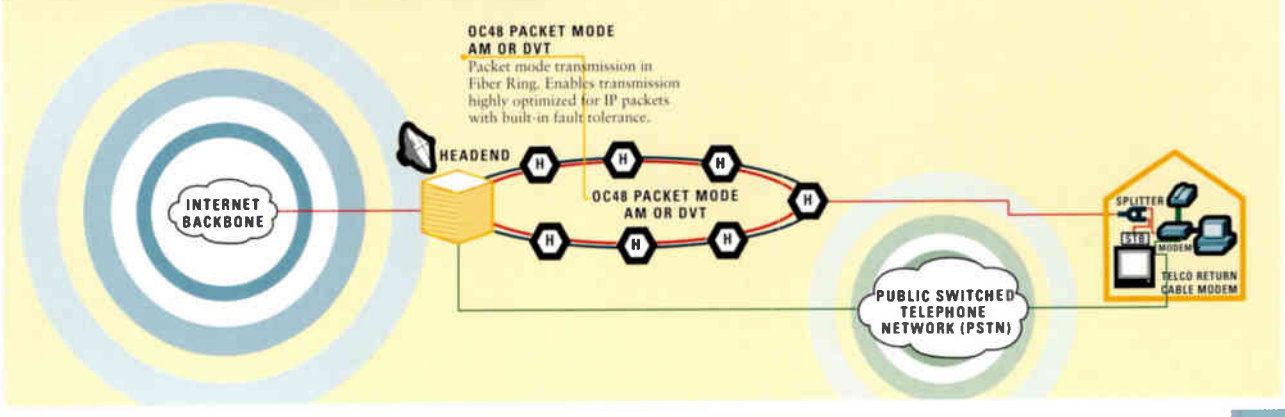
Reliability

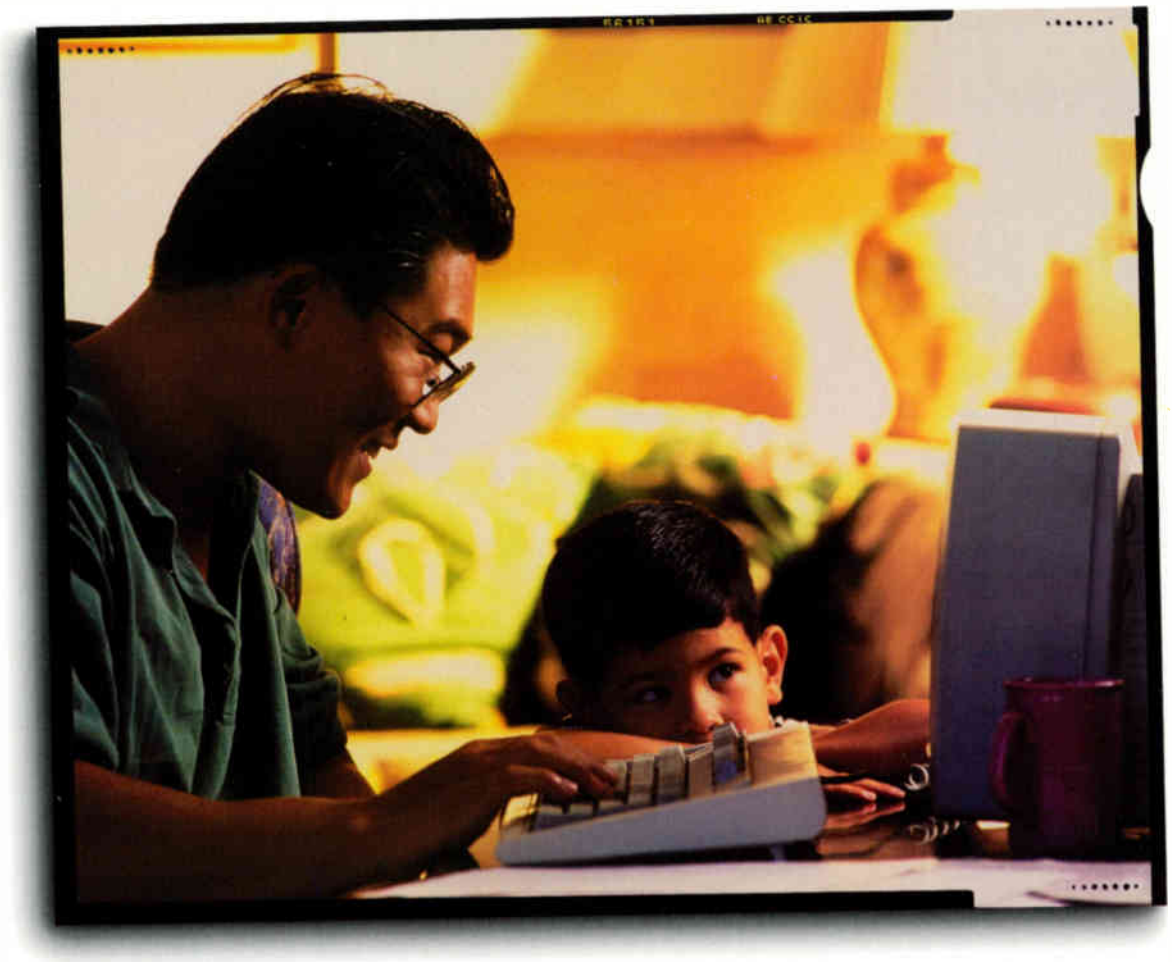
Cisco headend offerings are all DOCSIS-compliant, so they interoperate with the ever-growing world of DOCSIS network devices. In fact, Cisco was the first vendor to have its cable modem termination system (CMTS) officially qualified by CableLabs.

In addition, Cisco Systems offers Technical Assistance Center support, which is available 24 x 7 for problem resolution, along with an award-winning Web site, which offers the most comprehensive collection of online technical resources in the industry. The Cisco extensive service and support offering ensures that your Cisco network exceeds your highest expectation.

Visit the Cisco Web site at www.cisco.com/cable for more information. ■

An IP solution from headend to the home





By 2002, over 13 million homes will access the Internet with cable modems.

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Wireless modem jacks are unlicensed devices that are authorized under Part 15 of the FCC's rules, where they are defined as "unintentional radiators." Because they use a home's electrical wiring to transmit their signals, they must comply with the regulations for "intentional radiators," also found in Part 15.

These rules allow radiated signals in the 9 kHz to 30 MHz spectrum of up to 30 µV/m at a 30-meter measurement distance. But the rules also say the devices cannot interfere with licensed users of the spectrum, regardless of their radiated signal strength.

When they do, the operator of the Part 15 device has to take necessary steps to reduce or eliminate the interference. In this particular situation, the cable company was the Part 15 device operator.

Solving the problem

When the source of the interference was identified, Phonex changed the wireless modem jack remote frequency from 3.52 MHz to 3.3 MHz and made engineering changes to prevent the units from transmitting a carrier when not in use.

Phonex has agreed to retune or replace units that are found to be causing interference. As an operator of the wireless modem jacks, TCI has implemented a company-wide plan to stop using units that operate on 3.52 MHz and replace existing 3.52 MHz units with retuned versions or install a permanent phone line (where possible) all the way to the digital set-top.

Both companies are to be commended for responding quickly and positively to this situation; they clearly demonstrate what mutual voluntary cooperation can accomplish in a short period of time. While the FCC was aware of what was going on, it didn't have to get involved.

I bring this up because TCI is not the only user of Phonex's wireless modem jacks. Any cable company that installs (or has installed) them where a conventional phone line does not exist or can not be installed needs to be aware of interference potential, especially if any of the earlier 3.52 MHz units have been deployed.

The moral of this story

If a ham radio operator or other licensed over-the-air user contacts you about this type of interference problem and you are using the wireless modem jacks, then you are responsible for resolving the interference—assuming your company owns them, of course. If you don't have good records of where they were installed, you may have to track them down using portable short-wave receivers.

If your system doesn't use wireless modem jacks and you get an interference complaint, don't go on the defensive. Instead, politely explain that your system doesn't use them and that the interference could be coming from something else: a wireless modem jack someone purchased at retail for computer modem hookup or direct broadcast satellite (DBS) reception, or perhaps a wireless telephone jack.

It's certainly possible that the interference could be something else altogether, too.

The nice thing about this particular situation is how quickly the parties identified it and worked together to solve it.

Ed Hare, the ARRL's lab supervisor and one of the leading experts on RFI (his ham radio callsign is, interestingly, W1RFI), summed it up best when he said, "If every RFI problem that involves amateur radio could be fixed so quickly, I would probably be out of a job."

If you'd like to learn more about this topic, I encourage you to check the ARRL Web site. Specific information can be found at www.arrl.org/tis/info/rfiteljx.html. Phonex's Web site is www.phonex.com.

Ron Hranac is vice president of RF engineering for HSA Corp. in Denver. He also is senior technical editor for "Communications Technology" magazine. He can be reached via e-mail at rhranac@aol.com.

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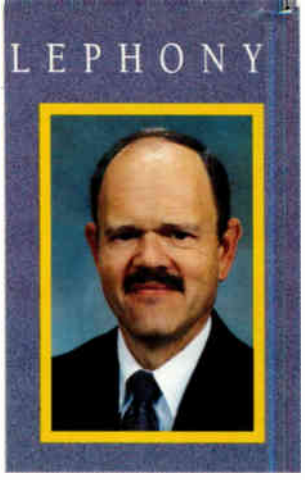
By Justin J. Junkus



IP Telephony Meets The Signaling Network

It's no secret that Internet protocol (IP) telephony is in its infancy compared to its circuit-switched cousin. You'll remember from last month our discussion about the need for a feature server to emulate the ability of a local telecommunications switch to deliver call waiting, call transfer, caller identification and so on.

That capability solves only half of the feature parity problem for IP telephony. The other half of the solution requires a standard interface to circuit-switched telephony's Signaling System 7 network (SS7).

Some background

Bellcore originally created SS7 as a way to remove call setup from the voice path used to connect the call. The old way of establishing a connection across the public switched telephone network (PSTN) used a system of voice frequency tones to control network cut-throughs and establish that billing needed to be done.

Because the tones were in the voice frequency range, this method of control is called in-band signaling. Although in-band signaling is an easy way to set up a call, its disadvantage is that anyone with a tone generator can simulate the signaling sequences. This makes the system think the call pirate is part of the network, rather than a user who should be billed for a call. Blue and black boxes proliferated when in-band signaling was prevalent, and the telcos lost money.

Separating the signaling from the voice path provides a solution, but it also requires a separate network. This new, out-of-band signaling network is an overlay to the voice network, and it exists only for control and administration. After a call is connected, it drops out of the picture.

A series of communications between the signaling network and switches in the voice network perform call connection. The messages include a way to verify path availability between voice switches before cutting through a voice connection.

The first implementation of out-of-band signaling was called common channel interoffice signaling (CCIS). AT&T introduced CCIS in the mid-1970s. The initial network used 4,800 bps links (slow by today's standards, but lightning fast in the '70s) between nodes on the signaling network.

> "Both hardware and software are needed, and the protocols have to be built with consensus from both data and telephony standards bodies."

The underlying transport was over analog circuits. The nodes contained computers called signal transfer points (STPs) that managed the retrieval of network status information from databases called network control points (NCPs). The STPs also sent messages back to the switches in the voice network.

Signaling System 7

SS7 is the current version of out-of-band signaling. In SS7, the links between the nodes are leased data lines. The bandwidth of these lines is now 56 kbps, although provision has been made for higher data rates in the International Telecommunications Union standards. At this bandwidth, the network is capable of managing the connections between approximately 30,000 circuits and processing 12 million call attempts per hour.

Today, the databases are used for far more than network status information. The NCPs have evolved to service control points (SCPs). They are the basis for the number translations that give us 800, 900 and 500 number service. They allow a telco to provide citywide Centrex service to its business customers.

Most importantly to cable companies as new providers of telephony service, the STPs and SCPs are the mechanism for providing number portability for our new customers when they move their telephone service to our systems.

Remember that SS7 is designed to work with the circuit-switched telephony network. As IP telephony emerges as an alternative to circuit-switched telephony, it must therefore build appropriate new interfaces to SS7 to match the feature capability of the circuit-switched network.

Herein lies an irony. The basic technology of SS7 is packet switching. In fact, CCIS was the earliest packet-switched network. Unfortunately, it is built upon its own protocol. Although it carries digital data in packetized form, its technology has no

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more in common with IP than American football has in common with soccer.

Interface needs

Hence, the required interfaces are complex, as well as new. They must be made so that IP calls can seamlessly integrate into the PSTN. Both hardware and software are needed, and the protocols have to be built with consensus from both data and telephony standards bodies.

On the hardware side, SS7 devices called media controllers, media gateways and signaling gateways must be developed to work together with H.323 IP telephony gatekeepers and gateways. The signaling gateways will need to accept and relay messages between the SS7 network and H.323 gateways and gatekeepers. The types of messages will depend upon the placement of the IP telephony component in the total call path.

For example, if IP telephony were to be used as a backbone network to complete routing between cities, call setup messages similar to those used in today's SS7 network would be exchanged. In this case, retrievals of subscriber-specific database information might not be needed.

On the other hand, if IP telephony were used as the local call origination technology, different messages would be exchanged, and subscriber information might be passed from an SS7 database to an H.323 gateway. An example might be the routing used for a ported telephone number.

The standards development is just as complex as the new architecture. On the circuit-switched side, the Intelligent Network Forum has created an IN/SS7-IP working group. On the data side, the Internet Engineering Task Force has formed a Signaling Transport working group. In addition, a group of carriers has banded together in the Packet Multimedia Carrier Coalition.

Most of the drive to define the rules currently comes from the IP telephony side; vendors in this arena are trying to improve feature parity to gain market share from the switched technology. As market share increases and as carriers begin to realize the benefits of using IP telephony internally in their own networks, expect to see more activity on the telephony side.

In the interim, some enterprising vendors are marketing their own solutions for interfaces between SS7 and IP telephony. In a short search on the Web, I found information from GTE Intelligent Network Services, MicroLegend Telecom Systems, Nortel Networks, and Trillium Digital Systems.

With diversity like this, I'll stick with my position that IP telephony will be continue to be an evolution, rather than a revolution. CT

Justin Junkus is president of KnowledgeLink, a consulting and training firm specializing in the cable telecommunications industry. To discuss this topic further, or to find out more about KnowledgeLink, you may e-mail him at jjunkus@aol.com or call (630) 820-8205.

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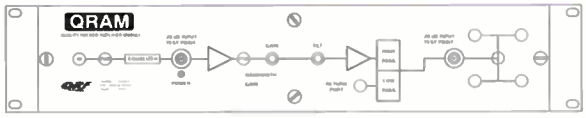

QRAM Front View

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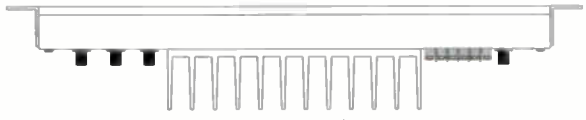

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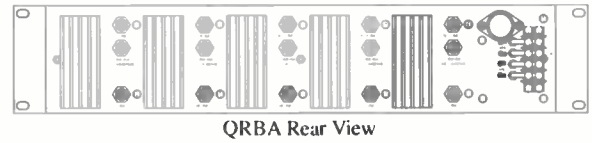

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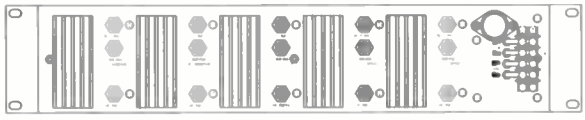
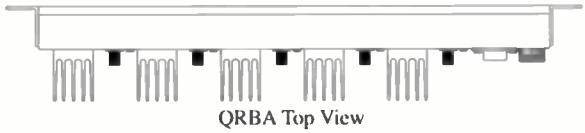


QRBA Rear View



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By Jennifer Whalen

Technology, Customer Service Hand-in-Hand at Road Runner

With more than 250,000 high-speed customers on its network, ensuring top-notch customer service and network performance is a high priority at Road Runner. Executives are promoting the use of new technologies that could stop Wile E. Coyote in his tracks.

Road Runner is adding roughly 6,000 new customers a week to its network. Keeping them satisfied can be daunting for both the Internet service provider (ISP) and its affiliated cable operators. To guarantee uniform, nationwide customer service, Road Runner has hired Stream International for 24/7 help desk support.

Stream will handle voice and e-mail inquiries for tier 2 service calls at no charge to the cable operators, explained David Temlak, Road Runner's vice president of customer care. Tier 2 calls are technical questions that can't be answered by a prewritten script. "We believe 45 percent of calls are tier 2 based," Temlak said. "We fully expect to drive that number down by providing more technical information to tier 1 people and tools to end users to resolve the issues themselves."

Common tier 2 questions include how to configure your current bookmarks for a new browser; how to change your e-mail address and still have access to old messages; why performance has slowed down on the network and so on.

"Our people have tools to troubleshoot such questions that aren't available at the local level," Temlak said. If Stream discovers a network problem, it then notifies the local operator, which decides what follow-up action to take, he added.

Local affiliates handle tier 1 calls, which could include billing, product inquiries and technical questions that can be scripted, such as how to change a password. Tier 3 calls involve a network problem or hardware failure and require the local cable operator to dispatch a technician. Stream can escalate a call to tier 3 if the problem can't be solved over the phone.

Online customer care coming soon

All of Road Runner's cable affiliates and their end users have access to Stream's telephone support. Half of those also have access to e-mail support, and the rest will soon. "By the end of Q2, all of our affiliates and end users will have the ability to submit technical e-mail questions with guaranteed response times," Temlak said.

That's not all. Road Runner recently began a technical chat support pilot with two of its cable affiliates. "If a customer is on the Web and doesn't want to pick up the phone or wait for an e-mail, (he or she) will now have the ability to go online and ask a technical question of a tier 2 support person from Stream in real time," he explained. "We will offer this service to all of our affiliates by the end of Q2."

Why add new forms of customer care? "It will change the makeup of how technical questions are submitted," Temlak predicted. About 98 percent of questions come via phone, 2 percent via e-mail. By adding chat and e-mail, that mix will change. "This helps from a customer satisfaction level because it gives customers more options, but more importantly, it changes the makeup from an efficiency point of view. It allows us to leverage knowledge. I can provide more consistent answers through both e-mail and technical chat."

Road Runner's second customer care activity is to provide self-help tools for customers to resolve their own problems themselves. Road Runner already offers e-desk, an advanced FAQ (frequently asked question) search engine, and the company plans to add intelligence to that system.

"We'll start a pilot in Q2, where customers can ask questions in free form, and the system prompts them for additional information," Temlak said. "The difficulty in customer care is not being able to solve the problem—that's actually pretty easy. It's getting the customer to articulate the problem correctly so you know exactly what to troubleshoot." The new Web-based problem resolution system will look at the original question, provide answers and ask additional probing questions.

Other improvements planned include enhancements to trouble-ticketing, problem-resolution and general knowledge-base engines to provide the customer with the most advanced self-help possible.

What are the benefits?

Besides the customer satisfaction benefits of 24/7 tech support, cable operators can fine-tune their operating procedures based on information from Stream and Road Runner. The companies provide operators with confidential daily, weekly and monthly reports that show the operator's performance and how it compares to the overall average from other operators.

For example, Stream can track calls by subject matter for affiliates on e-mail, browsers, connectivity, bandwidth performance, login clients, third-party content and plug-ins. "This helps our local operations team detect trends," said Temlak. "For example, if in the first two weeks in March we detect a larger number of calls coming in regarding the login client, that indicates a problem for that affiliate. ➤

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"Now that we've completed the conversion with MediaOne and Time Warner," he continued, "we're making radical changes to the call tracking environment....The advantage of centralizing your support mechanism is that economies of scale and best practices all begin to bubble to the surface."

Customer care isn't the only action item at Road Runner. The company also is building a new network operations and quality assurance center, reported Carl Rossetti, interim CEO for Road Runner. Other initiatives include broadening local content to attract more women, minorities and children, as well as leveraging partnerships with Compaq and Microsoft to foster self-provisioning of cable modems.

Self-provisioning would help alleviate the backlog of roughly 22,000 customers facing two-week waits before service connection. "Our biggest problem is not getting customers to sign up, but hooking them up," Rossetti said. "We'll need self provisioning to grow from thousands of new customers a month to hundreds of thousands of new customers a month."

But there is progress. "With CableLabs approving DOCSIS-certified modems, the market will move quickly to be self configuring," said Larry Levine, Road Runner's interim executive vice president.

At press time, 3Com had the first internal modem undergoing Data Over Cable Service Interface Specification (DOCSIS) certification tests at CableLabs. Widespread retail sales of internal cable modems would greatly cut installation time. Motorola, also a DOCSIS hopeful, has licensed Intel's universal serial bus (USB) cable modem reference design. Adding USB interfaces to cable modems would enable plug-and-play installation.

Creative Install Strategies

Until internal personal computer (PC) cards and USB interfaces for cable modems go retail, operators are pursuing other strategies to cut install times. The Stream partnership will help: installers can access the same tech support and online help as end users; if they run into problems, they can call the support line.

Levine also said the operators are cross-training installers, so that technicians who perform RF work also handle PC work and Ethernet network interface card (NIC) installation. "Now we can send one person out instead of two," he explained.

Levine added that Time Warner Cable of Austin, Texas, also is teaching customers how to install modems. The operator signed up 5,000 customers before service was even launched, so to cut the waiting time, it started its own Road Runner installation night.

"Every Wednesday night, 25 customers can come in and be trained on how to install the modem themselves at home," Levine said. "That's 25 truck rolls you don't have to do." And 25 customers who start paying for service sooner. CT

Jennifer Whalen is editor of "Communications Technology." She can be reached at (301) 340-7788, ext. 2057, or via e-mail at jwhalen@phillips.com.

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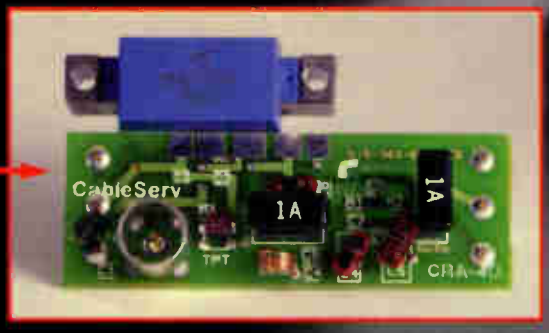

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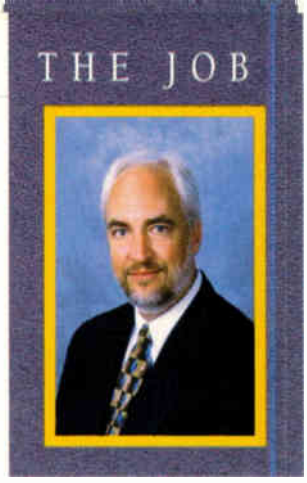
By Alan Bobcock



Use Tests and Inspections To Evaluate Performance

Last month, we began discussing how to implement a pay-for-performance program. We briefly discussed the need to analyze each job and identify the competencies required at each level within the technical workforce.

Assuming that you now have an exhaustive list of competencies for each classification, you need to determine how to test individuals against the competencies.

These performance assurances include written exams, interviews and field inspections of work completed. The field inspections and interviews can be done only by personnel close to the workplace, such as quality control personnel, supervisors and trainers.

Written tests

Written exams are important for verifying individuals' knowledge and abilities. Make sure that written exams are nondiscriminatory and that they represent an appropriate level of knowledge for the job. Effective testing confirms that an individual can apply the knowledge; ineffective testing confirms only that the person tested can recite information from a training program.

Some companies successfully use Society of Cable Telecommunications Engineers certification testing to help determine job competency. One key to making this work is aligning the appropriate SCTE certification program with the competencies required.

For example, the competencies for a fiber technician would not likely include the same skills required for an installer. Therefore, it would not be appropriate to include the SCTE Installer certification program and accompanying exams as part of the regimen for the fiber technicians. Incorporation of testing for Broadband Communications Technician/Engineer Category III—Transportation Systems for the Fiber Technician would be appropriate, however, because that category includes information on fiber optics.

> "Field verifications . . . are the best way to be sure that an individual can perform to the level required on the job."

Likewise, it would not make sense to have an installer take the exams for transportation systems because the knowledge in that category does not relate to most installers' jobs.

SCTE does not claim that its certification programs provide all the verification necessary for a particular job classification. No written exam, no matter how good, can confirm how an individual will perform on the job—it simply indicates whether the individual has the knowledge covered by the test. Field verifications by knowledgeable personnel are the best way to be sure that an individual can perform to the level required on the job.

Field testing

Designing appropriate field-testing can involve a couple of aspects. A field verification can be done either in a controlled environment or "live" on the job. Both have benefits.

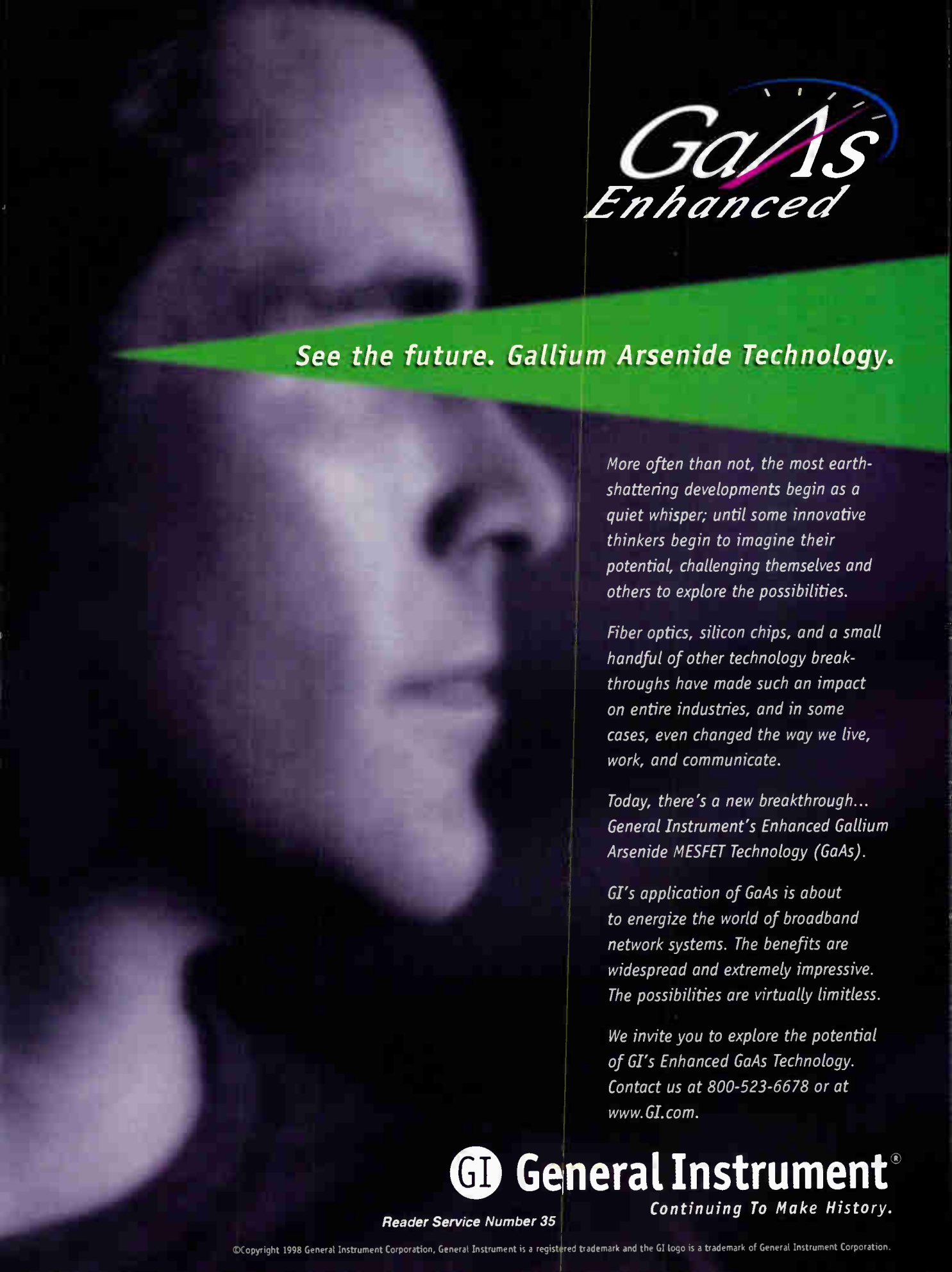
Field testing in a controlled environment tends to make verification less subjective. All candidates are exposed to the same sets of circumstances so that the exams are consistent and nondiscriminatory. However, a formal environment can set some candidates at ease while creating distress for others, and such checks still don't confirm that the individual will perform the tasks correctly on the job.

Field verifications on the job can be done either during task performance or after job completion. Again, both methods have value.

Checking work after completion improves anonymity, decreases subjectivity and indicates how well the individual performs without supervision. Some tasks can be verified only by watching an employee's performance. For example, the only way to evaluate ladder- or pole-climbing techniques or safety practices is to observe them in progress.

To deploy complete and effective pay-for-performance programs, you need to implement all of the verification techniques discussed here. Only through the use of all methods can you be sure that employees are meeting the predetermined competencies. CT

Alan Babcock is director of training development for the Society of Cable Telecommunications Engineers. He can be e-mailed at ababcock@scte.org.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Cox Communications—A Cable "Three-Peat"

By Rex Porter

The Cox Communications corporate engineering team, clockwise from left: Hugh McCarley, director of engineering technology; Richard Wallace, director of materials management; Christopher Bowick, vice president of technology development; Richard Mueller, vice president of operations engineering; Mark Davis, director of engineering for telephony technology; and Alex Best, senior vice president of engineering

Not pictured: John Hildebrand, director of multimedia technology

How do you decide that a particular company is *The Best*? You could choose the biggest, simply by looking at the number of subscribers. But to find the best, you need to talk with those customers. J.D. Power and Associates did just that in 1996, 1997 and 1998. Cox Communications won the J.D. Power Award in 1996 and captured the top spot for customer satisfaction among cable multiple system operators (MSOs) in 1997 and 1998. ➤

Alex Best, senior vice president of engineering

An inside look at the Cox customer care center.

Cox President and Chief Executive Officer James O. Robbins has defined a clear vision to every Cox employee: "We will be the recognized leader in the communications business, driven by quality and committed to our customers, employees, shareholders and communities through innovation and growth."

What probably sets Cox apart from other cable operators is that Cox

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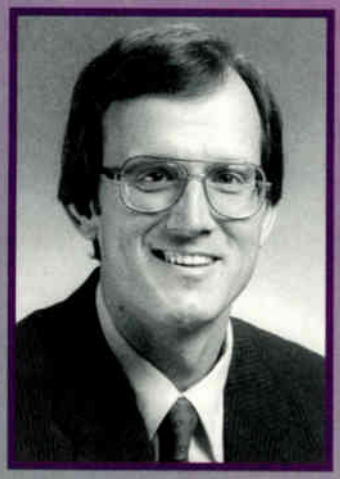

Christopher Bowick, vice president of technology development

understands that technology must fully serve the customers' needs. The customers don't care how complicated the network is; they simply demand reliable, uncomplicated service in their homes.

The company's roots

How could a cable operator that ranks sixth in size gain such esteem when judged for customer satisfaction? Cox Cable entered the cable business in 1962 in Pennsylvania. Like most cable operators, Cox turned its early efforts toward acquisition and internal growth. In 1993, Cox and Southwestern Bell Corp. planned a merger. Then, six months later, the deal was cancelled. In June 1994, Cox merged with Times Mirror Cable, and Cox Cable became Cox Communications. On February 1, 1995, Cox began trading publicly on the New York Stock Exchange under the ticker symbol COX.

1995 and 1996 continued to be robust years for Cox as the company purchased, sold and clustered systems in pursuit of its "right strategies for success." During 1995, Robbins re-emphasized that the best equipment, offices and people would lead to recognition and satisfaction by customers across the nation. Training would be paramount to unblock the lines of communication from headquarters down to system operations, to the technical side, and to the marketing and financial departments.

Customer service

But more importantly, the company message would be understood fully by customer service representatives (CSRs) and installers. CSRs and installers simply must understand their business's directions because they interface with customers by phone and face-to-face on a daily basis.

In 1989, Cox established customer service standards and tracked their performance. Cox's results led the industry to adopt many of the service standards nationwide. Then, in 1995, Cox became the first cable operator to provide an "on-time

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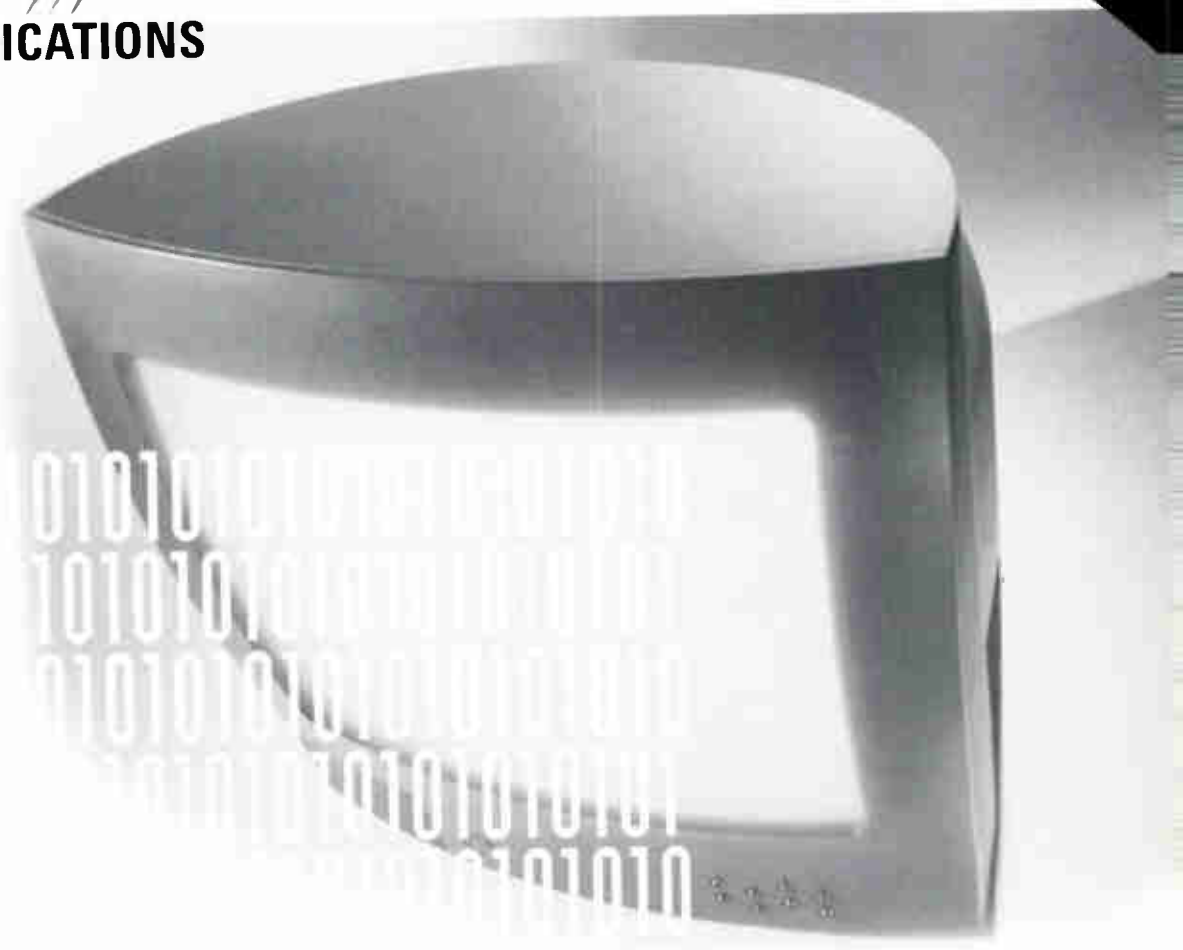

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Richard Mueller, vice president of operations engineering

guarantee," offering customers their money back if Cox did not handle their service calls in a timely fashion.

New avenues

In the midst of a nationwide rebuild and upgrade program, Cox introduced Cox Wirelink, a new inside telephone wire maintenance program, going head-to-head with the incumbent local telco. The service is a prelude to future Cox telephony offerings.

In another prelude, this time to data carriage, Cox also unveiled its World Wide Web site, www.cox.com. From this Web page, Cox customers could enjoy a better understanding of broadband telecommunications technology. They could learn about cable modems, Internet protocol (IP) telephony or just about anything you ever wanted to know about broadband networks.

Future directions for the Web site could include avenues for customers to place service requests and order pay-per-view (PPV) features online.

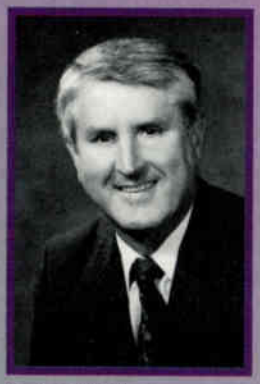
By mid-1996, Cox had begun construction of new headends and hubs for its eight largest systems. Cox calls them MTCs, short for master telecommunications centers, and they're built to last. Unlike some headends that are about to burst the seams of inadequate buildings, Cox's MTCs will be highly expandable and nearly bomb-proof.

The new facilities will feature modular design for easy expansion either vertically or horizontally; solid concrete walls, floor and roof, all set on underground pilings for earthquake protection; both battery and generator backup power systems; surge protection and static control systems; and a full suite of techniques and technologies to keep Mother Nature at bay.

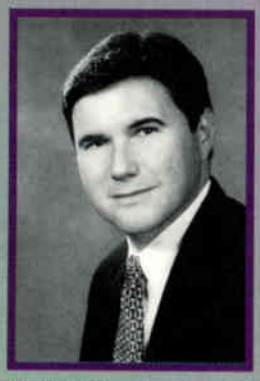
The watchword here is reliability, both as a competitive advantage and also for future deployments of lifeline telephone service and other advanced offerings.

Awards and further progress

Continuing to grow through clustering as 1996 ended, Cox won the first-ever



Richard Wallace, director of materials management



Mark Davis, director of engineering for telephony technology

J.D. Power Award given to a cable company for achieving the highest customer satisfaction rate in the cable industry.

During 1997, Cox's Orange County, Calif., system made the company's first venture into residential high-speed data service and Internet access, bringing Cox@Home to 30,000 homes. Cox then initiated plans to provide digital video and a new wired telephony service, Cox Long Distance by Frontier. Through Fibernet, Cox expanded telephony service for business customers—then operating in Hampton Roads, Va., and Oklahoma City—to the system in New Orleans and other systems. The Fibernet system, as its name suggests, is an all-fiber synchronous optical network (SONET) system, coupled with asynchronous transfer mode (ATM) switching capabilities.

Support for schools

By June 1997, Cox@Home had its debut in San Diego and Phoenix. Under the Line to Learning program, Cox expanded its commitment to education by agreeing to install high-speed Internet access in some 200 schools nationwide each year. Before 1997 ended, the Walter Kaitz Foundation honored Robbins, and J.D. Power again bestowed kudos upon Cox for its top customer satisfaction ranking among MSOs.

Realizing that employees who understand their systems thoroughly can communicate better with their customers, in 1998 Cox launched Cox University. This is an online, intranet-based platform designed to develop and educate employees. Cox employees have access to information on subjects ranging from Cox@Home installations to Microsoft Office software.

Milestones

As 1998 ended, Cox recorded some memorable milestones. Cox Digital TV enrolled 65,000 subscribers in one year. Cox@Home expanded from Orange County, Calif., into eight additional markets. Cox acquired systems serving Las Vegas and Tucson, Ariz., and nearby communities. Data revenues for the fourth quarter grew from $2.6 million to $8.2

Hugh McCarley, director of engineering technology

John Hildebrand, director of multimedia technology

million. Telephony revenues leapt from $3.9 million to $11.5 million. And Cox again received J.D. Power recognition for customer satisfaction among MSOs.

Perhaps this Service In Technology Award to Cox would better be called the Service *and* Technology Award. If it seems that I haven't written specifically about technology itself, I believe the combined efforts of Cox employees have shown the true goal of technology.

It is common knowledge within our engineering community that Alex Best is our resident expert on telecommunications technology. Hardly a technical seminar or meeting is planned without a request for Best to speak or deliver a paper. The dedicated service by Hugh McCarley, our Society of Cable Telecommunications Engineers board chairman and also director of engineering and technology at Cox, is applauded almost continually. The commitment of Cox to Broadband Communications Technician/Engineer (BCT/E) certification and attendance at SCTE chapters is well-known throughout the industry. Cox employees just seem to want to do a better job for their customers.

A personal note

I am a Cox subscriber at my home in the Phoenix area. For a number of years, I was retired and watched a lot of cable TV on the Mesa, Ariz., system. I never knew of an outage in almost seven years and don't remember ever watching any reception that was less than excellent.

If there's only one truth in this world, it's that, to paraphrase Abraham Lincoln, "You can please some of the people some of the time, but you can't please all of the people all of the time." But it looks as though Cox Communications is doing a very good job of getting as close as possible to that ideal. CT

Rex Porter is editor-in-chief of "Communications Technology" in Denver. He can be reached via e-mail at tvrex@earthlink.net.

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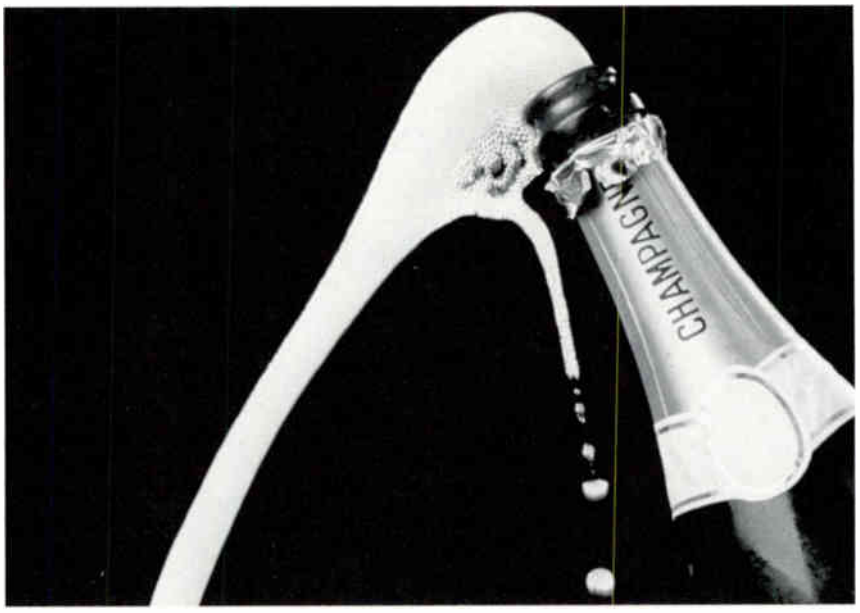

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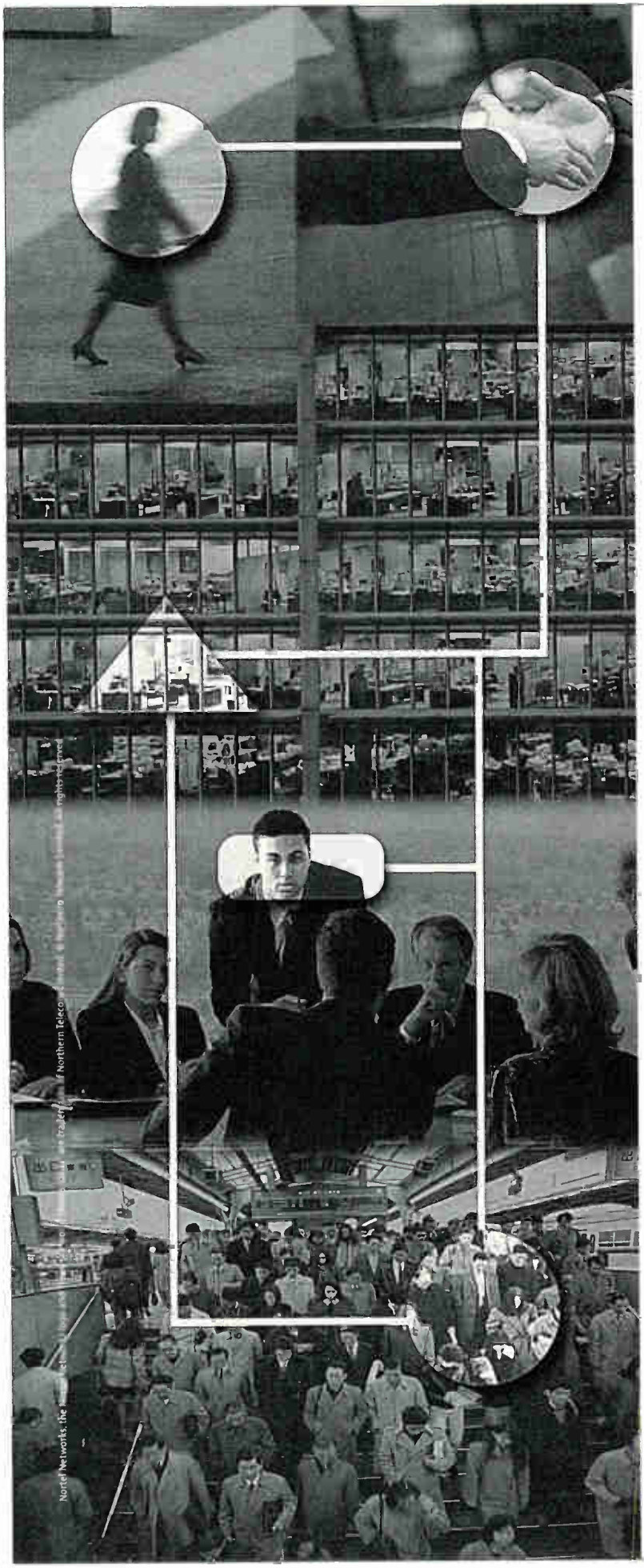

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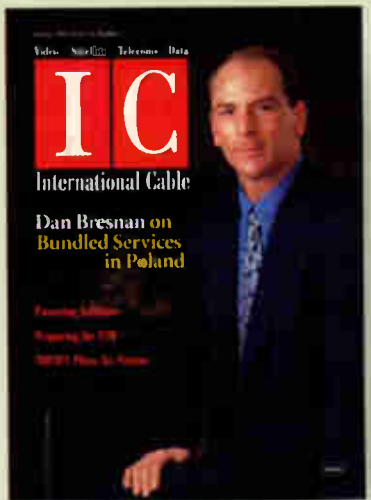

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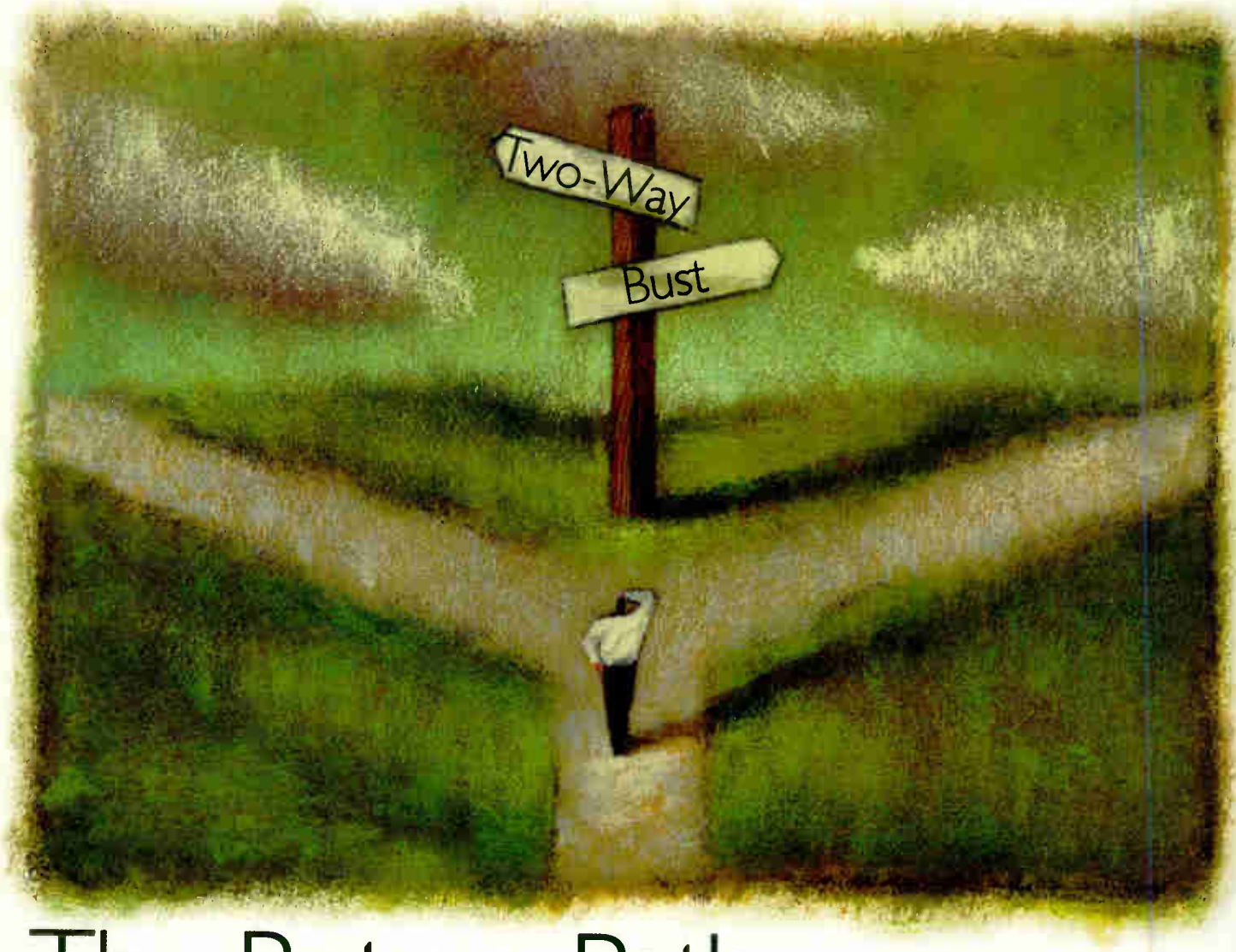

The Return Path MORE Traveled

Engineers Brave the Trenches for Two-Way Activation

By Greta Durr

In the more than two decades since cable TV officially began its evolutionary foray into the full-service cable telecommunications arena, there has been speculation about how two-way activation will take place and at what cost to operators. Market analysts have emitted numbers that illuminate the broadband landscape like particulate matter in the Los Angeles skyline. ➤

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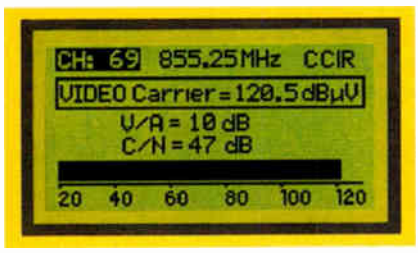

The equipment can also be configured for measurements on digital channels, giving us the value of the digital CHANNEL POWER as a figure and also on the graphic bar.

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Figure 1: A glimpse of Oberlin Cable Co-op's noise floor

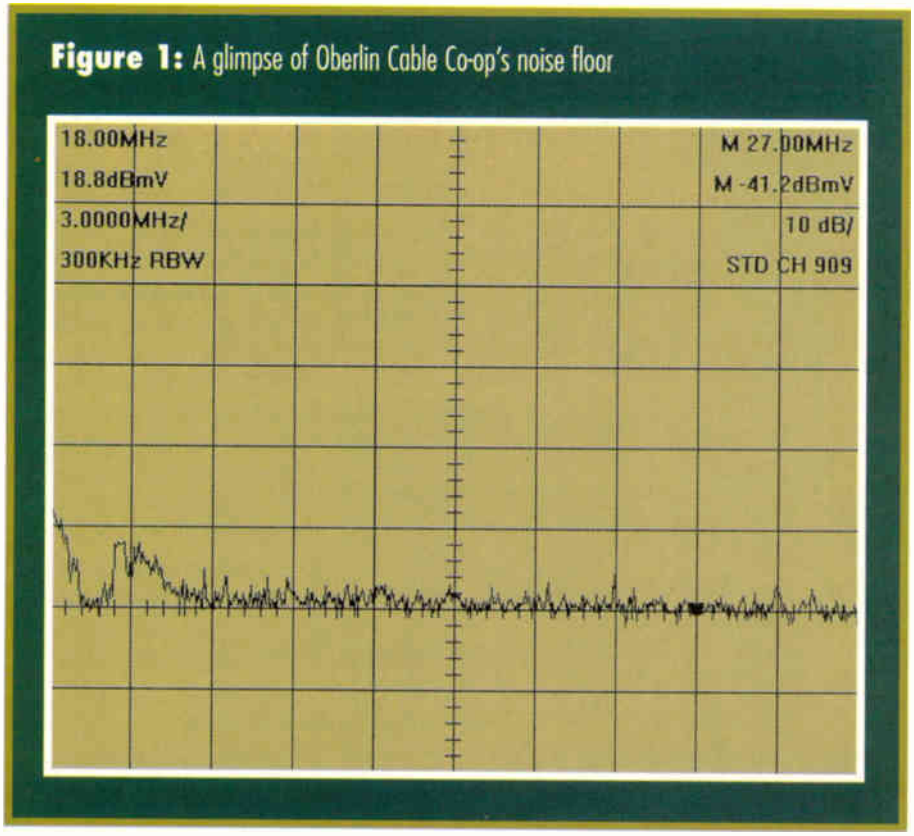

Figure 1: The total return path noise floor of Oberlin Cable Co-op's entire system, including approximately 120 trunk amps and line extenders with about 2,000 filtered drops into the hub, which feed input to the LANCity headend controller.

Figure 2: Modem traffic relative to Oberlin's noise floor

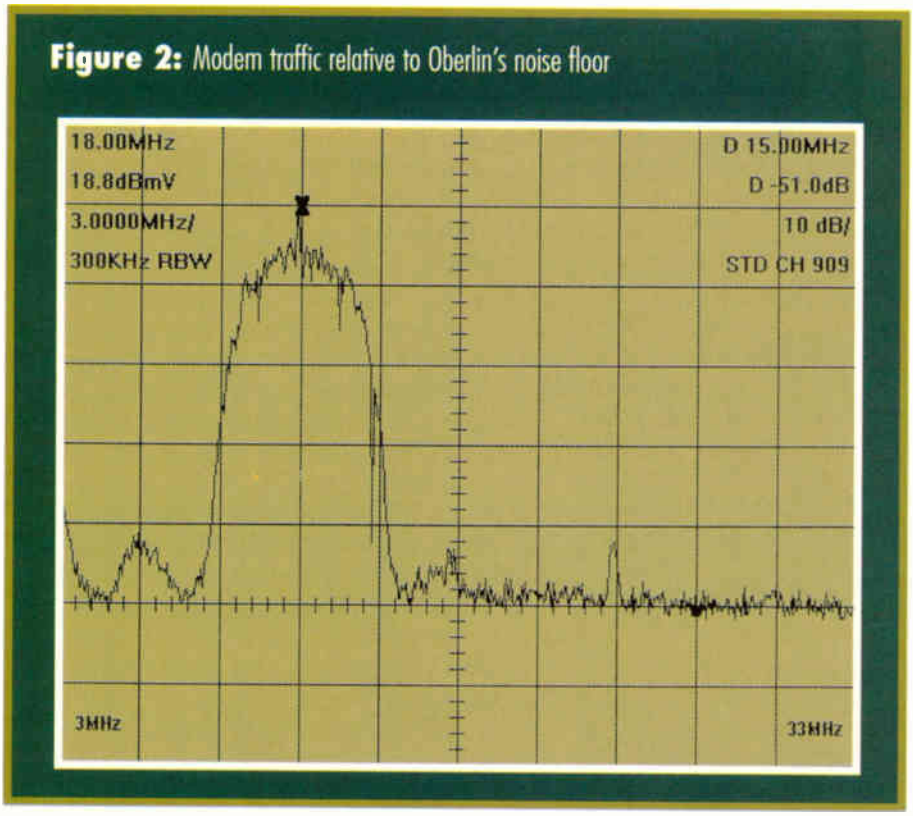

Figure 2: Represents identical conditions with Zenith cable modem traffic depicted relative to the noise floor indicating the relationship between the traffic and the noise floor. Because Oberlin's setup uses Zenith gear for schools and municipal government intranet, and LANcity equipment for its Internet subscriber platform, it is a very flexible hybrid data solution, says Poge Smit.

Still, engineers in systems of all sizes are finding that two-way's inherent concerns remain unchanged.

Cable's market changes form

According to Forrester Research, by 2002 cable companies will capture an estimated 80 percent of the residential broadband services market.

The firm also projects that cable data services will surge from 350,000 subscribers in mid-1998 to more than 2 million by the end of 2002, primarily because of falling cable modem prices and rising consumer awareness.

"Broadband will alter the Internet landscape, changing customers' use and experience of online resources and forcing service providers to sharpen their broadband strategies," says Forrester research analyst Christopher Mines.

Clustering trend ignites

Vigorous deal-making indicates that the cable industry has come of age. A clustering pattern has emerged, as multiple systems operators (MSOs) become increasingly motivated to draw their lines in the system sand. This trend will forever change the way broadband services are delivered in the United States. (See Table 1 on page 78.)

One such deal was Adelphia's $2 billion purchase of FrontierVision that, upon its completion, will add 702,000 cable subscribers to Adelphia's existing base of 2.36 million customers.

At the time of the announcement, approximately half of FrontierVision's customers were located adjacent to Adelphia's existing operations in New England and Virginia.

"The FrontierVision systems represent the largest group of cable systems located within our Northeast region of operations that were likely to come up for sale," explains John Rigas, who founded Adelphia in 1952.

The deal, like many others taking place nationwide, will help the MSO to consolidate its efforts in offering enhanced services over two-way networks and insulate its holdings from formidable competition.

An agreement between leading contenders MediaOne and Cox indicates that the clustering trend shows no signs of slowing.

This swap, scheduled to be completed

later in 1999 at an undisclosed price also covers systems in the Northeast.

Cox is trading its systems in Massachusetts, representing 54,000 customers, for access to 51,000 MediaOne customers in Connecticut and Rhode Island. This is not the first such deal for either MSO, nor is it likely to be the last.

Each company's efforts to consolidate operations into large clusters are aimed at better enabling new services such as digital TV (DTV), data, high-speed Internet access and telephony services.

"This transaction, our trade with Time Warner announced earlier this year and last year's swap with TCI, which will increase our presence in South Florida, are part of our strategy to increase our strength in the areas we already serve," comments Jan Peters, an executive at MediaOne.

There is no doubt among cable's engineers that deals such as these pose a new world of challenges to the people charged with bringing the new systems into the fold while working to upgrade and maintain existing plant.

Worth the effort

The industry is dealing and engineering so vigorously for good reason. According to the Strategis Group, the average monthly revenue per cable subscriber, estimated at $37.50 last year, will increase by 50 percent in 2003. (See Table 2 on page 80.) Combined with increased premium service offerings, analysts agree that the impact on revenue is bound to be significant.

At what cost?

According to a National Cable Television Association report, based on Paul Kagan Associates' research, cable companies invested nearly $8 billion in infrastructure upgrades in 1998 to bring subscribers higher quality pictures and sound, more programming, and two-way capable systems.

The same study estimates that since the 1996 Telecommunications Act, cable's infrastructure investments have totaled more than $20 billion.

At this point, the study estimates that 56 percent of all cable homes are passed by activated two-way plant, allowing the deployment of DTV, data, high-speed Internet access and telephony.

Ready, aim, fire ...

As the projections indicate, the chaotic broadband market has top guns and zip guns alike eyeing the same target: enhanced services deployment over whatever plant they can get their hands on.

In the meantime, engineers with systems of all sizes and upgrade status are working diligently to implement the changes. The work is no simple task for any of the operators making the transition.

A large upgrade

Cox Communications reports that two-way activation efforts are nearing the halfway mark throughout its rapidly expanding plant. Swaps and other dealings aside, the MSO anticipates that the majority of its two-way activation goals will be completed by 2000.

The huge upgrade effort has been nearly 10 years in the making, says Cox Telephony Technology Director Mark Davis.

In the planning process, the MSO decided that some of the elements of successful two-way activation would require additional downstream bandwidth coupled with useable upstream bandwidth for interactive services.

Davis says that by deploying ring-in-ring architecture and generator-backed power supplies in the outside plant, network reliability has been maximized.

Cox Vice President of Engineering Operations Dick Mueller says he can barely express the extent of what he has learned about activating the return path since the MSO's effort began. Headend design isn't the only thing that's changed, he says, or the only thing that's bound to change as two-way activation becomes more widespread.

"Early on, we looked at the available technologies," he says. "We did some market research relative to customers, and we decided that the best way to do powering on the NIUs (network interface units) on the side of the house was through network power."

At the time, he says, the only technology available was the very large and costly central power supplies. "You have to pick a penetration level when you do that design that you think you're going to hit. We picked 20 percent."

The market research didn't indicate they would reach the specified penetration level for years to come, he says. "We launched the service and started getting 20 percent in a few months rather than in several years, so we had to rethink our position."

Soon, he notes, Cox made the decision to move from centralized powering with generator backup back to distributed locations with generator backup.

"That gave us much higher penetration potential," says Mueller, "in some cases as much as 100 percent higher." ➤

BOTTOM LINE

Return Path Challenges

For years, there has been speculation about how two-way activation will take place and at what cost to operators. Despite all the numbers floating around, engineers in systems of all sizes are finding that two-way's inherent concerns remain unchanged.

According to a National Cable Television Association report, cable companies invested nearly $8 billion on infrastructure upgrades in 1998. At this point, the study estimates that 56 percent of all cable homes are passed by activated two-way plant.

Cox Vice President of Engineering Operations Dick Mueller says that the MSO's two-way deployments have been educational for all parties involved. Headend design, system architectures and associated equipment are evolving with the rest of the industry.

Oberlin, Ohio, cable system co-op engineer Poge Smit says he also has learned a great deal from activating the return path in his 2,000-subscriber system. For Smit, the challenge of going two-way and activating data services has been an in-the-trenches battle.

Regardless of a system's architecture, size or enhanced service goals, engineers who have traveled the return path's activation requirements agree that ingress remains the top concern.

Table 1: Paul Kagan Associates' top 10 cable deals in history

Date	Buyer	Seller	Amount
6/98	AT&T	TCI	$46.95 billion
2/96	U S WEST Media Group	Continental Cablevision	$9.85 billion
7/98	Vulcan Ventures (Paul Allen)	Charter Comm.	$4.5 billion
2/89	Time, Inc.	Warner Comm.	$3.63 billion
4/88	Comcast/TKR	KKR/STORER	$2.88 billion
4/98	Vulcan Ventures (Paul Allen)	Marcus Cable	$2.78 billion
5/93	U S WEST	Time Warner	$2.73 billion
2/95	Time Warner	Cablevision	$2.72 billion
10/93	TCI	Liberty Media	$2.51 billion
3/88	United Artists Comm.	United Cable Television	$2.45 billion

Currently, Cox has migrated about 40 percent of its system to distributed power from centralized power. It costs about the same, Mueller says, without being "the size of a Volkswagen bus." Another advantage to the turn in powering strategy, Mueller says, is avoiding the necessity of powering from subscribers' front yards. "That's always an issue."

Old ideas become new tricks

With the increasing demand for enhanced services and aggressive deployment schedules for two-way activation, Mueller says the industry is poised for changes in design and engineering strategies.

"Architectures will always evolve. They have to," he says. "As new technologies become available and the cost of existing technologies goes down, the design has to change."

Though multiplexing, in concept, is not new, dense wavelength division multiplexing (DWDM) is a technology many MSOs are looking to for expanding the capabilities of their broadband pipe without having to deploy as much additional fiber.

Comcast and TCI, for example, have been experimenting with Harmonic's METROLink DWDM technology in a number of systems.

Among the reasons for the product's emerging popularity, says Harmonic Transmitter Product Specialist Ketan Gadkari, are its offerings of a complete two-way, eight-wavelength solution that stands only 12 rack units tall. Efficient use of space in the hub is an important consideration for many operators seeking to deploy two-way and expand their service offerings.

As the technology becomes more pervasive, he says, prices for DWDM and associated equipment such as Erbium-doped fiber-optic amplifiers (EDFAs) will continue to drop.

Other vendors, such as ADC, ANTEC, Ciena, Philips, Scientific-Atlanta and Siemens, to name a few, also are working on it and are in various stages of ensuring a place for their DWDM products in the telecommunications marketplace.

"We're not deploying it at the moment," says Mueller, but Cox is regarding it as insurance for the future. "We have always planned that DWDM would be available to us going forward if we need to shrink node sizes. We've got a standard on how many we'll place, and if we have to shrink the node sizes down over time, we'll do it through wavelength division multiplexing (WDM)," he says.

A smaller upgrade

Ohio cable system engineer Poge Smit also has learned a great deal from activating the return path in his system; moreover, he is never at a loss for words about it.

His system, the Oberlin Cable Co-op, is owned and operated by its 2,000 subscribers via an elected board of trustees. Oberlin's traditional plant may be considered archaic by some standards.

For Smit, the challenge of going two-way and activating data services to

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Table 2: Strategis Group's projected revenue per subscriber per month, 1997–2003

1997	1998	1999	2000	2001	2002	2003
$37.50	$40.30	$43.40	$46.60	$50.10	$53.90	$57.90

bring connectivity to the city and its schools has been a two-year, in-the-trenches challenge that few engineers would dare to tackle.

In the Two-Way Fast Lane

At a recent CableLabs news briefing held in Denver, engineering executives from several cable telecommunications operations discussed their two-way capability status and their goals for future return path activation. It's clear that the ongoing deal-making and consolidation trends will impact two-way upgrades, but here's what the executives had to say.

- Bud Wonsiewicz, senior vice president and chief technical officer of MediaOne, destined to be absorbed by Comcast upon completion of a recently announced merger, says that his plant is now 50 percent capable of two-way operations, but forecasts that figure to jump to 70 percent by the end of this year.
- Comcast's Vice President of Strategic Planning Mark Coblitz says that 60 percent of the company's plant is now two-way capable.
- Time Warner CTO Jim Chiddix estimates that 75 percent of his total plant is currently two-way capable. By the end of 1999, he says that the company has estimated that 85 percent of the plant will be upgraded, and by 2000, two-way operations will be at 100 percent.
- Tony Werner, vice president of engineering and technical ops for TCI, now AT&T Broadband & Internet Services, says that by the end of 1999, 60 percent of the company's plant will be two-way capable. By 2000, he says, the upgrades will reach 100-percent two-way capability.

"As a small, 'classic' 450 MHz cable system contemplating two-way plant activation for data services, we faced many of the same obstacles and considerations as any larger operator," says Smit. "The biggest difference, other than the management logistics of a larger deployment, was the lack of fiber optics in our system.

"Without the convenience of multiple nodes combining at the headend, each with only five to seven actives representing several hundred drops, our noise battle was considerably more formidable than

Powering The Winds Of Change

With all the changes in the cable industry, it's easy to get blown away. Alpha has a whole new family of cable powering solutions designed to help you keep your feet on the ground while planning for the future.

Alpha understands the critical role that power plays in ensuring overall network reliability, and continues to design and develop products that meet today's power requirements, while considering tomorrow's powering objectives.

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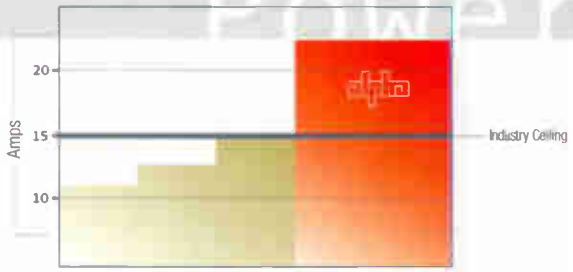
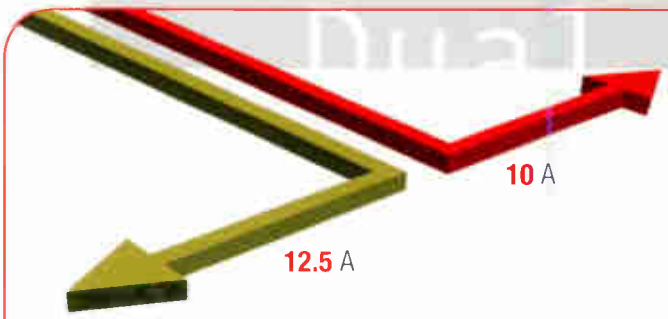
Today's cable networks require more power. Alpha's XM Series 2 CableUPS® breaks through the industry's traditional 15-amp power ceiling with the first 90-volt, 22.5-amp power supply. That's a 50 percent increase! This improved power density is ideal for the simple upgrading of applications requiring additional power.



Redundant Power

Alpha has again pioneered cable TV powering technology. The optional PIM card enables the XM Series 2 module to be configured with true N+1 redundancy. This critical feature has been developed in direct response to the industry's need for increased network reliability.



Dual Independent Output

Alpha's revolutionary PIM option allows flexible power distribution. Fully programmable, real-time current limited, dual independent outputs provide the ability to optimize power resources.

Advanced Communications

Advanced communication capabilities make not only more information more accessible, but also provide embedded diagnostics, for quicker, more efficient servicing. The serial interface available for the XM Series 2 also provides a simpler, more accurate connection to digital transponders, eliminating costly analog-to-digital converters.

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Two-Way Survival Guide

An estimated 95 percent of ingress and related problems affecting the upstream path originate in subscriber drops. Problems occurring between the tap and the side of the subscriber's house comprise 25 percent of that number. Between the side of the house and the TV set, 70 percent of the culprits are lurking. In all, a mere 5 percent of ingress problems may be blamed on the distribution network. The following checklist is an updated version of a 1997 workshop presentation made by Ron Hranac at the Society of Cable Telecommunications Engineers' Cable-Tec Expo in Orlando, Fla.

✔ Understand the business
- Stop thinking like a cable TV operator.
- Start thinking like a telecommunications provider.

✔ Architecture
- Hybrid fiber/coax (HFC) is preferred over tree-and-branch.
- HFC allows relatively small service areas to be fed by fiber.

✔ Downstream coax plant electrical
- Correct amplifier setup—proper attenuators, equalizers, automatic level control (ALC/ASC) and so on.
- Correct input and output operating levels.
- Sweep and align all amplifiers for optimum flatness, even if cascades are only two or three deep.
- Make sure there is no measurable signal leakage.

✔ Upstream coax plant electrical
- Correct amplifier setup (proper attenuators, equalizers and so on).
- Correct input and output operating levels.
- Sweep and align reverse for optimum flatness.
- Fix distribution and headend ingress problems.

✔ Coax plant physical considerations
- Proper grounding and bonding
- Tight hardware
- No broken lashing wire
- No kinked or cracked cables
- Use only pin connectors.
- Good weatherproofing
- All passive and active device lids/closures properly torqued
- Unused 5/8-24 ports with port plugs installed and correctly tightened

✔ Subscriber drops
- Use only messengered cable on aerial drops.
- Use corrosion inhibitor type cable for all aerial drops and flooded cable for all underground drops.
- Use tri-shield or greater shielding on all drops.
- Use good quality connectors, hardware and drop passives.
- Use good installation practices.
- Fix drop-related leakage and ingress problems.
- Use proper common-point grounding/bonding to minimize ground loops and sheath currents.
- Use drop splitters with blocking capacitors on all ports. (See related article by Ron Hranac on page 96.)
- Use high pass filters and common mode chokes for problem drops.

in a typical HFC (hybrid fiber/coax) design," he explains.

Bringing it all together with only a few people on staff and a similarly limited budget meant breaking a few rules, defying some conventions of modern broadband engineering and some experimentation, but it's all starting to pay off, he says.

> "Whether you're a monster MSO poised to conquer the world or a little popstand in the Midwest just having some fun, two-way is THE way."

"We currently have a combination of nearly 120 trunk stations and line extenders representing approximately 1,600 service drops converging into one hub 'supernode' with a consistent noise floor of –40 dBmV," Smit says. (See Figures 1 and 2 on page 76.)

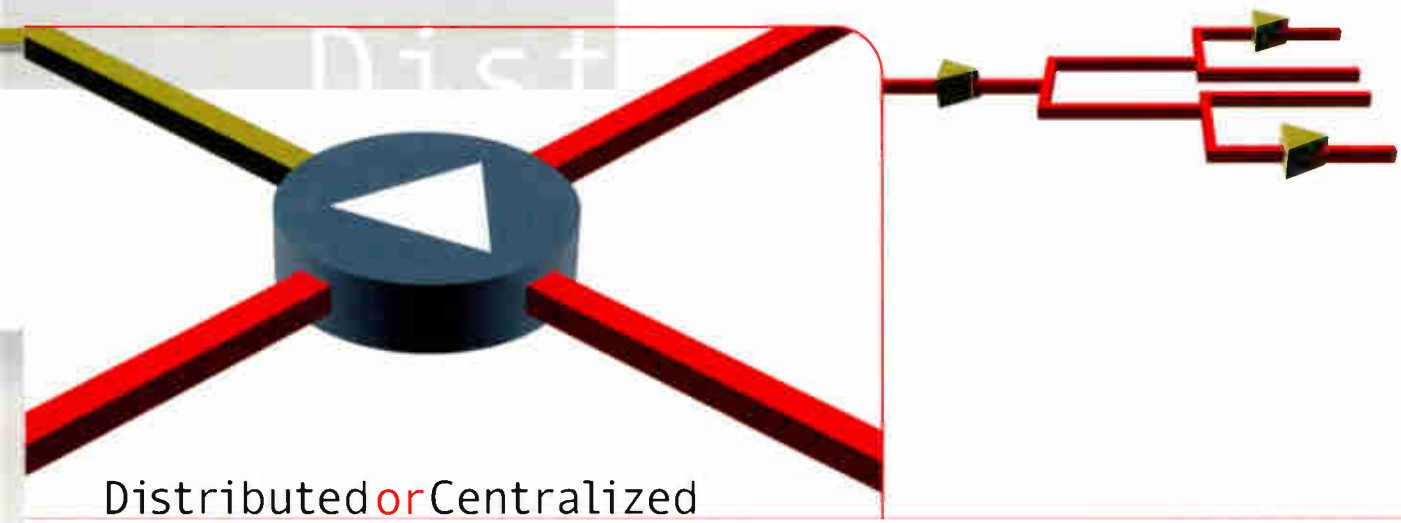
"The keys to our success were meticulous attention to the initial reverse design considerations in a 'classic' coax system, combined with a thorough understanding of the obstacles before us," Smit explains.

The song remains the same

Regardless of a system's architecture, size or enhanced service goals, ingress remains the top concern of operators seeking to activate and maintain a clean return path.

"We all know that ingress is the biggest problem in the return path," says Smit. "Despite the 'cleanroom' engineering philosophy of those who proclaim high pass filtering of drops is the 'wrong way' to eliminate return impairments, we chose to utilize high pass filters on all drops not receiving two-way services.

"As a small system, the cost was minimal, and 90 percent of the most likely sources of ingress inside the subscriber premises have been



Distributed or Centralized

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Battery Technology

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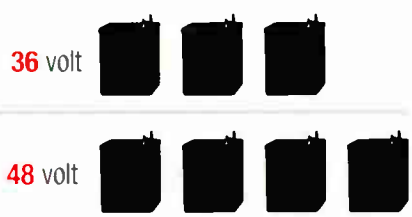

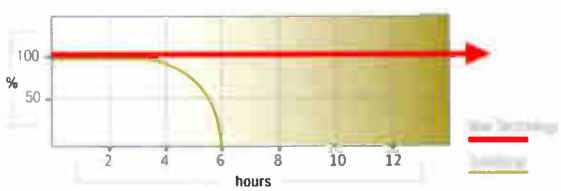

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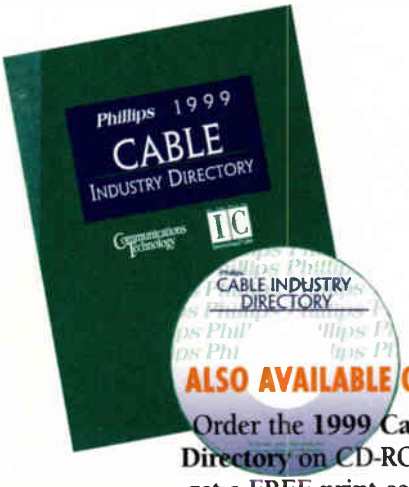

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eliminated. This approach has been extremely effective in helping to isolate the occasional return aberrations in the cable plant itself.

"A very important element of any return path activation and two-way service deployment is having quality instrumentation for correct sweep/alignment and subsequent analysis/monitoring of the reverse spectrum on an ongoing basis. One must also understand what he is actually viewing on the instrument's display and how to most effectively use test gear," says Smit.

Mueller agrees on the importance of monitoring for ingress. "Obviously, when we were a one-way downstream service, we didn't really pay attention to the upstream path and the ingress issues. Now that we're a two-way service, we have a significant amount of preparation of the network to get it ready. It's a matter of fixing it and then keeping an eye on it going forward and having the tools in place f efficient monitoring. When things loosen up, you start getting ingress. It's a job of diligence more than anything else," he says.

Training is an issue initially, he says "It's just a matter of taking the time to train people on the theory of return path operation, and when you see certain phenomena displayed on the scope—what it means and how to find the problem. It's not a huge issue," he says, adding that the magnitude of the staff is more significant than the material that needs to be covered.

The last word

"Probably the most important aspect of establishing and maintaining a clean and efficient return path is to abandon some of the old ways of dealing with the forward path," says Smit. "The mindset of 'the pictures look OK' is hardly appropriate for the strict requirements of two-way deployments.

"Use quality materials," he emphasizes. "Take installation procedures and general system maintenance and leakage detectio practices to the highest possible level.

"Our entire project is nearly compl It was accomplished by very careful study of the design considerations, se of-the-pants learning, aggressive purs of our objectives, and plenty of hard work by one engineer and one technician," Smit says.

Smit's words of wisdom ring true for nearly any engineer working on return path activation in a system of any size, anywhere.

"It's not magic or rocket science," Sm concludes. "It all boils down to sound e gineering and adherence to fundamenta practices. Whether you're a monster M poised to conquer the world or a little popstand in the Midwest just having so fun, two-way is THE way." CT

Greta Durr is assistant editor at "Commun cations Technology." She may be reached vi e-mail at gdurr@phillips.com.

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INSTRUMENTS

To Boost Capacity, You Have to Be Dense

DWDM Offers Quantum Leap in Network Throughput

By Arthur Cole

Getting the most out of your fiber is the name of the game in cable network design these days, and with many systems adding data, Internet access and telephony on top of that bandwidth hog called video, more and more systems are facing a capacity crunch.

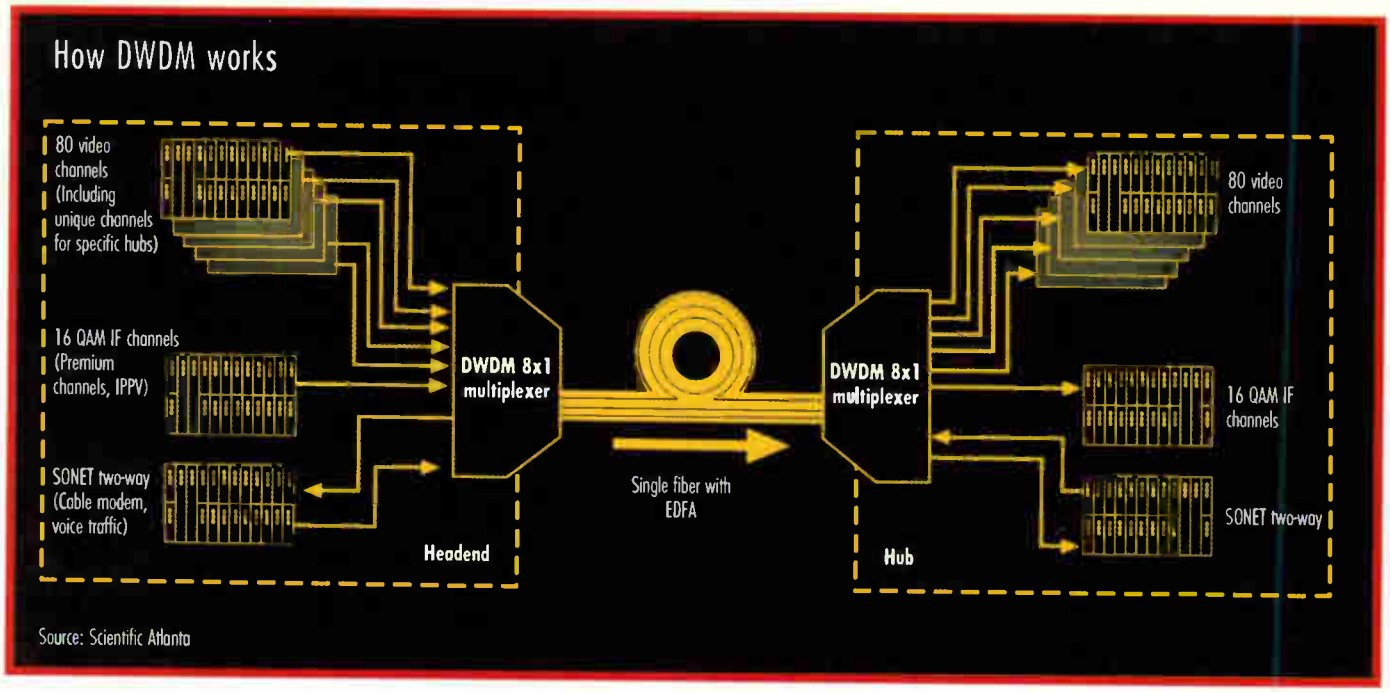
But before you think all hope is lost and you're doomed to expensive fiber overlays and installation of new network gear to keep up, know that new optical transmission technologies are pushing the capability of fiber beyond what anyone thought possible just a few years ago.

One of the hottest technologies right now is dense wavelength division multiplexing (DWDM). Basically, the technology combines multiple wavelengths onto a single fiber at the same time, making it ideal as a distribution system from the headend to the hub and all the way to the neighborhood node. (See the accompanying figure on page 88.) It also offers benefits for the reverse path in an interactive network.

Researchers are so high on DWDM that many call it the network technology of the future, far outclassing other capacity-increasing schemes such as time division multiplexing (TDM) and frequency stacking.

"TDM rates are tailing off at maybe 40 Gbps," said Ken Wirth, director of marketing at Lucent Technologies' Optical Networking Group. "The development curve and research curve will give us a lot more on the dense wavelength side than on the TDM side."

Lucent recently launched a DWDM platform geared for telco networks capable of placing 80 2.5 Gbps (OC-48) channels onto a single fiber, with 160 expected by this time next year. The system allows a total of eight



fibers. Do the math, and you come up with a whopping 3.2 terabits per second.

Telephone companies have been working with DWDM for several years, but it has caught the attention of cable operators only in the past year or so. TCI and Comcast have announced DWDM rollouts, while others such as Time Warner say they are very interested. At the moment, it appears that systems delivering eight wavelengths will suffice for the cable industry, with early adopters upgrading to 16 next year.

"If you already have fiber in place, it makes you think hard (about installing

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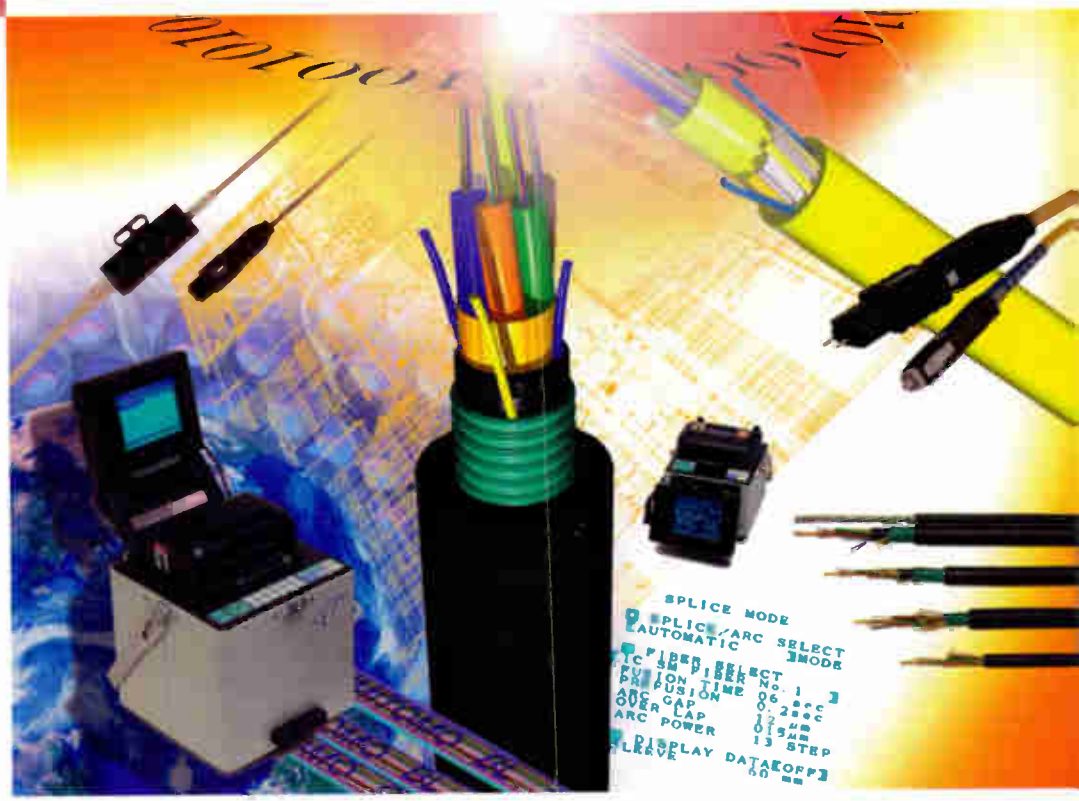

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DWDM)," said Jim Chiddix, vice president and chief technical officer at Time Warner. "I'm sure it will find even more uses as costs come down."

Chiddix said Time Warner conducted some early experiments with DWDM several years ago, but has not yet committed to a large-scale rollout of the technology.

But at TCI, DWDM systems are going in across the country as the company beefs up its two-way capabilities for the merger with AT&T. The rollout also takes advantage of DWDM's other main benefit: the ability to target services to specific nodes outfitted to carry only designated wavelengths.

"We're implementing it for segmenting nodes to have them ready for telephony and high-speed access," said Oleh Sniezko, vice president of engineering at TCI. "The beauty is that it is fully scalable and fully transparent. We don't have to do anything in between (headends, hubs and nodes), just add transmitters as we go. We can quickly re-engineer the network to increase bandwidth per homes passed."

Meanwhile, Comcast is installing Harmonic Inc.'s METROLink DWDM system on the hub-to-headend return path at its system in Sarasota, Fla. ➤

BOTTOM LINE

Do More With Less

If you haven't heard of dense wavelength division multiplexing (DWDM) by now, you're behind the curve. Researchers say it is the hottest technology out right now for increasing network capacity, and it will be far cheaper to install than new fiber in most cases.

Not only is it useful for broadening the pipeline to the home, it also has tremendous applications for the return path, virtually eliminating network overloads even in the highest traffic periods. Other advantages are that it allows for greater node segmentation, making it easier to target specific areas for commercial insertion, local programming and other services. It also makes adding new channels a snap.

For cable operators worrying about the expense of pushing active systems and personnel farther out into the network to deliver interactive services, DWDM is a lifesaver because it allows all of that gear to be centralized at the headend.

Meanwhile, optical amplifiers are getting more powerful at less cost, making it likely that less powerful lasers will be needed to drive the network.

The end result is that cable still has the widest pipe into the home and now has a powerful solution for the return path. Who's afraid of the telcos now?

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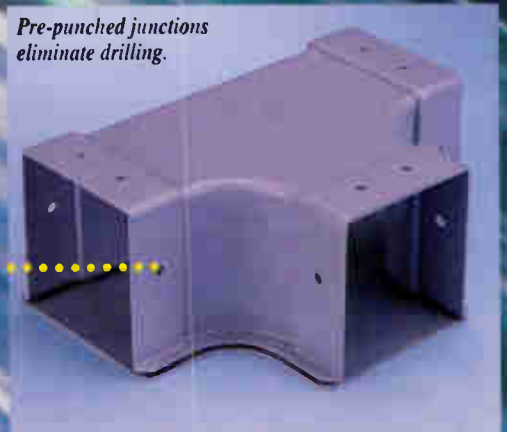

In the return

In fact, the return path is likely to be the deployment of choice for most operators for the next several years as interactive services become more prevalent. All those requests, particularly at peak hours, are expected to quickly overload traditional return networks.

"You have to maintain segmentation back to the headend," said John Trail, director of product line management for transmission systems at Harmonic. "You can't really accumulate signals from too many homes because the noise levels get too high.

"By transporting them back as separate data streams, you maintain good signal-to-noise ratios (S/Ns), even in the presence of ingress noise, and you maintain good bit error rates (BERs)."

Centralization is easier

DWDM also can help overcome one of the main disadvantages to interactive networks: the need to place active equipment, and the personnel and power supplies to run them, farther out into the network. Under a DWDM system, different wavelengths can be targeted to nodes, allowing the nodes and even the hubs that serve them to become completely passive. This allows most, if not all, of the active systems and engineering staff to remain at the headend.

> "New optical transmission technologies are pushing the capability of fiber beyond what anyone thought possible just a few years ago."

Of course, not everyone is buying into the idea of completely passive hubs and nodes. MediaOne is adopting a point-to-point architecture in many of its systems and is looking to develop what it calls Power Domain Node architecture. The idea is to provide one power supply for each node, which would feed only 200 to 400 homes, rather than the customary 500 to 1,000.

"We're taking a look at more passivity in the hubs, but not exclusive passivity," said Joe Wetzel, vice president of technology at MediaOne. "The node is where the conversion (from optical to RF) happens, so I need powering and activity there."

Is DWDM going to play a part in MediaOne's future? Probably, but the company is likely to field a mixture of technologies, Wetzel said.

"DWDM is a great reinforcement technology," he said. "It's probably very economical compared to hanging more fiber. But when someone comes in and says all

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your operations can run on one platform, the savings of doing that has to be greater than a combined solution."

That question of cost is an elusive one when it comes to implementing DWDM. Manufacturers say the final price tag of a fully operational DWDM platform varies depending on the number of channels, the length of the link, how many stops along the way and other factors. Still, many say it will come in at one-half to one-third of the cost of laying new fiber, particularly if it's underground. Once the system is in place, adding new services is a simple matter of plugging in another transmitter and running it through another port on the multiplexer.

Another advantage to a DWDM architecture is that it doesn't preclude the use of other transmission methods. Imagine a fiber carrying 16 wavelengths, one or all of them carrying two or more TDM signals delivering asynchronous transfer mode (ATM) packets, and you get an idea of the flexibility of the system.

High power, dropping prices

The key technologies driving DWDM are advanced lasers capable of delivering tighter wavelengths in the 1,550 nm region. These are coupled with more powerful filters that prevent crosstalk between wavelengths, plus new lines of amplifiers that produce little or no degradation.

"We've just barely scratched the surface in the capacity of dense wavelength multiplexing," said Bob Scott, director of marketing for Scientific-Atlanta's optical electric business unit.

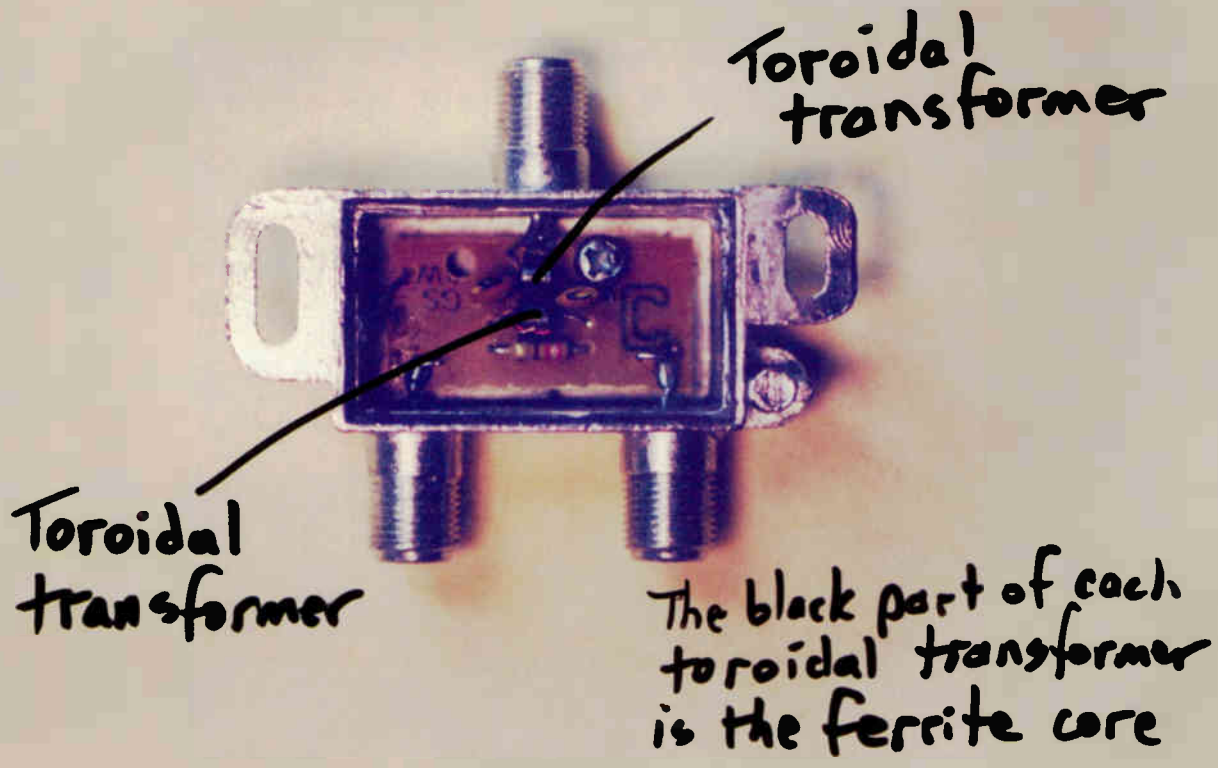
When it comes to further advancements in transmission hardware, few people see any major advancements in items such as lasers and amplifiers. It seems that the industry has settled on the 1,550 nm and 1,310 nm wavelength regions established in the International Telecommunications Union grid.

The result is that these products are now seen as commodities competing on price and performance levels. If anything, the ever-increasing power of optical amplifiers—24 dBm Erbium-doped fiber amplifiers (EDFAs) for 1,550 nm and 14 dBm EDFAs are now available—is likely to produce a run on lower power lasers. As MediaOne's Joe Wetzel put it, he'd rather install a pair of more reliable 2 dB lasers instead of a single 4 dB if he's got adequate power in the field.

Any way you look at it, cable is still in the driver's seat when it comes to delivering mass quantities of data to and from the home.

Just ask executives at AT&T. With coax still the widest pipe in the neighborhood and fiber backbones gearing up to two-way communication at a rapid rate, it's time for cable operators to stop asking "How will I be able to provide all these services?" and start asking, "What else can I add to my system to stay out in front in the 21st century?" CT

Arthur Cole is a contributing editor for "Communications Technology."



Hum Got You Down?

Block Capacitors Fix Reverse Path Woes

By Ron Hranac

It seems the more we learn about two-way cable system operation, the less we know. As if ingress, common path distortion (CPD), group delay and even basic network alignment aren't enough to keep us occupied, there is yet another piece to this puzzle.

Shaw Cablesystems' Allan Hamilton posted an interesting message on the SCTE-List describing a reverse path interference problem that manifested itself as upstream data packet loss. In addition to identifying the problem, he described an effective fix. The accompanying sidebar includes his original List message.

In a nutshell, Hamilton and his staff found that the usual neutral fault currents that exist on the outer surface of cable shielding were entering a subscriber's drop wiring via the toroidal transformer found in the drop splitter. This current saturated the transformer's ferrite core, which caused fairly nasty hum modulation that appeared to affect only the reverse path. The result was up to 40-percent packet loss, which obviously did a number on data throughput. ➤

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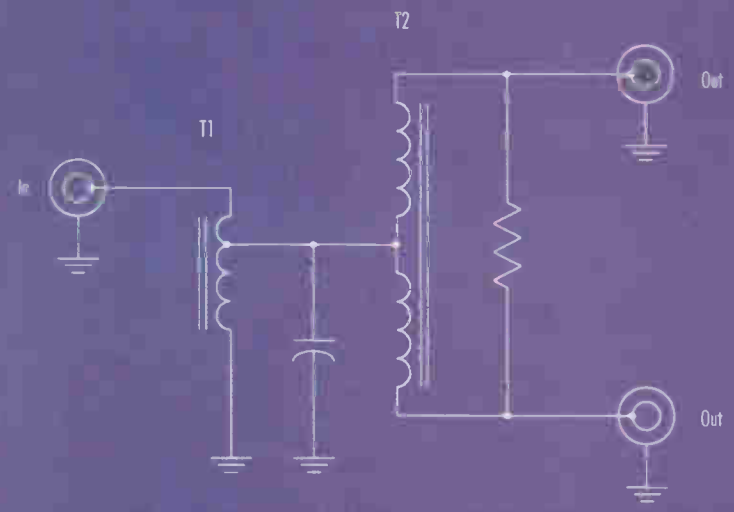
Figure 1: Typical two-output drop splitter



When drop shields are compromised

Take a look at Figure 1. It's a schematic diagram of a typical two-output drop splitter. Transformers T1 and T2 are toroidal devices; that is, they are wound on small ferrite cores.

All of the components shown in the schematic are installed in a metallic housing that provides suitable RF shielding, which in theory keeps cable signals inside the splitter and over-the-air RF signals outside the splitter.

But what happens when the cable shielding, and consequently also the splitter housing, is bonded to the building's "grounding electrode" as specified by the National Electrical Code (NEC) or other requirements? The shield and splitter housing are placed at the same ground potential as the building's electrical power neutral conductor.

This is done to minimize potential differences between cable and power grounds. It also means that power company or in-house neutral fault currents will be shared between the neutral conductor and cable shield.

Thus, some of those neutral fault currents will be present as sheath currents on the outside of our cable. So far, so good. A properly bonded and grounded plant can in most cases deal with this situation.

Now look at Figure 2. This is the same splitter schematic shown in Figure 1, with a path highlighted where low-frequency electrical interference can get inside the splitter via transformer T1's grounded end.

While RF can't follow the same ground-to-center conductor path, the transformer windings present a very low resistance to DC and low-frequency AC.

Out of curiosity, I connected an ohmmeter between a drop splitter's input connector center conductor and the housing, and I measured only 0.1 to 0.2 ohm.

How It All Started

The SCTE-List is a great place to share your success stories as well as your engineering challenges. Shaw Cablesystems' Allan Hamilton posted the following message on the SCTE-List.

Hello, Listers. I am a new subscriber to the List and thought you might be interested in a cable modem service call problem we recently had.

A new modem install had trouble getting dynamic host configuration protocol (DHCP) to get Internet protocol (IP) connectivity. It eventually got an address, but our tech found that pinging the gateway showed 40-percent packet loss.

He found that removing the ground at the entrance splitter totally cleaned up packet loss. We measured 4.5 VAC from the disconnected shield to building ground. Connecting an ammeter from shield to ground showed 1 amp of ground fault current (barely visible spark). Our underground plant is bonded to electrical utility service about six poles away on a different power distribution line.

My experience is that small potential differences in grounds is very common.

We installed a voltage block coupler (VBC—an inline "F" device with a 0.001 µF capacitor in center conductor) at the entrance splitter. Pings gave 100-percent return; we removed the VBC, and pings immediately began to miss.

To gain a better understanding, we injected an 18 MHz continuous wave (CW) carrier at the splitter and measured hum back at the headend. With ground and no VBC, we measured 20-percent hum (2 dB peak-to-peak). Without ground or VBC, we measured 2 percent with erratic jumps to 20 percent. With ground and VBC, the hum was stable at 2 percent.

We feel that the ground fault current on the shield also is carried on the center conductor because of the small ferrite transformers at the multitap port and house splitter input causing the center conductor and shield to be in parallel. The current through the ferrite transformer causes saturation of the ferrite with hum modulation resulting, particularly at lower return frequencies. The TV picture quality was good with or without the VBC. The VBC does not stop the ground fault current; it just prevents the center conductor from carrying it.

Ground fault current is not new, but we believe it may be just as serious a return path problem as common path distortions (CPDs) and ingress in our return plant. It can vary with earth moisture, time of day and electrical loads as well as the condition of our plant and the electrical utility. It cannot be reduced by adding more fiber nodes, and it can't be detected by our signal leakage programs or spectrum analyzer noise monitoring.

It can be fixed with a simple VBC device, although a still better solution is indoor passives with built in blocks.

Allan Hamilton, A.Sc.T
Technical Supervisor
Shaw Cablesystems
Kelowna, British Columbia
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Here's where things get interesting. If the subscriber tap at the pole or pedestal is a type without blocking capacitors in series with the center conductor, some of the neutral fault current present on the drop shielding at the side of the house will flow from the splitter ground (housing) through T1's windings and onto the center conductor.

From there it will flow through the drop's center conductor to the toroidal transformer in the tap, completing a "circuit." If the current is high enough, it will saturate the splitter ferrite material and possibly also the ferrite material in the tap port circuit, causing hum modulation.

Likewise, if there is a similar path present in a matching transformer or TV or videocassette recorder (VCR) input inside the home, an electrical current could flow from T1 through T2 and through the house side of the drop wiring, causing the same hum modulation problem.

This is by no means a new phenomenon. Nearly 10 years ago, Ron Hepler, then group engineer with Prime Cable, wrote about this in an article that appeared in the May 1990 issue of *Communications Technology* ("Hum Modulation in Drop Passives," page 28).

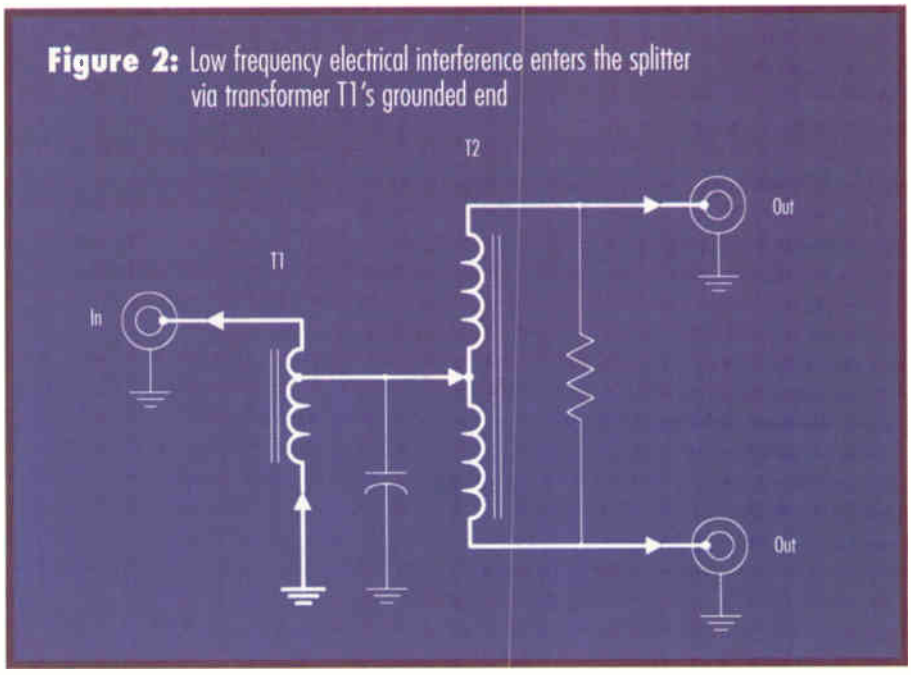
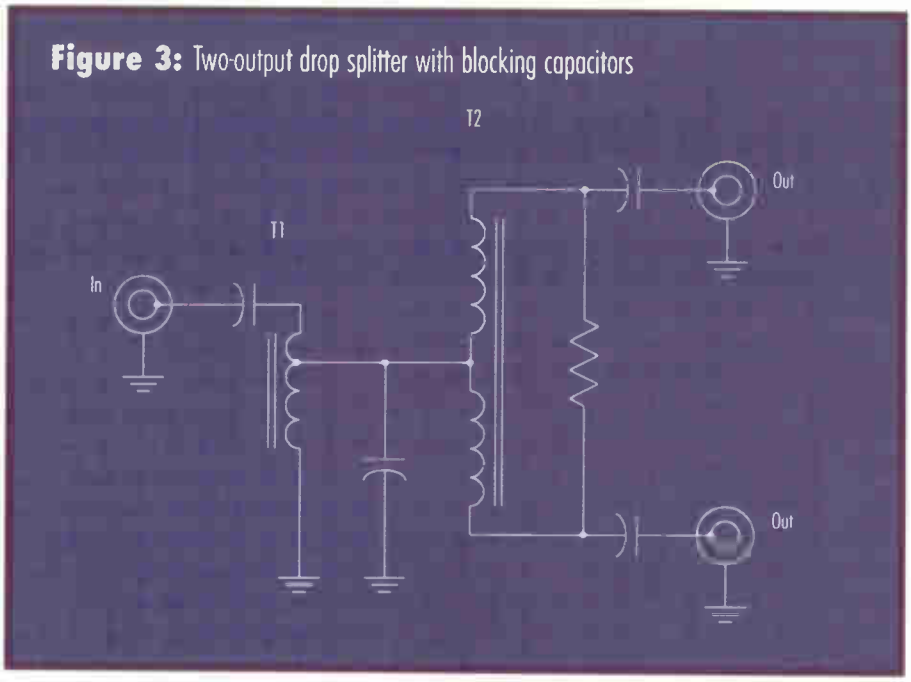


Figure 2: Low frequency electrical interference enters the splitter via transformer T1's grounded end

Hepler's focus was how this problem affected addressable converter data carriers in one-way systems. His article described an example where a voltage drop of just 3 V across a neutral conductor

Figure 3: Two-output drop splitter with blocking capacitors



could produce a current flow of 5.53 amperes on a drop, 17 percent of which would appear on the center conductor. That's 0.94 ampere, clearly enough to saturate a drop splitter's tiny ferrites.

Block capacitors to the rescue

The problem went away if you temporarily disconnected the neutral bond wire from the drop, but this created a safety hazard and noncompliance with the NEC. Prime Cable's permanent fix was to buy drop splitters with blocking capacitors on the input port.

Figure 3 shows blocking capacitors added to the original splitter schematic. The capacitors will allow RF to pass, but not DC or low-frequency AC.

The capacitors eliminate the DC/low-frequency AC path through the cable center conductor, preventing current from flowing through any of the splitter's transformer windings.

Ferrite saturation cannot occur, and neither will hum modulation. In practice, this fix requires more than just adding the capacitors; the capacitors by themselves will affect the splitter's RF performance somewhat, so a few other components are necessary. I've left them out to simplify the diagram.

There's another benefit to using splitters with blocking capacitors. The capacitors are one way to help to keep the splitter ferrites from developing residual magnetism, which can cause passive device intermod. (See my col-

umn in the September 1998 issue of *Communications Technology* for more on this subject.)

Several manufacturers now have available drop splitters that come with blocking capacitors built-in.

If you've been pulling your hair out trying to solve reverse path data transmission woes that occur despite an apparently clean reverse path, you might want to look at this as a possible solution. It's a cheap and effective tool for your two-way toolbox.

Ron Hranac is vice president of RF engineering for High Speed Access Corp. in Denver. He also is senior technical editor for "Communications Technology" He can be reached via e-mail at rhranac@aol.com.

BOTTOM LINE

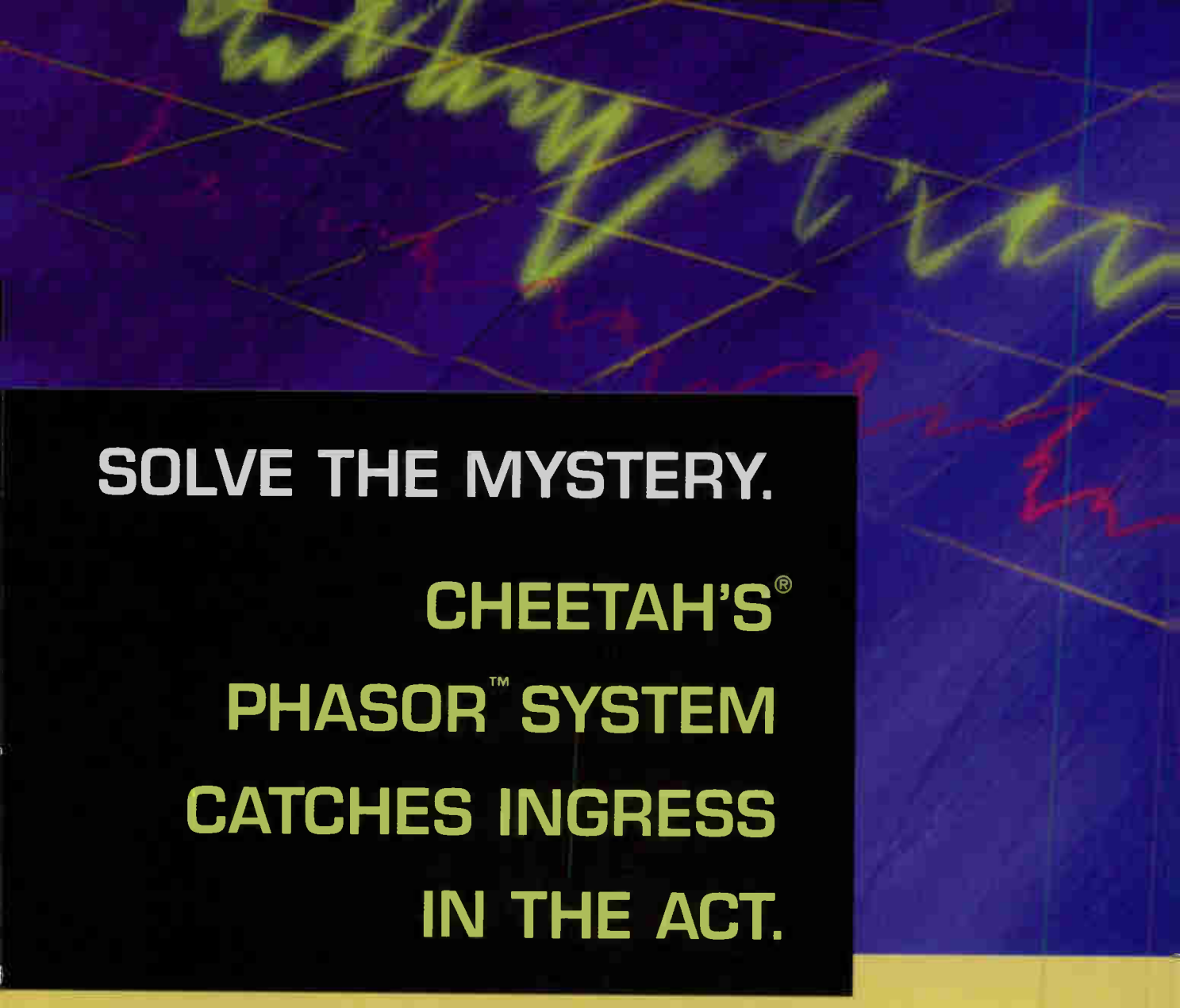
When Hum Modulation Strikes

Neutral fault currents that exist on the outer surface of cable shielding can enter a subscriber's drop wiring via the toroidal transformers found in drop splitters.

This will, under some circumstances, cause an electrical current to flow on the cable's center conductor. If the electrical current is large enough, it will saturate the splitter's toroidal transformer ferrite core and cause hum modulation.

Shaw Cablesystems personnel in Kelowna, British Columbia, found instances of this that appeared to affect only the reverse path. The result was up to 40-percent data packet loss, which degraded cable modem performance.

The initial fix was to install a voltage blocking coupler (VBC) on the splitter's input port, which prevented the unwanted electrical current from flowing in the drop. This success led to the use of drop splitters with built-in blocking capacitors on all of the splitter ports, a low-cost and effective fix to this potentially serious problem.



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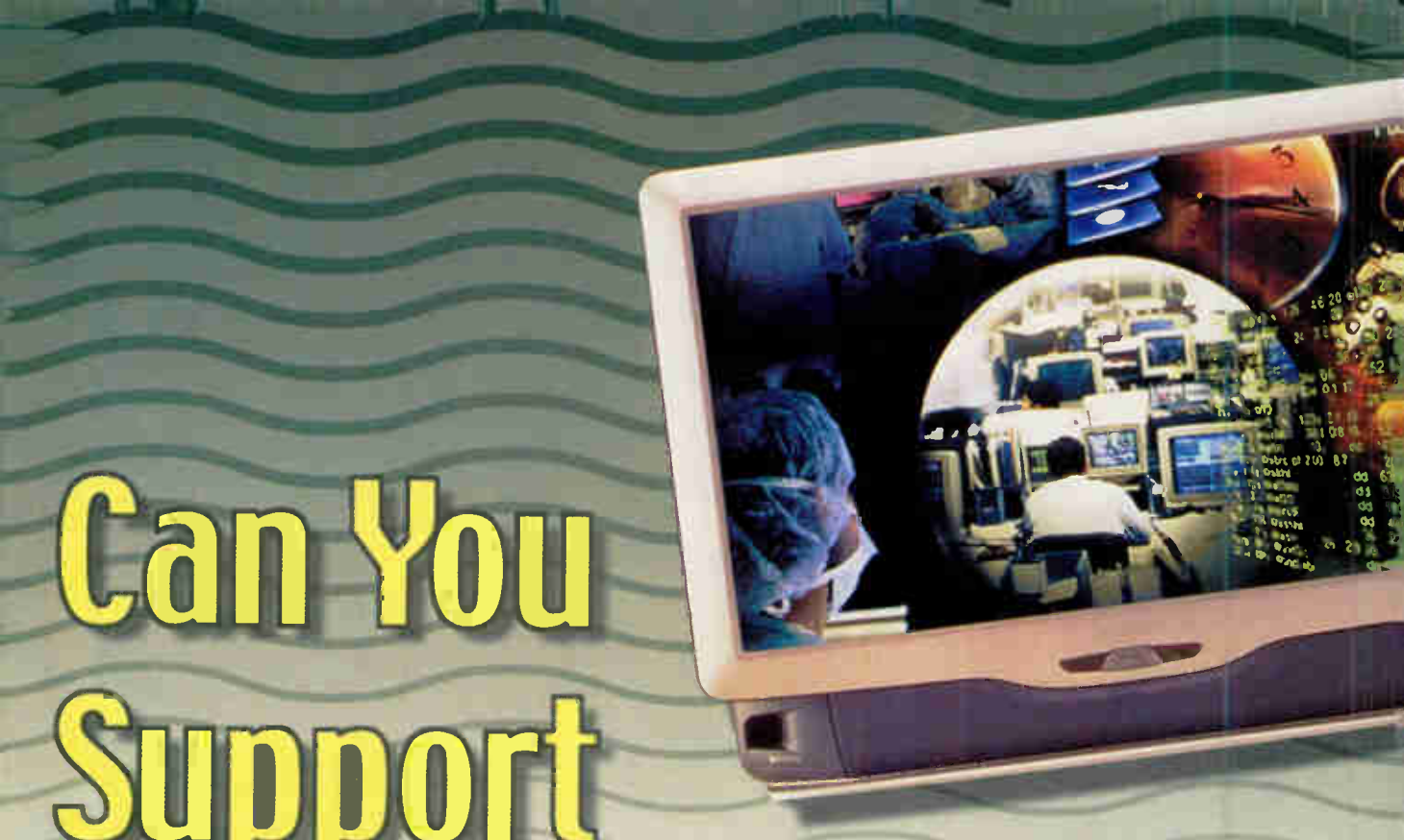


Can You Support Today's HDTV Sets?

Dealing with the Next Generation

By Bill Wall

High definition TV (HDTV) is here at last, and we can expect its foothold to expand. Indeed, the standards are mostly in place for manufacturers to build cable-compatible digital TV (DTV) sets and, eventually, digital cable-ready TV sets. But when this new generation arrives, what do we do about the present generation of HDTV sets?

How do we provide digital and high definition service to those very expensive pieces of legacy consumer equipment without having to set up parallel systems just for them? Read on.

Let's fast-forward to 2001. American consumers are being inundated with advertising to purchase the new, better and cheaper HDTV sets. By that time, ideally, delivering the new HDTV channels over cable will not require any additional infrastructure equipment in the cable system.

Receivers of over-the-air signals, satellite-fed signals or direct fiber feeds will bring digital baseband signals to cable headends. These signals will be multiplexed together and upconverted to a quadrature amplitude modulation (QAM) format just like any DTV source in a cable system. This approach is identical to how operators handle standard definition TV (SDTV) digital signals today.

Consider three cable subscribers in 2001, represented in Figure 1 (on page 106). Subscriber A has a digital set-top box to decode HD signals directly and down-convert them to analog NTSC for display on a conventional TV set. Subscriber B has an HDTV set-top box with "FireWire"—a high-performance bus based on the Institute of Electrical and Electronics Engineers' 1394 interface—that delivers digital signals into new HDTV sets that support FireWire. And

subscriber C gets HD digital signals directly off the cable to an even newer TV set: a cable-ready DTV with its own built-in circuits that accept QAM signals.

Tomorrow's ideal way of putting HDTV channels on cable must be tempered with today's realities. Today, there are no cable-ready DTV sets that can decode QAM. Also, neither the digital set-tops being deployed today nor first-generation DTV sets include IEEE 1394, which was only recently adopted as an official SCTE standard. For that reason, manufacturers won't be able to deliver FireWire-compatible DTV sets and set-tops until the end of this year.

While the rocky road to HDTV is getting smoother for audiences characterized by subscribers A, B and C, another group of subscribers faces an undetermined path. They are the early adopters who are buying first-generation DTV sets.

What constitutes a DTV set?

The Advanced Television Systems Committee and the Consumer Electronics Manufacturing Association have a joint program to establish a DTV "seal" for digital TV sets.

To sport the DTV logo, for example, a DTV set must be capable of decoding all 18 ATSC formats used by terrestrial broadcasters. Some of these are HD formats; the others are SDTV formats.

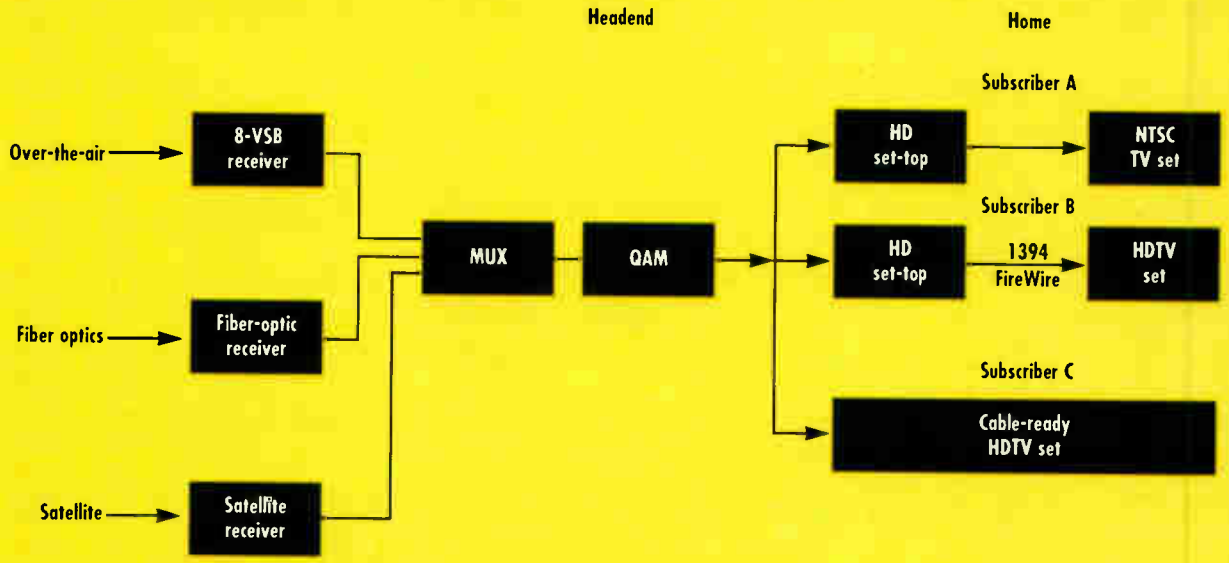
ATSC's specifications for HDTV are very similar to what's already on cable. The main differences:

1) Modulation: Cable's modulation technique is QAM, but the Federal Communications Commission mandates 8-VSB (vestigial sideband) as the modulation method for terrestrial broadcast.
2) Cable has agreed on two profiles of broadcasting: Profile 1 has 15 SDTV formats, nine of which also are ATSC formats. Profile 2 includes all 18 ATSC formats. New cable-ready DTV sets will accommodate Profile 2.

The cable, consumer electronics and broadcasting industries are making progress with several issues impacting next-generation HDTV sets and set-tops. The first of these is copy protection. The cable industry has made the IEEE 1394 interface specification a standard, but the consumer electronics industry has not yet agreed to the "Five Companies" digital transmission copy protection (5C DTCP) techniques that have been endorsed by the cable industry.

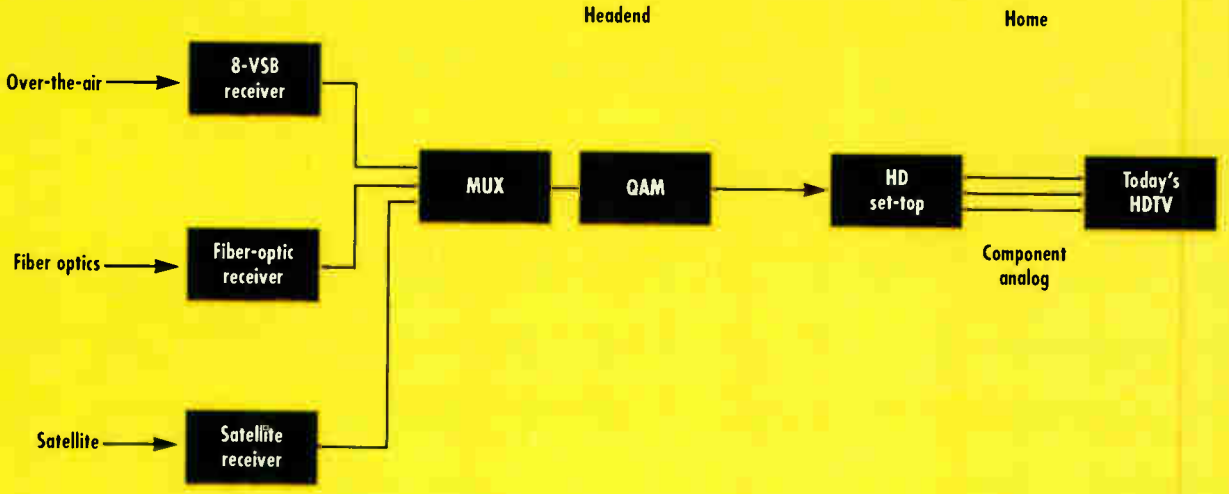
The second issue involves set-top-generated graphics. In the original 1394 specification, there were no provisions to handle graphics originated by the set-top (such as an electronic program guide, or EPG) that

Figure 1: SDTV, HDTV and DTV in 2001



Note: Conventional NTSC TV sets and future HDTV sets will be able to receive broadcast DTV signals, but first-generation DTV sets are not cable-ready and don't have IEEE 1394.

Figure 2: HD set-tops for legacy HDTV sets



Note: HD set-tops with component analog output can deliver cable channels to first-generation HDTV sets.

need to be displayed on the TV set. So far, the ultimate way to get set-top-generated graphics onto the DTV set remains unresolved, though the current SCTE home digital network interface (HDNI) specification allows limited graphics.

The third issue is control mechanisms. How do you use a single remote control for the set-top and the DTV set so they can pass control information back and forth on the 1394? The cable and consumer electronics industries have agreed to postpone this issue and let either two remotes or a universal remote provide the short-term solution.

These issues impact the definition of what constitutes a cable-ready DTV set. A joint committee has made progress, but retail availability of cable-ready HDTV sets capable of receiving QAM signals directly probably is at least 18 months away.

Legacy DTV sets

One of the greatest challenges is: What happens to the early HDTV sets? CEMA estimates that up to 150,000 first-generation HDTV sets will have been sold by year-end 1999 at prices up to $10,000. Lacking support for QAM signals, these TV sets can't receive HDTV over cable. They can receive HDTV signals only via over-the-air terrestrial broadcasts. ➤

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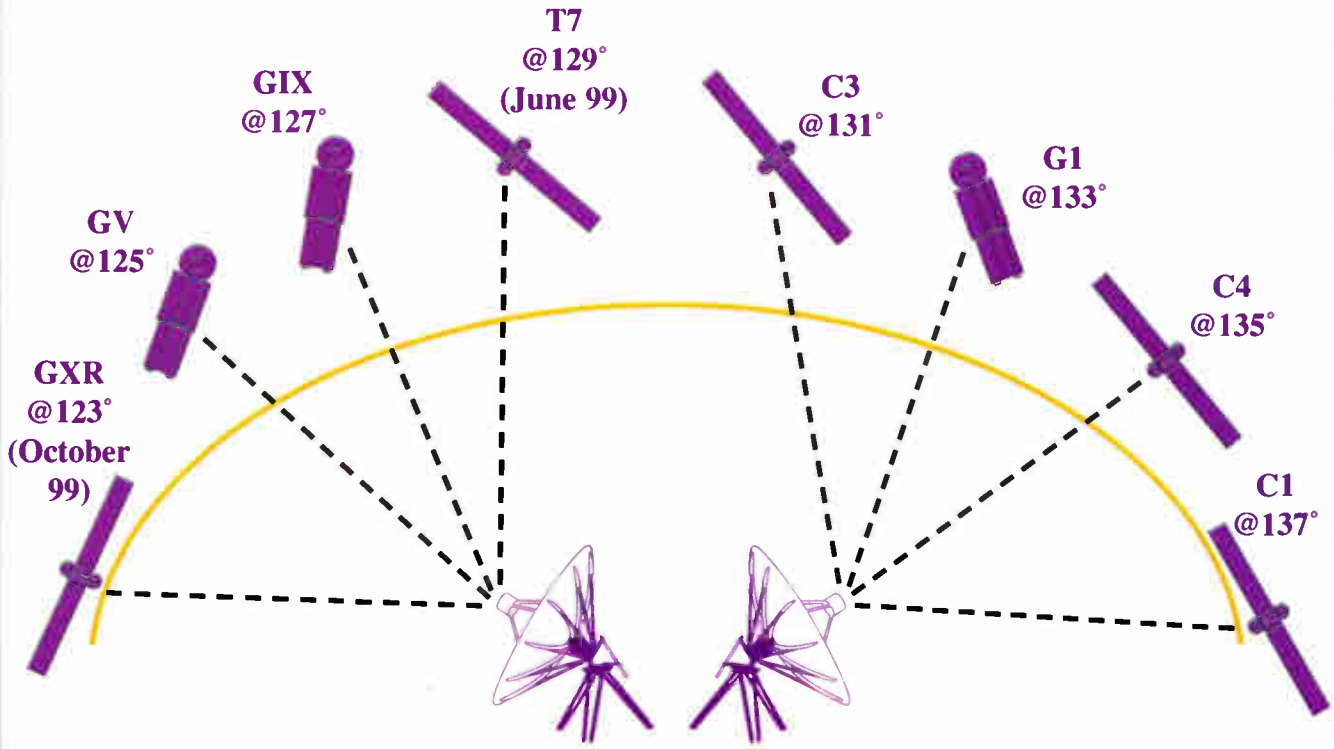

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BOTTOM LINE

Out With the Old, in With the New

Although some high-definition TV (HDTV) issues are not yet resolved, recently approved standards have cleared the path for a new breed of digital TV (DTV) sets to be on the market by the end of this year. Cable subscribers with conventional standard definition TV (SDTV) sets, the upcoming FireWire-compatible DTV sets or future cable-ready DTV sets will be able to receive HD programming without modification to the cable network infrastructure.

However, unless the cable, broadcasting and consumer electronics industries can agree on a practical solution, a fourth category—the early adopters of about 150,000 expensive first-generation DTV sets—will not be able to decode cable signals.

There's no perfect solution, but one alternative stands out as the best way to avoid rapid obsolescence of these legacy HDTV sets. That is to receive over-the-air signals at the headend and carry them via quadrature amplitude modulation (QAM) over the cable system to a high-definition set-top. The set-top decodes the HD signal and feeds it with a component analog output to legacy HDTV sets.

QAM—the standard specified by SCTE for cable carriage of digital signals—has been in place since November 1996. A month later, the FCC adopted 8-VSB as the broadcast standard. Both standards can be cost-effectively integrated into consumer devices in the future, providing compatibility with both cable and terrestrial broadcast.

The cable-ready DTV sets of the future will support QAM, but controversy remains on how to get cable signals to the 150,000 first-generation set purchasers. What are the alternatives? One is to send 8-VSB signals via cable to today's DTV sets. That approach is technically feasible, but has several disadvantages:

- It's inefficient. QAM enables two HD signals to be placed in a single 6 MHz cable channel—twice the carriage capacity of 8-VSB.
- It doesn't support conditional access (CA). Cable operators want to be able to control the access to premium services. If a premium service is carried on 8-VSB, legacy HDTV sets have no way of handling CA.
- It's not compatible with existing digital set-tops. By the end of this year, there will be more than 5 million digital set-tops deployed that can receive SDTV formats via QAM. Broadcasters are in the business of capturing viewers, so it makes little sense to let 150,000 legacy HDTV sets undermine the utility of millions of digital set-tops. In its early

years, HDTV broadcasting will be largely limited to prime time; the rest of the time the major networks will be broadcasting multiple channels of SDTV. If cable operators use 8-VSB for primetime HD shows and then broadcasters switch to SDTV outside of prime time, the only people who will be able to watch the SDTV channels outside of prime time will be the 150,000 HDTV owners. On the other hand, using QAM, broadcasters can reach not only the legacy HDTV sets but also the millions of viewers using today's digital set-tops.

- It would be difficult to get rid of 8-VSB. Even in expanded cable systems, bandwidth is at a premium. If an operator begins serving a small number of DTV sets via 8-VSB, those subscribers will continue to want service for many years after real cable-ready DTV sets become available. The operator is stuck with a legacy service that eats up bandwidth for a very small number of subscribers.

Overall, 8-VSB is a poor solution for delivering HD on a cable system—which is why so few systems are committing resources to it.

A much better solution is to receive over-the-air signals at the headend and convert them to QAM for carriage over the cable system, but now to a high-definition set-top. The set-top decodes the HD signal and feeds it with a component analog output to legacy HDTV sets. (See Figure 2 on page 106.)

> "Tomorrow's ideal way of putting HDTV channels on cable must be tempered with today's realities."

Out of 20-plus HDTV models now on the market, a recent survey found that only one lacks a component analog input. Most models use either a luminance and color difference (YPrPb) interface or a red-green-blue (RGB) interface. A new HDTV digital set-top with a programmable component analog output will be able to configure to either of these interfaces.

Having the component analog output in the HDTV set-top solves another problem: It enables high-performance set-top graphics to be mixed with video.

The cable industry and its suppliers can solve the most vexing of the problems associated with first-generation HDTV sets. The lack of copy protection will continue to be an issue, but HDTV set-tops with component analog output appear to be the best short-term solution to save first-generation HDTV sets from near-term obsolescence. Set-tops for the solution outlined here will be available soon; then, owners of legacy DTV sets can count on cable as the source of their HDTV viewing. CT

Bill Wall, Ph.D., is technical director, subscriber networks, at Scientific-Atlanta. He can be reached at (770) 236-5052 or via e-mail at bill.wall@sciatl.com.

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Digital TV Glossary At a Glance

By Panasonic and the Consumer Electronics Manufacturers Association

In this age of rapid technological advances, jargon can tend to accelerate faster than we can absorb it. The emergence of digital TV (DTV) offers a prime example, with a mix of familiar and new terminology, all of which can combine into a muddle of confusion.

So in the interests of not being left alone and puzzled in technology's dust, here follows a glossary of some of the important terms and acronyms associated with the realm of DTV.

A-B

AC-3: Also known as Dolby Digital, delivers digital audio (CD-quality), provides five full-bandwidth channels for front left, front right, center, surround left and surround right, plus a low frequency effect (LFE) subwoofer channel (total 5.1 channels).

Advanced Television Systems Committee (ATSC): Committee responsible for DTV standards and development, as well as its 18 formats of DTV.

A/D: Analog-to-digital conversion or converter used at the transmission end of a broadcast.

Addressable resolution: The highest resolution signal that a display device (TV set or monitor) can accept. The device, however, may not be capable of displaying this resolution.

Artifacts: Unwanted visible effects in the picture created by disturbances in the transmission or image processing, such as "edge crawl" or "hanging dots" in analog pictures or "pixilation" in digital pictures.

Aspect ratio: The width of a picture relative to its height. If an NTSC picture is 4 feet wide, it will be 3 feet high. Thus, it has a 4:3 aspect ratio. High definition TV (HDTV) has a 16:9 aspect ratio.

Confused by digital TV jargon? This glossary will set you straight.

Bit rate: Measured as bits per second (bps) and used to express the rate at which data is transmitted or processed. The higher the bit rate, the more data that is processed and, typically, the higher the picture resolution.

C-D

Component video connection: The output of a video device, such as a set-top box for DTV, or the input of a DTV receiver or monitor consisting of three primary color signals (red, green and blue, called RGB) that together convey all necessary picture information. With current consumer video products, the three component signals have been translated into luminance (Y) and two color difference signals (Pb, Pr), each on a separate wire.

Composite video: An analog, encoded video signal (such as NTSC) that includes vertical and horizontal synchronizing information. Having the luminance (brightness) and chrominance (color) signals encoded together means that a single connection wire is needed, such as RCA-type cable.

Compression: A method of electronically reducing the number of bits required to store or transmit data within a specified time or space. The video industry uses several types of compression methods, but the method adopted for DTV is called MPEG-2 (Moving Pictures Experts Group-2).

D/A: Converter of digital to analog signals. The device also is referred to as DAC (D/A converter). In order for conventional TV technology to display digitally transmitted TV data, the data must be decoded first and then converted back to an analog signal.

DTS: Digital Theater Systems sound. Discrete 5.1-channel surround system similar to, but not the same as, Dolby Digital. Dolby Digital is the DTV standard, but DTS competes with it on videotapes, digital versatile disk (DVD) and in the movie theaters.

Downconvert: A term used to describe the format conversion from a higher resolution input signal number to a lower display number, such as 1,080i input to 480i display. ➤

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E-I

EPG: Electronic program guide. An on-screen display of channels and program data.

High definition TV (HDTV): HDTV is approximately twice the vertical and horizontal picture resolution of today's NTSC TV, essentially making the picture twice as sharp. HDTV also has an aspect ratio of 16:9 as compared with most of today's TV screens, which have an aspect ratio of 4:3. HDTV offers reduced motion artifacts and 5.1 independent channels of CD-quality stereo surround sound, also referred to as AC-3.

IEEE 1394 (aka "FireWire"): The Institute of Electrical and Electronics Engineers' standard interface for the transfer of high-speed digital data between devices such as a digital set-top box and digital videocassette recorder (VCR). Sometimes referred to as firewire or i.link.

Interlaced scanning: In a TV display, the process of reassembling a picture from a series of electrical signals (video signal). In the NTSC system (current TV picture), 525 scanning lines are used to create a picture (frame). The frame/picture is made up of two fields: Field 1 has 262.5 odd lines (1, 3, 5...), and Field 2 has 262.5 even lines (2, 4, 6...). The odd lines are scanned (or painted on the screen) in 1/59.94 of a second, and the even lines follow in the next 1/59.94 of a second. This presents an entire frame/picture of 525 lines in 1/29.97 of a second.

L-R

Letterbox: The term used to describe the way a 16:9 aspect ratio image is displayed on a 4:3 screen, where black areas are visible above and below the image.

Line doubling: A method, through special circuitry, to modify an NTSC interlaced picture to create an effect similar to a progressively scanned picture. The first field of 262.5 odd-numbered lines are stored in digital memory and combined with the even-numbered lines. Then all 525 lines are scanned in 1/29.97 of a second. The result is improved detail enhancement from an NTSC source.

MPEG-2: A system adopted by the Moving Pictures Experts Group that was developed for compressing digitized video to save bandwidth.

Pixel: Short term for picture element—essentially, a single displayable video dot.

Progressive scanning: Typically used by VGA computer monitors, all the horizontal scan lines are "painted" on the screen at one time. Adopted DTV formats include both interlaced and progressive broadcast and display methods.

Resolution: The density of lines or dots per line that make up a visual image. Usually, the higher the numbers, the sharper and more detailed the picture will be. In terms of DTV, maximum resolution refers to the number of horizontal scanning lines multiplied by the total number of pixels per line, called pixel density.

S-Z

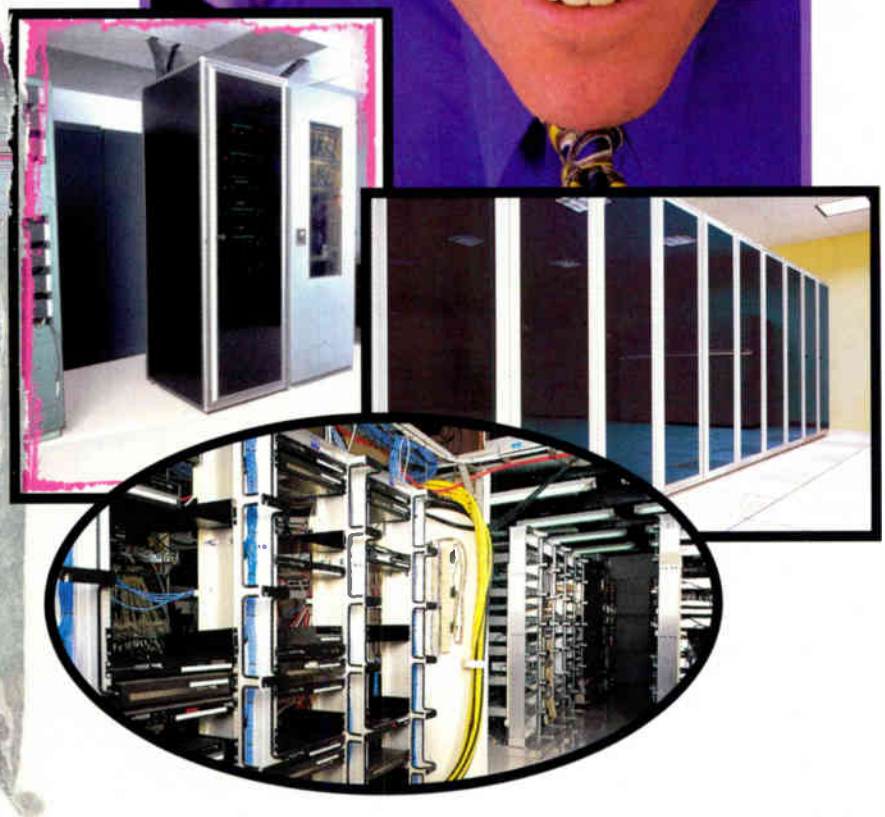
Standard definition TV (SDTV): Digitally transmitted SDTV includes 480-line resolution in both interlaced and progressively scanned formats. It offers significant improvement over today's conventional NTSC picture resolution and is similar to DVD or direct broadcast satellite (DBS) quality because the digital transmission eliminates snow and ghosts, which can be common with the current NTSC TV format. Also, because of digital compression technology, several programs can be transmitted simultaneously within the same channel.

Upconvert: The term used to describe the conversion of a lower apparent resolution to a higher number, such as upconverting 720p to 1080i. This is a misnomer because, to accomplish this, the horizontal scanning frequency actually is reduced from 45 kHz to 33.75 kHz. Resolution quality is not improved by this method.

Y, Pb, Pr: Generally used where a DTV signal source is employed. The video signal is separated into its component parts of brightness and color differentials. The most advanced method for interconnecting decoded video data.

Y, U, V: Also sometimes referred to as Y, Cr, Cb where a video signal is separated into its components of brightness and color. CT

For more information, point your browser to www.panasonic.com.



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Reader Service Number 63

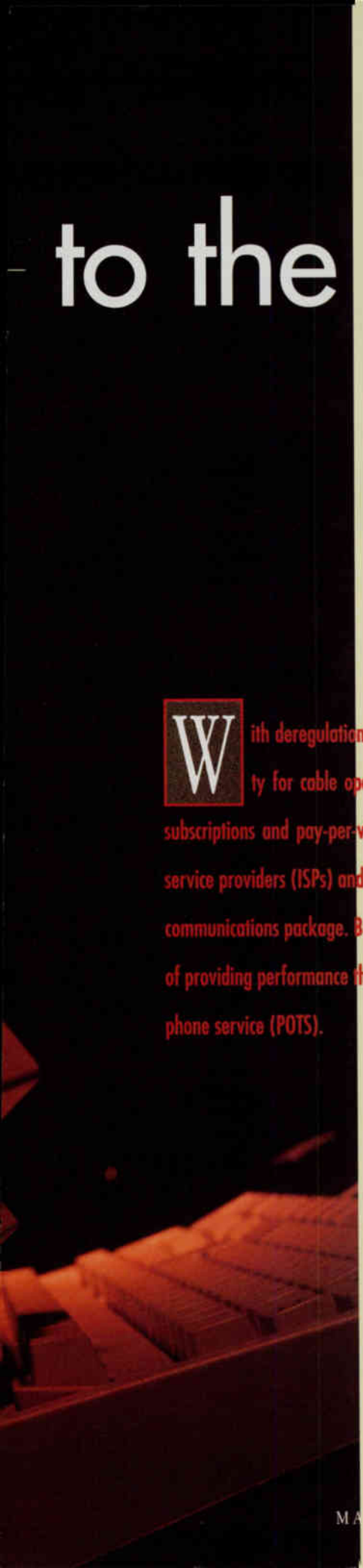
Put an End

to the Paper Chase

By Randall Anderson

Detailed Maps Are Just A Click Away

With deregulation of telecommunications has come the opportunity for cable operators to offer customers more than just cable subscriptions and pay-per-view (PPV). You're now competing with Internet service providers (ISPs) and the local phone company in offering o complete communications package. But with this new opportunity comes the challenge of providing performance that's as good as, if not better than, plain old telephone service (POTS).



In the past, cable network managers have had no other tools than reams of paper to refer to when locating a fault, or putting together a map for management and marketing review. Essentially, we've been using 19th century techniques for managing a technology moving into the 21st century. However, new, cost-effective personal computer (PC)-based applications are rapidly changing this deficiency.

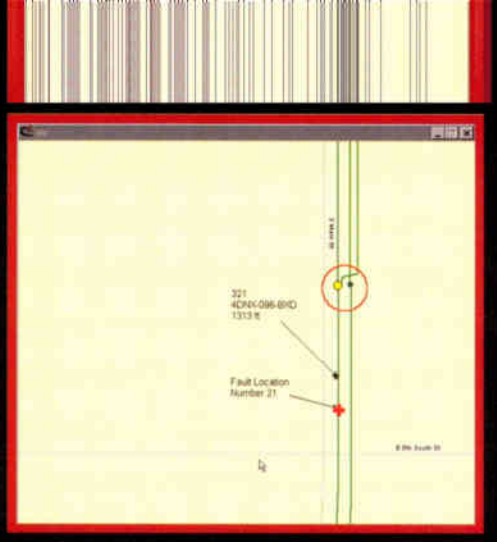
Benefits of document management

These applications, an outgrowth of the burgeoning telecommunications industry, now make it possible for a manager to document all network attributes, specifications, routes and other data electronically. This means that all data—tables, specifications, equipment lists, enclosure descriptions, cable routes—can now be stored in a computer application that makes them easy to retrieve in a matter of seconds. Literally, it puts network data at your fingertips.

The advantages of such a system are obvious: Fiber and cable monitoring become more effective because data supporting the network are rapidly accessible. Management reports, which take hours (even days) using a paper documentation system, can now be produced in a matter of minutes. And network maps for marketing and engineering are available at the click of a mouse.

Further, you can greatly reduce the time it takes to locate service faults (in many cases to only 10 to 15 minutes) so that you can make repairs to the network very rapidly.

Perhaps a better way to ask this is, "What do you need to know to really manage your network?" You'll need to



Network management systems can help locate service interruptions fast. By inputting the "length-to-fault" distance obtained from an OTDR trace, you can quickly find the fault and display it on a map.

assemble a very thorough set of documents that cover the details of splices and their locations, cable routes, termination points, and other network attributes—information that you probably have right now in paper form. But many of you are asking for electronic documentation.

When evaluating a network management system, you must go through the same exercise. What information do you need to do your job? What kinds of reports must you provide to management, marketing and engineering on a regular basis? What data do you require to locate and repair faults?

The devil is in the details

Pursuant to providing information and creating reports is the degree of detail you require. Most network management systems will allow you to input a significant amount of detail. You need to choose a system that accepts the greatest amount of detail possible and reports it. This must include:

- Cable routes
- Cable and fiber attributes, including cable type (number of fibers and capacity), manufacturer and which customers are assigned to which fibers
- Splice keys (including splice type and date), splice enclosures
- Termination points, access points
- Customer/building locations
- Amplifier locations (plus type, manufacturer, date installed, specifications)
- Computer-aided design (CAD) drawings and schematics
- Manufacturers' drawings and photographs
- Cable spans and lengths, including fiber lengths

> "Relating documentation to geographic mapping puts the information where it logically belongs—on the network."

Remember that the quality of this electronic documentation will be only as good as the accuracy of the data you input. If you put garbage in, you'll get garbage out.

Mapping pulls it all together

What makes these systems so valuable is not merely the ability to document and then report all network attributes, but also the capability to illustrate this information geographically. Mapping applications that are integral parts of network management systems provide very powerful solutions that permit two things:

- Mapping of cable networks, detailing each and every cable span, splice, termination and customer location
- Overlaying these routes onto actual geographic maps of cities, towns and regions to provide an extremely accurate view of your network

Relating documentation to geographic mapping puts the information where it logically belongs—on the network. A typical network management scenario would involve calling up a network map and then clicking on specific icons on the map to retrieve data. Splice locations, splice keys and enclosures; a specific cable span; a customer location; verification of optical fiber count; and who is on each fiber are examples of data available via network maps.

What it really means

Network management systems really save time and money. For example, using paper documentation, it could take a network administrator up to two days simply to find a splice location to verify the splices and their attributes. With modern network management systems, this can be accomplished in minutes. Obviously, time is money.

What's more, when real emergencies occur, such as a fault in service, you can take an optical time domain reflectometer (OTDR) trace, plug the distance to the fault into the management system, and quickly display the fault

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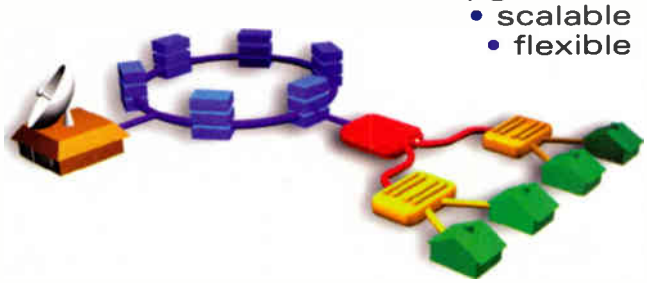

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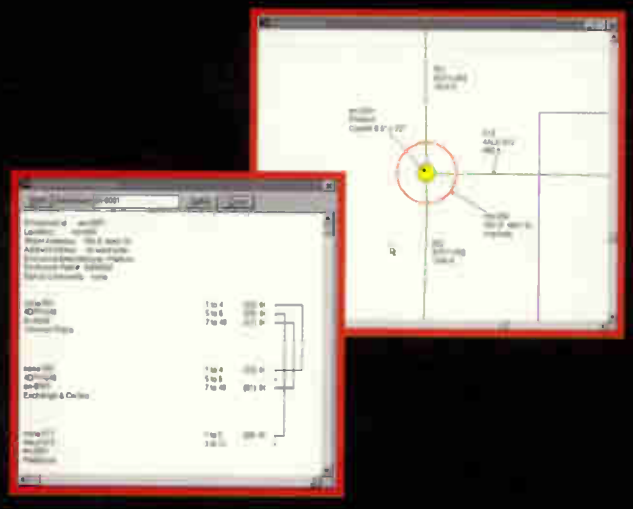
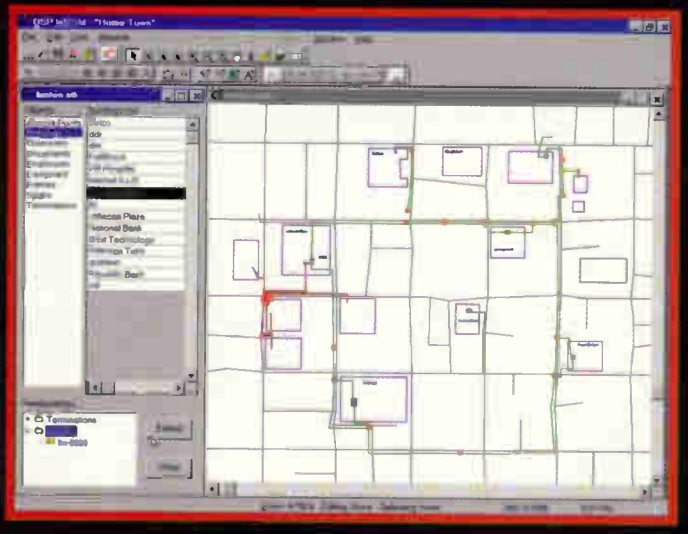
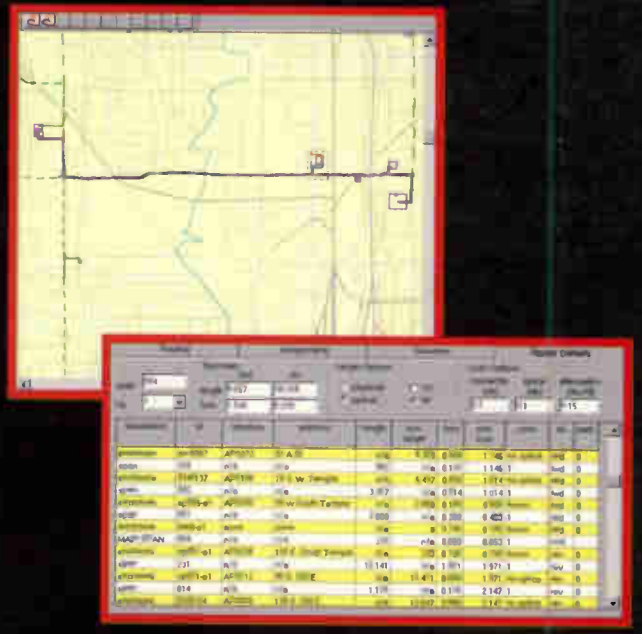


Cable engineers can now use computer tools to give them access to a variety of physical plant data including: fiber routes, cable lengths, cable type and count, splice type and location, and loss values.





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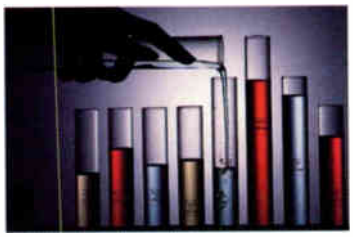

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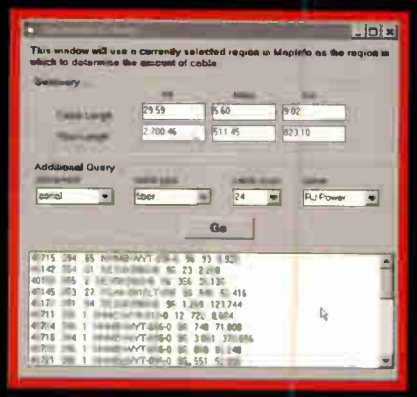
Geographic reports are one of the strongest reasons for implementing a network management system with a mapping application. You can determine cable lengths, identify areas of service for new customers and project network growth using demographic forecasts.



BOTTOM LINE

Mapping Your Cable TV Network

With competition increasing in the telecommunications market, cable operators are under pressure to improve the performance of their systems. Network management systems that feature mapping applications can make a difference in your success or failure.

These applications enable you to document electronically all network attributes, including specifications, equipment lists, enclosure descriptions, cable routes and other data.

Fiber and cable monitoring becomes more effective because data supporting the network are rapidly accessible. Management reports, which take hours (even days) using a paper documentation system, can now be produced in a matter of minutes. And network maps for marketing and engineering are available at the click of a mouse.

Further, you can greatly reduce the time it takes to locate service faults (in many cases to only 10 to 15 minutes) so that you can make repairs to the network very rapidly.

Because the implementation of a network management system is mission critical, you'll need to evaluate the systems based on your specific needs, not just product capabilities. Be sure to demand a thorough demonstration, with the opportunity to use the demo on your own, before making the final decision.

location on a map. Then you can dispatch repair crews in a matter of minutes. Of course, manually finding faults takes hours. The savings in manpower alone can quickly repay your investment.

Test your network before construction

Because these network management systems actually help you build a virtual network, you have the added bonus of testing network designs before and during construction. You can also use the system for quality assurance. By using a simple circuit tracer to verify that circuits are done correctly, the administrator can confirm the network's design integrity—without ever installing a single cable.

How to select the right system

Because the implementation of a network management system is mission critical, you must evaluate systems based on your specific needs, not just product capabilities. Be sure to ask the following questions:

1) Is the system large enough, and powerful enough, to handle your network?
2) Is the system scalable? If your network outgrows your system, does the vendor offer upgrades that accept your current database without having to input the data a second time?

3) Is it easy to use? The best systems let you click on network icons to view your documentation.
4) Do the maps provide a bird's eye view and zoom-in capabilities to see both the entire network as well as minute details?
5) Can it document both optical fiber and copper?
6) Does it incorporate data from network testing and monitoring (such as OTDR traces) to give a complete picture of network health?
7) Will the vendor "tweak" your system to handle needs specific to your operation?

A "yes" to all or most of these questions probably will identify the best system for your cable network. However, make sure you demand a thorough demonstration, with the opportunity to use the demo on your own, before making the final decision.

With the scramble to capture a bigger piece of the telecommunications pie already in high gear, you may get only one chance to prove your value to the customer. A comprehensive network management system is the best way to get your company ready to compete. CT

Randall Anderson is president and founder of Advance Fiber Optics. He can be reached via e-mail at randya@advancefiber.com.

Image courtesy of Enghouse Systems Ltd.

Intelligent Mapping

Get a Handle on Your System

By Edward Coffman

Imagine how a system's planning and mapping department might work in the year 2010.

"Bob, here are the map changes the field techs made today. Could you plot those out right away?"

"Sure. Hold on."

"Whirrrr, click, click"—the plotter runs a high-speed draft, taking its instructions from the HAL 6000 mainframe. After a few minutes, the familiar "ffdoop" sound signals Bob to walk over to the plotter and retrieve all the plots showing the system changes.

"There you go, Jim. I'll set the intelligent mapping (IM) system to create new CD-ROMs by morning for the field laptops." ➤

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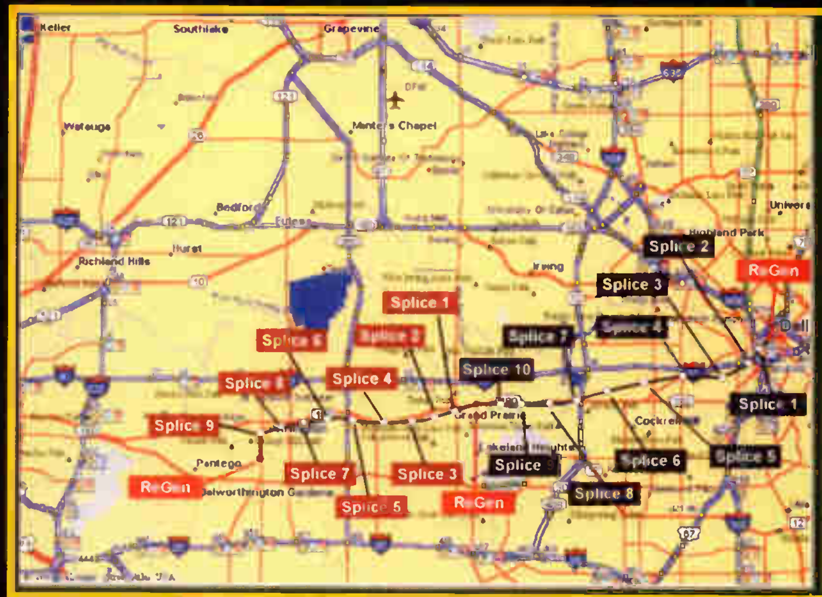
What IM can do: This example shows several aspects of a system map, such as routing and locations of splices and regeneration cabinets, all quickly and easily accessible via computer.



Source: JAM Reports

Do we need intelligent mapping?

Does the cable industry really need IM? Are we behind the times when other utilities use IM systems such as geographic information systems (GIS)? In a word, yes. Having a working, up-to-date IM system carries great benefits.

The cable industry might need to rethink its attitude about mapping in general. Do you think all your maps are up to date and that not much can be done to improve what you already have? For some of us, this may be true, but the cable industry tends to treat mapping as the sacrificial lamb when it comes to budgeting.

Let's face it: Mapping is important mainly when you need to construct the plant or trace a problem. Even during a rebuild or upgrade, some people accept sub-par mapping because they don't want to spend the money to design the system correctly.

I'm not just talking about when the designer receives the maps to design an area; I'm also talking about pre-engineering, walkouts, test design, fiber allocation and budgeting based on your needs in five years, not just tomorrow.

I'm talking about accurate mapping for fiber schematics, amplifier schematics, coax design, headend layout, multiple dwelling unit (MDU) layout and design, businesses, schools, government, and that's not all. This all takes time, and most of it could be avoided with 99-percent-accurate maps and information stored in an IM database. ➤

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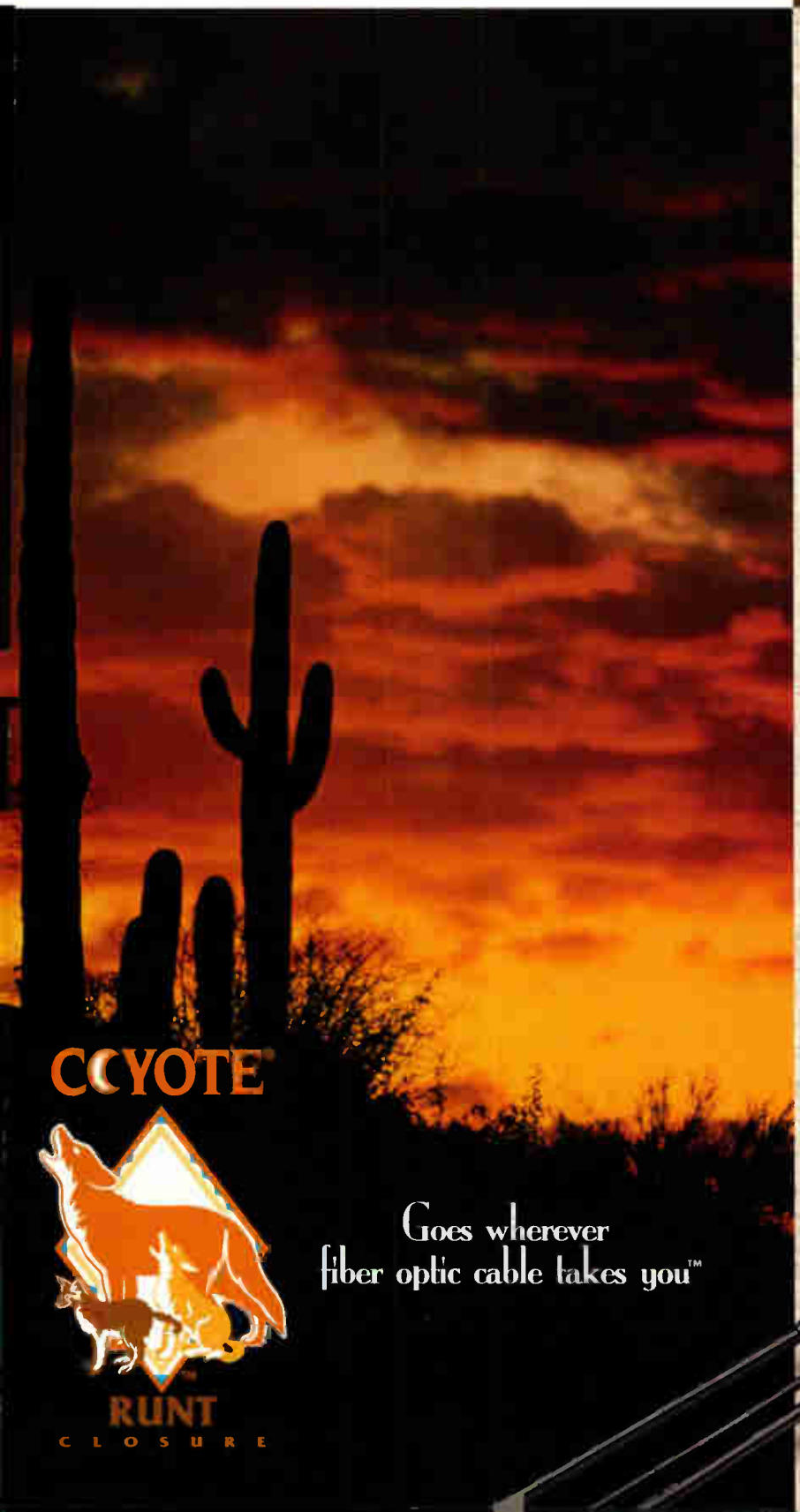

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PREFORMED LINE PRODUCTS

Reader Service Number 72

Source: JAM Reports

By using an IM database, you will be able to store any data related to your system: equipment, specifications, installation dates, fiber counts, bandpass, sweep measurements and so on. Don't stop there. If some data can be collected, IM can store it, and you can query it for your decisions.

What kind of decisions do you make? Are you making decisions about your two-way plant? Can you accurately determine what your costs and timelines will be for turning on your digital platform? Do you have accurate records for the types of equipment you have, their age and condition, and bandpass for each piece of equipment? How about that old amp or line extender—what return module can be put in it, if any? Knowing these things will greatly influence how quickly you can get your return up and running and what its cost will be.

How good are you, really?

Many systems have great techs who know their systems intimately. But that doesn't translate into increased revenue because techs don't sell new business to potential customers.

If a business were to ask you to create a fiber link between two buildings that are 5 miles apart, how would you find out—if you could? Do you have enough fiber to support a video link and wide area network (WAN) for the business? How much would it cost to gather all the necessary information and put in a bid?

Oops, too late—the telco was ready to serve that business today, while you were still piecing together hand-drawn maps of your fiber network and sending techs out to see whether that "dark fiber" really is. Or worse yet, you might think you have what it takes and get into a contract, only to find out that you can't deliver.

> "Some say there's no such thing as 'intelligent mapping.' They're right, of course. It still takes people to make IM work, and people are fallible."

Without IM, your records likely are spread out all over your company, might be inaccurate, and certainly are difficult to find and use quickly.

fact: COMMSCOPE OFFERS AS COMPLETE A LINE OF LAN/WAN CABLES AS ANYONE IN THE INDUSTRY.

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Designed for when maximum fiber performance is required but cost and installation difficulty (crowded conduits, tight radius pulls etc.) preclude the use of a large loose tube cable. Made in outside plant dielectric, armored, self-support and riser-rated indoor/outdoor versions.

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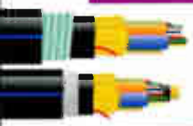

For use in special conditions such as corrosive agents/petrochemicals that would quickly destroy standard cables. Double and triple-jacket armored versions offer toughness for the rigors of the outside plant, including -55/+75°C environments. Indoor/outdoor harsh duty version available.

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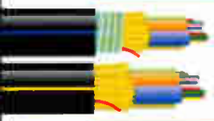

When maximum fiber performance is required over long distances, order your armored or dielectric versions in lengths of up to 8.4 mi/14 km. Available for outside plant and indoor/outdoor installations.

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Use them when maximum fiber performance is required but issues of installation difficulty (such as crowded conduits or tight radius pulls) preclude the use of a large loose tube cable. Available for outside plant and indoor/outdoor installations.

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EXPERIENCE and INNOVATION

fact: IF YOU MAKE A CABLE THAT'S EASY TO INSTALL, IT ALSO BECOMES EASY TO SPECIFY

fact: EXPERIENCE MATTERS.

CommScope has been a leader in the design and manufacture of communication cable since our first patent in 1966. If you watch cable TV, there's a 60% chance that your programming is delivered over a CommScope cable. What we learned by wiring the world has been applied to the creation of the most diverse offering of fiber optic cables for LAN/WAN and CATV applications.

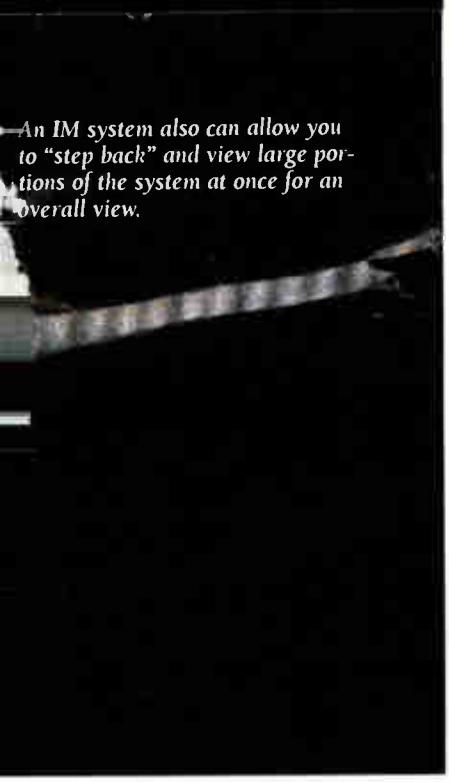
fact: INNOVATION IS A CHANGE THAT SOMEBODY ACTUALLY WANTS.

When we started to engineer fiber optic cable, we based our designs on the most stringent of industry standards augmented by customer input. How can a cable be made for my application? How can it be made to **perform better, install easier, cost less, survive longer?** We answered those needs with real-world solutions to everyday situations. **fact:** NO MATTER WHAT IT COST, IF YOU DIDN'T NEED IT, YOU PAID TOO MUCH. That's why we developed Fiber Feeder™ cables. They deliver loose tube performance at greatly reduced installed cost for 18 fibers or less.

fact: IT'S LESS EXPENSIVE TO INSTALL ONE CABLE INSTEAD OF TWO.

CommScope indoor/outdoor loose tube cables allow you to transition through exterior walls without changing cables - they are riser-rated safe yet tough enough to survive in the ground or on the pole. And our Triathlon™ low-smoke/zero-halogen cable is the first true indoor/outdoor that combines tight-buffer ease of handling with excellent attenuation and environmental characteristics. **fact:** ONE SIZE (OR FIBER TYPE) DOES NOT FIT ALL. Because applications vary, CommScope cables are available in multiple fiber types, including our high bandwidth UltraFiber™, a 1000 MHz•km @ 1300 nm fiber which allows extended transmission distances and faster data rates.

fact: IT ISN'T BRAGGING IF YOU CAN PROVE IT. To show our commitment to delivering a quality cable, CommScope **individually tests each reel** of fiber optic cable and attaches a copy of that test to the reel at no extra charge. **fact:** INNOVATION AND EXPERIENCE ARE A TOUGH COMBINATION TO BEAT. CommScope is the fiber optic cable company who knows that installability is as important as attenuation, and that budgets need to be followed as closely as blueprints. CommScope truly makes **FIBER FACE THE FACTS** of real-world performance.



An IM system also can allow you to "step back" and view large portions of the system at once for an overall view.

e test

If you're still thinking, "That's not ır company," then try this. Pick three stems that haven't done any prep ork for two-way digital, and ask em to determine how soon they uld deploy a digital service such as ternet access and how much it would st. Ask them to show a short-term an just to get things up and running ıd then determine how to migrate to a ll-service network.

Don't just take them at their word; ake them prove it. They will need cords for their entire network (headend home), including bandpass, to deterine how many customers can be serced for cable modems, how many nplifiers can be funneled back into the eadend, how many nodes can even reach ack to the headend and so on.

e you prepared?

Part of preparing for IM is to gather ll the information you want your IM system to incorporate. Think carefully, and gather as much information as you an through a "network inventory assessment," including map accuracy. This may require a walkout for both oax and fiber portions of your system. our gathered information must inude not just what your system looks like now, but also what you want it to become. ➤

Another useful IM feature is the ability to "zoom in" and obtain detailed location and contact information for installers and field technicians, as in this example.

Source: JAM Reports

In other words, if you want to provide high-speed Internet access to businesses, where are the businesses, how many are there, and what is the probable take rate?

You might want marketing to get involved. Your billing system is another area for linking to IM, making sure all of its fields are up to date.

You might want to do this prior to a rebuild, retrofit or upgrade to help absorb the costs. After collecting the data, you can store much of the information on your computer-aided design (CAD) system through attributes and linking to other databases. This will make a conversion to IM easier and less costly.

Yes, this will cost some money to implement; however, think of the revenue you could lose to others who are better prepared to move forward quickly. Finally, IM vendors are many, which can be confusing, but consultants can help you out in your quest for IM.

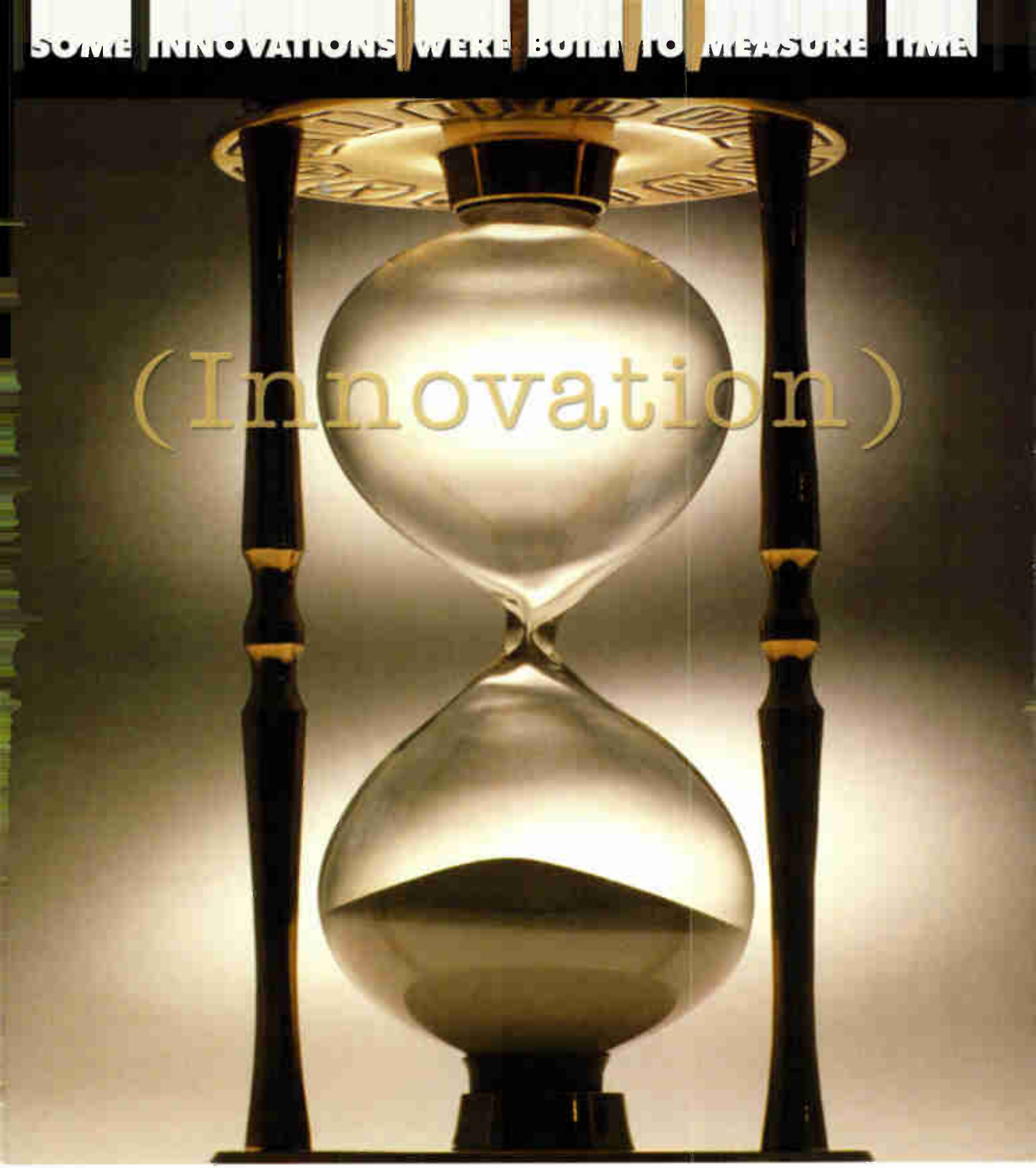
The real story

"Bob, here are the changes the techs made in the field today according to your design."

"Thanks, Jim, I'll input the changes in the IM system and plot the new map books at the end of the month as agreed."

"OK, thanks. I'll see you in the morning. Oh, and by the way, Bob, the VP called to thank us for getting all the system design parameters together so quickly. It looks like we'll be able to begin the new Internet service by the end of the second quarter."

Edward Coffman is a network integration specialist at Jones Intercable. He can be reached via e-mail at ecoffman@jic.com.



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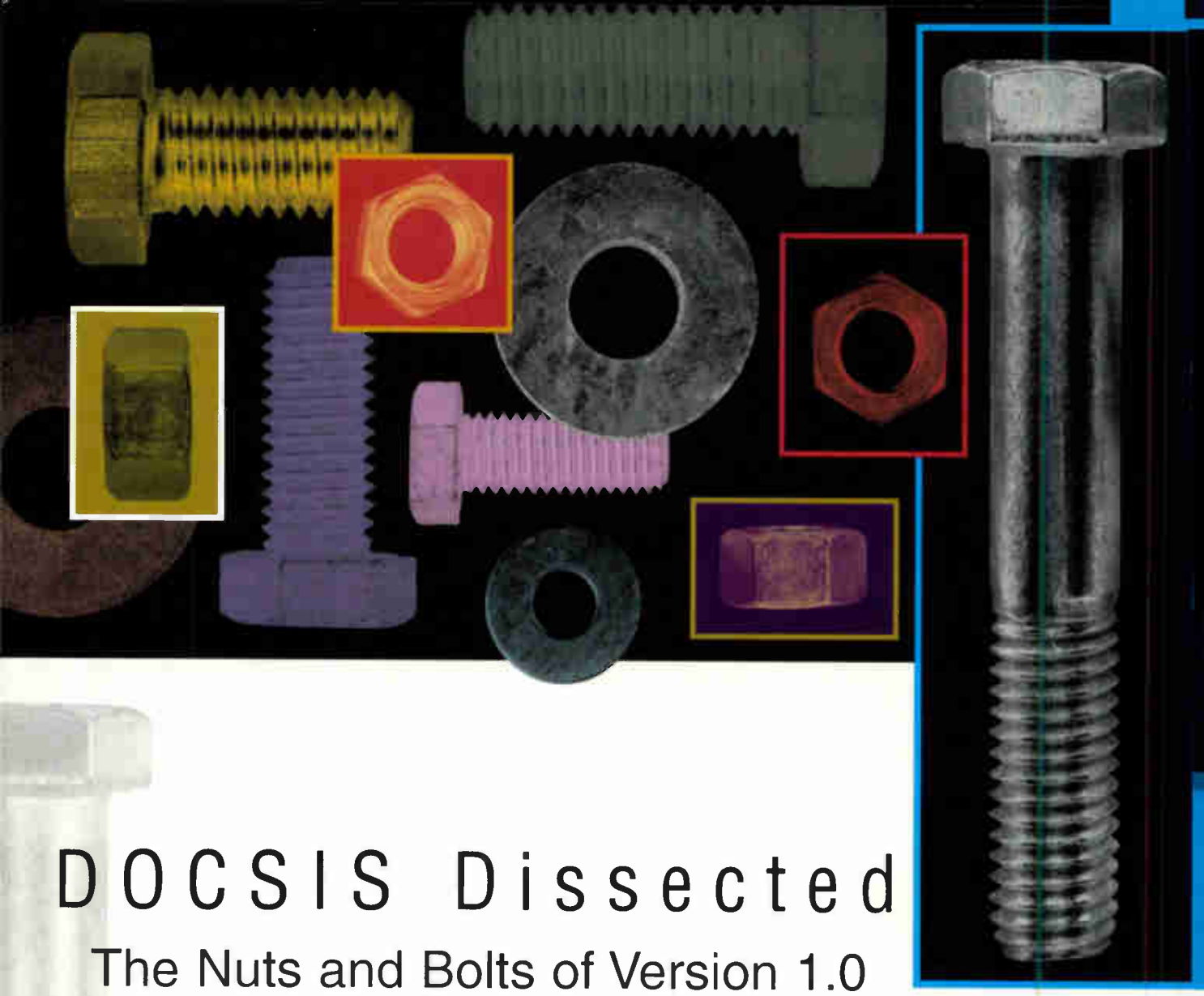

DOCSIS Dissected

The Nuts and Bolts of Version 1.0

By Doug Jones

With demand for high-speed data services rising, it is critical that cable operators have a selection of interoperable equipment from multiple vendors. To achieve that goal, CableLabs and several multiple system operators (MSOs) created the Data Over Cable Service Interface Specification (DOCSIS) Version 1.0 that describes a cable data system. ➤

How does it feel to use the world's fastest DOCSIS modem?

DOCSIS sets the standard for cable modem interoperability. But when you look beyond DOCSIS compliance, you'll see that all cable modems are not created equal.

Our DOXport™ family of DOCSIS cable modems is the fastest in the industry because we're the only company to use intelligent hardware for packet filtering.

This means you'll see the quickest Internet response with our DOXport cable modems. While other cable modems limit performance by relying on software-based packet filtering, our custom Packet Accelerator Chip™ has our DOXport cable modems running at maximum speed—today.

Which gives cable modem users exactly what they're looking for. Speed.

And as dedicated leaders with years of development expertise in the cable modem industry, we will continue to provide innovative solutions to delivering data and telephony over cable.

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These companies, among others, have submitted cable modems to CableLabs for DOCSIS certification trials.

A cable data system consists of multiple subscriber modems and a cable modem termination system (CMTS), all connected by a cable TV plant. The CMTS can reside in the headend, distribution hub or other location depending on the plant layout.

DOCSIS is now an international standard. The Society of Cable Telecommunications Engineers, American National Standards Institute, and International Telecommunications Union have all adopted the standard.

CableLabs is testing modems for interoperability and conformance to the specs and is working toward certifying the first commercial DOCSIS modems. *Editor's note: During the first week of March 1999, CableLabs announced that cable modems manufactured by Thomson Consumer Electronics and Toshiba were the first to receive CableLabs certification under DOCSIS 1.0.* Having components available from multiple vendors means MSOs will no longer be tied into proprietary systems from a single company.

In addition to the DOCSIS 1.0 protocol, which many vendors are implementing, CableLabs has begun defining versions 1.1 and 1.2. DOCSIS 1.1 includes extensions to the media access control (MAC) layer protocol. DOCSIS 1.2 includes extensions to the physical layer (PHY) protocol. (See the sidebar on page 144.)

DOCSIS protocol stack

The protocols chosen for DOCSIS, from the modulation schemes up to the networking protocols, all have specific functions. The relationships among these functions are shown in a protocol stack.

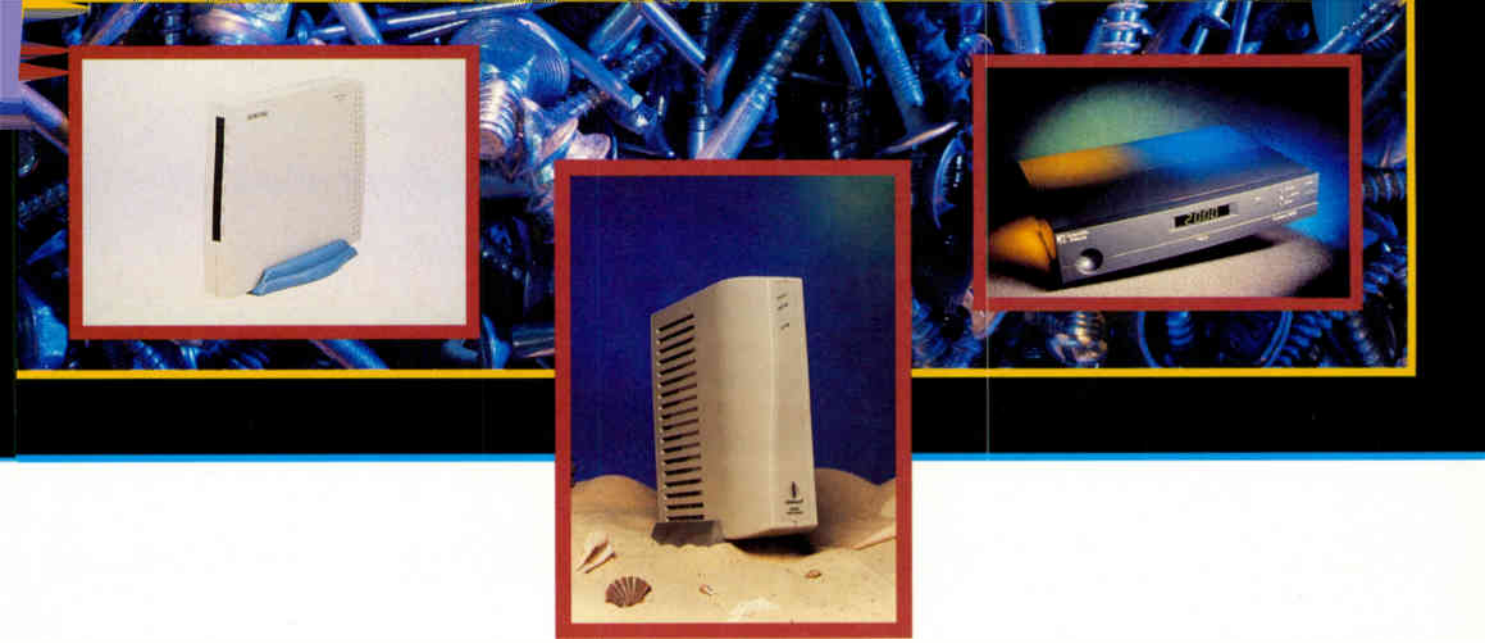
The accompanying figure (on page 138) shows such a stack for a DOCSIS modem. The lower four protocols are specific to cable data networks and are present only between the modem and CMTS over the cable network. The higher layer protocols, Internet protocol (IP) and above, are carried by the DOCSIS layers across the cable network and are used for Internet communication.

The modem performs the lower four protocols shown in the figure. The modem will receive an IP packet (over Ethernet, universal serial bus, or USB, and so on) from the host customer premise equipment (CPE) and will add link encryption, mediate access to the return path and modulate the data onto the cable network. Note, the Moving Pictures Experts Group (MPEG-2) layer is present only on the forward path of the cable data system.

Above the DOCSIS protocol layers is the IP layer. This protocol is the glue that binds together the Internet. The layers at the very top of the figure are Internet service protocols, such as mail, news, Web, and such, and are beyond our scope here. However, DOCSIS is designed for use with these protocols; hence, DOCSIS is expected to grow as the Internet grows.

A short overview of the four lower layers in the figure follows:

- PHY includes the modulation schemes used on the coax network. These are 64- and 256-QAM (quadrature amplitude modulation) on the forward and quadrature phase shift keying (QPSK) and 16-QAM on the reverse.
- The MPEG-2 transmission convergence (TC) layer (downstream only) means DOCSIS modem data is encapsulated in 188-byte MPEG-2 frames. This allows modem data to be multiplexed with other MPEG streams on the same forward path RF carrier. An example would include sending MPEG-2 video and audio on the same carrier as MPEG-2 encapsulated DOCSIS data.
- MAC layer controls modem access to the return path. Because there may be many modems trying to transmit simultaneously on the return path, the MAC protocol provides an orderly method for the CMTS to tell a modem when it can transmit and for how long.
- The data link encryption layer protects user data. Because the cable network is shared, there must be a method to protect user data from malicious users. DOCSIS has defined baseline privacy.



Protocol descriptions

PHY protocol: The PHY protocol describes the modulation formats for the cable network, both forward and reverse paths.

DOCSIS RF channel model: The starting point was to describe both forward and return path channel models that are the worst-case RF channels in which a DOCSIS cable data system has to operate.

In the forward direction, we assume the cable has a passband with a lower edge at 50 MHz and an upper edge that is implementation-dependent but typically is in the range of 300 MHz to 860 MHz. Within that passband, we assume that NTSC analog TV signals in 6-MHz channels are present on either of the standard, harmonically related carriers (HRC) or incrementally related carriers (IRC) frequency plans (EIA/ANSI-542) as well as other narrowband and wideband digital signals.

In the upstream direction, the cable system may have a subsplit (5-30 MHz) or extended subsplit (5-42 MHz) passband. NTSC analog TV signals in 6-MHz channels, as well as other signals, may be present on the reverse path.

A modem, configured with at least one set of defined PHY parameters (such as modulation, forward error correction, symbol rate) from the range of settings described in DOCSIS, must be capable of operating with a packet loss rate of less than 1 percent (assuming 1,500-byte packets), while forwarding at least 100 packets per second on cable networks having characteristics as defined in the following sections.

Downstream RF channel model: Table 1 (on page 138) illustrates the minimum RF channel transmission characteristics of the cable network in the downstream direction. This assumes nominal analog visual carrier level in a 6-Mhz channel bandwidth. All conditions are present concurrently.

Upstream RF channel model: Table 2 (on page 139) shows the minimum RF channel transmission characteristics of the cable network in the upstream direction. All conditions are present concurrently.

Forward path modulation format: The downstream PHY is based on ITU-T Recommendation J.83 (04/97), Digital Transmission of Television Signals, Annex B (ITU-T J.83B). This revision of ITU-T J.83B includes not only the original 64-QAM modulation and a fixed depth interleaver used to deliver digital video, but also includes 256-QAM for higher downstream channel data rates as well as a variable depth interleaver. DOCSIS-compliant downstream channels may occupy any 6-MHz band between 88 MHz and 860 MHz.

This 64-QAM modulation format is in use by many digital video applications. The 256-QAM modulation format has been proven in extensive tests and is being deployed by some operators. The reliability of QAM-modulated downstream channels is ensured because of the powerful concatenated forward error correction (FEC) provided by the ITU-T J.83B specification.

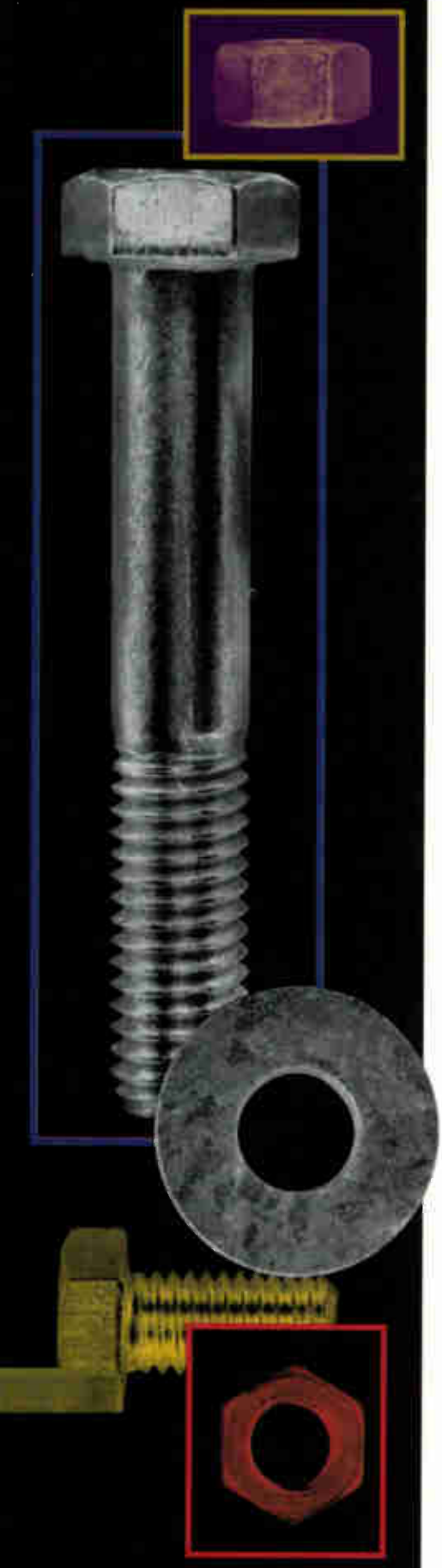
Multiple layers of error detection and correction, coupled with variable-depth interleaving to provide variable-length burst error resilience, deliver error rates ensuring customer satisfaction. The high data rates together with the low error rates provide a bandwidth-efficient delivery mechanism for digital data delivery.

Forward channels: The modem must accept an RF modulated signal with characteristics as described in Table 3 (on page 139). The output signal level of the CMTS is variable over the range of 50 dBmV to 61 dBmV.

The plant has to be tuned such that the modem receives the proper electrical input at end-of-line (EOL).

It is important to note that deploying 256-QAM channels requires higher carrier-to-noise ratio (C/N) than when deploying 64-QAM channels. This is one of the first choices to make when deploying DOCSIS modems: deciding which mode of operation to use for downstream channels.

In a clean hybrid fiber/coax (HFC) plant that currently delivers an equivalent video signal-to-noise ratio (S/N) of 49 dB or greater, the system may well support 256-QAM downstream channels to compete with satellite delivery services. However, if the plant consists of longer cascades working nearer to the Federal Communications Commission minimum specifications, consider deploying 64-QAM channels. ➤



DOCSIS cable modem protocol stack

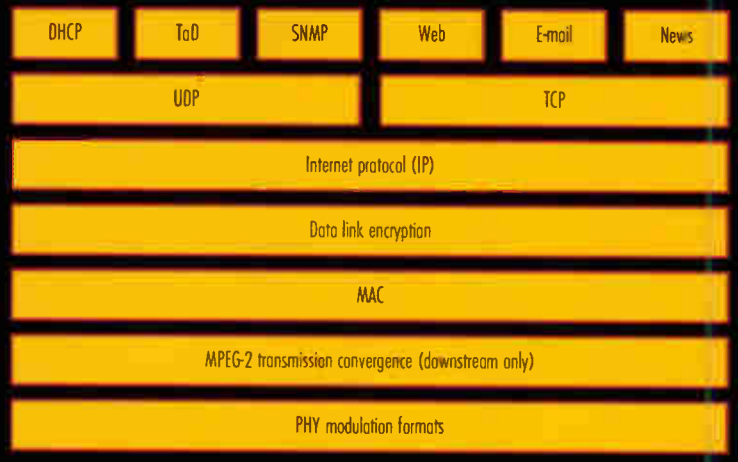


Table 1: Assumed downstream RF channel transmission characteristics

Parameter	Value
Frequency range	From 50 MHz to as high as 860 MHz (the values in this table apply only at frequencies >= 88 MHz)
RF channel spacing (design bandwidth)	6 MHz
Transit delay from headend to most distant customer	<= 0.800 msec (typically much less)
C/N ratio in a 6 MHz band (analog video level)	Not less than 35 dB (Note 4)
Carrier-to-interference ratio for total power (discrete and broadband ingress signals)	Not less than 35 dB within the design bandwidth
CTB for analog modulated carries	Not greater than -50 dBc within the design bandwidth
CSO distortion for analog modulated carriers	Not greater than -50 dBc within the design bandwidth
XMOD level	Not greater than -40 dBc within the design bandwidth
Amplitude ripple	0.5 db within the design bandwidth
Group delay ripple in the spectrum occupied by the CMTS	75 ns within the design bandwidth
Micro- reflections bound for dominant echo	-10 dBc @ <= 0.5 msec -15 dBc @ <= 1.0 msec -20 dBc @ <= 1.5 msec -30 dBc @ > 1.5 msec
Carrier hum modulation	Not greater than -26 dBc (5%)
Burst noise	Not longer than 25 msec at a 10 Hz average rate
Seasonal and diurnal signal level variation	8 dB
Signal level slope, 50-750 MHz	16 dB
Maximum analog visual carrier level at the CM input, inclusive of above signal level variation	17 dBmV
Lowest analog visual carrier level at the CM input, inclusive of above signal level variation	-5 dBmV

Notes

1. Transmission is from the headend combiner to the CM input at the customer location.
2. For measurements above the normal downstream operating frequency band (except hum), impairments are referenced to the highest-frequency NTSC carrier level.
3. For hum measurements above the normal downstream operating frequency band, a continuous-wave carrier is sent at the test frequency at the same level as the highest-frequency NTSC carrier.
4. This presumes that the digital carrier is operated at analog peak carrier level. When the digital carrier is operated below the analog peak carrier level, this C/N may be less.

Measurements methods by NCTA, *Recommended Practices for Measurements on Cable Television Systems, 2nd Edition*

Table 2: Assumed upstream RF channel transmission characteristics

Parameter	Value
Frequency range	5 to 42 MHz edge-to-edge
Transit delay from the distant CM to the nearest CM or CMTS	<= 0.800 msec (typically much less)
C/N ratio	Not less than 25 dB
Carrier-to-ingress power (the sum of discrete and broadband ingress signals) ratio	Not less than 25 dB (Note 2)
Carrier-to-interference (the sum of noise, distortion, CPD and XMOD) ratio	Not less than 25 dB
Carrier hum modulation	Not greater than -23 dBc (7%)
Burst noise	Not longer than 10 msec at a 1 kHz average rate for most cases (Notes 3,4 and 5)
Amplitude ripple	5-42 MHz: 0.5 dB/MHz
Group delay ripple	5-42 MHz: 200 ns/MHz
Micro-reflections — single echo	-10 dBc @ <= 0.5 msec -20 dBc @ <= 1.0 msec -30 dBc @ > 1.0 msec
Seasonal and diurnal signal level variation	Not greater than 8 dB minimum to maximum

Notes
1. Transmission is from the CM output at the customer location to the headend.
2. Ingress avoidance or tolerance techniques may be used to ensure operation in the presence of time-varying discrete ingress signals that could be as high as 0 dBc (CableLabs).
3. Amplitude and frequency characteristics sufficiently strong to partially or wholly mask the data carrier.
4. CableLabs report containing distribution of return-path burst noise measurements and measurement method is forthcoming.
5. Impulse noise levels more prevalent at lower frequencies (< 15 MHz).

Table 3: Electrical input to cable modem

Parameter	Value
Center frequency	91 to 857 MHz ±30 kHz
Level range (one channel)	-15 dBmV to +15 dBmV
Modulation type	64-QAM and 256-QAM
Symbol rate (nominal)	5.056941 Msym/sec (64-QAM) and 5.360537 Msym/sec (256-QAM)
Bandwidth	6 MHz
Total input power (40-900 MHz)	<30 dBmV
Input (load) impedance	75 ohms
Input return loss	>6 dB (88-860 MHz)

Table 4: Interleaver characteristics

I (#of Taps)	J (Increment)	Burst protection 64-QAM/256-QAM	Latency 64-QAM/256-QAM
8	16	5.9 µsec/4.1 µsec	0.22 msec/0.15 msec
16	8	12 µsec/8.2 µsec	0.48 msec/0.33 msec
32	4	24 µsec/16 µsec	0.98 msec/0.68 msec
64	2	47 µsec/33 µsec	2.0 msec/1.4 msec
128	1	95 µsec/66 µsec	4.0 msec/2.8 msec

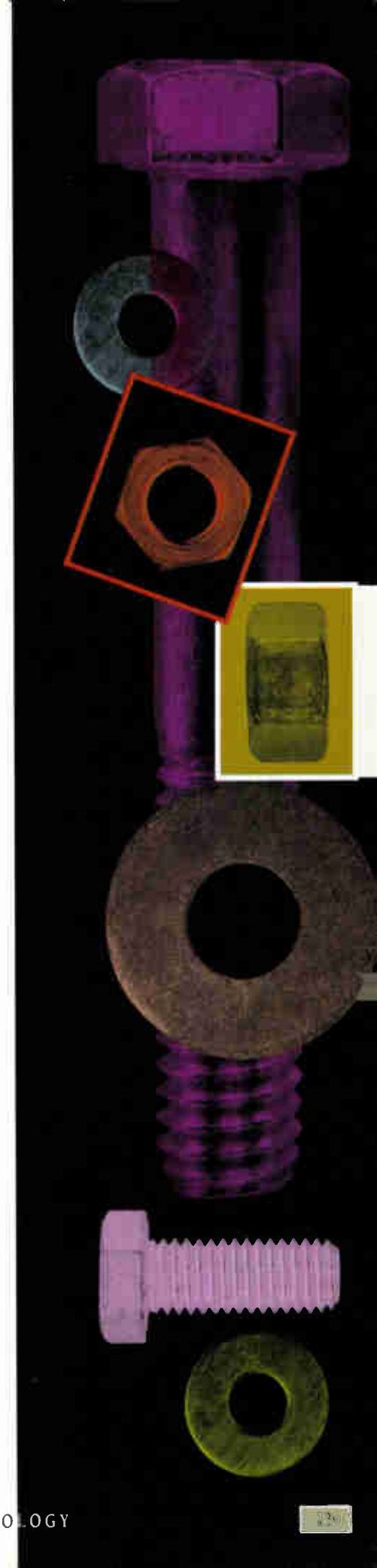


Table 5: Maximum channel width

Symbol rate (ksym/sec)	Channel width (MHz)[1]	QPSK rate (Mbps)	16-QAM rate (Mbps)
160	0.20	0.32	0.64
320	0.40	0.64	1.28
640	0.80	1.28	2.56
1,280	1.60	2.56	5.12
2,560	3.20	5.12	10.24

Note: Channel width is the -30 dB bandwidth

Variable-depth interleave: The forward path modulation formats support a variable-depth interleaver with the characteristics defined in Table 4 (on page 139).

Variable-depth interleave is a form of error protection. Based on the level of interleave, the data on the forward path is protected from noise burst lengths as described in Table 4.

Even with reduced noise margins, the downstream channels are designed to deliver 64-QAM signals with a bit error rate (BER) of less than 10^{-8} at a C/N of 23.5 dB.

You can expect 256-QAM channels to deliver a similar BER at 30 dB C/N. An additional benefit from the strength of this FEC is that it permits operation of the downstream digital data channels 10 dB lower than the nominal level of video carriers on the system. This helps minimize system loading while still delivering robust digital data services.

One of the side effects of the interleaver is it adds latency downstream. The process of interleaving—shuffling the position of the symbols so that normally adjacent related symbols are now separated by unrelated symbols that would otherwise be transmitted later—delays delivery.

The benefit is that a burst of noise damages only unrelated symbols. The FEC can correct the damage once the symbols are reshuffled into their normal order as long as the damage did not span too many related symbols.

There is an intrinsic relationship between the depth of the interleaving and the latency incurred. The deepest interleaving available in the DOCSIS RF specification provides 95 µsec burst protection at the cost of 4 msecs of latency. Four msecs of latency is insignificant when watching digital video or using standard Internet data services such as Web browsing, e-mail and file transfer.

However, when you engineer near real-time constant bit rate (CBR) services

BOTTOM LINE

DOCSIS in Detail

The premise behind the Data Over Cable Service Interface Specification (DOCSIS) is having interoperable modems from multiple vendors. CableLabs completed the main specification work in March 1997, and in March 1998 certified the first commercial DOCSIS modems from two vendors.

A cable data system consists of multiple modems in subscriber locations and a cable modem termination system (CMTS), all connected by a cable TV plant. Having all components available from multiple vendors means multiple system operators (MSOs) will no longer be tied into proprietary systems.

DOCSIS currently is an international standard. It has been adopted by the Society of Cable Telecommunications Engineers, American National Standards Institute and International Telecommunications Union.

In addition to DOCSIS 1.0, CableLabs has begun defining versions 1.1 and 1.2 of the protocol. DOCSIS 1.1 includes extensions to the media access control (MAC) layer protocol. DOCSIS 1.2 includes extensions to the physical layer (PHY) protocol.

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NEW AM1	250-3000	36	18	2.7	75

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> "Having components available from multiple vendors means MSOs will no longer be tied into proprietary systems available from a single company."

(such as telephony) that have tight end-to-end latency requirements, you'll need to consider latency.

The variable depth interleaver enables the engineer to trade between how much burst error protection is required and how much latency can be tolerated by the services. The CMTS also can dynamically control the depth of interleave based on RF channel conditions.

Return path modulation format: DOCSIS specifies both QPSK and 16-QAM modulation formats in the return path. Return path channels can be between 5 MHz and 42 MHz.

The return path channel uses time division multiple access (TDMA). Using TDMA, the upstream channel is divided into equal-time segments called mini-slots. A mini-slot is nominally 16 bytes long, but can be up to 128 bytes (in powers of two).

The CMTS controls the use of each mini-slot. The CMTS assigns contiguous intervals of mini-slots to individual modems to transmit in, or makes them available for contention by groups of modems to transmit in, or opens them up for contention by all modems.

DOCSIS-compliant modems must time-coordinate their upstream transmissions so that they transmit only within appropriately allocated mini-slots.

Return channels: The modem modulator must provide both QPSK and 16-QAM, at symbol rates and channel widths as described in Table 5 (on page 140).

The modem return path modulator must operate over the following power ranges.

- QPSK: 8 to 58 dBmV
- 16-QAM: 5 to 55 dBmV

As can be seen in Table 5, each upstream channel has an assigned bandwidth, and the occupied bandwidth is related to the data rate of the channel.

DOCSIS-compliant upstream channels occupy bandwidths of 0.20, 0.40, 0.80, 1.60 or 3.20 MHz. These correspond to channel symbol rates of 160, 320, 640, 1,280 and 2,560 kilosymbols per second (ksym/sec). Upstream QPSK and 16-QAM transmissions modulate two bits per symbol or four bits per symbol respectively.

Therefore, channel data rates are available between 320 kbps (QPSK at 160 ksym/sec) and 10.24 Mbps (16-QAM at 2,560 ksym/sec). While the bandwidth is fixed for any upstream channel because the symbol rate is defined for that channel, the bit rate on the channel is variable because independent transmissions on that channel can be either QPSK or 16-QAM.

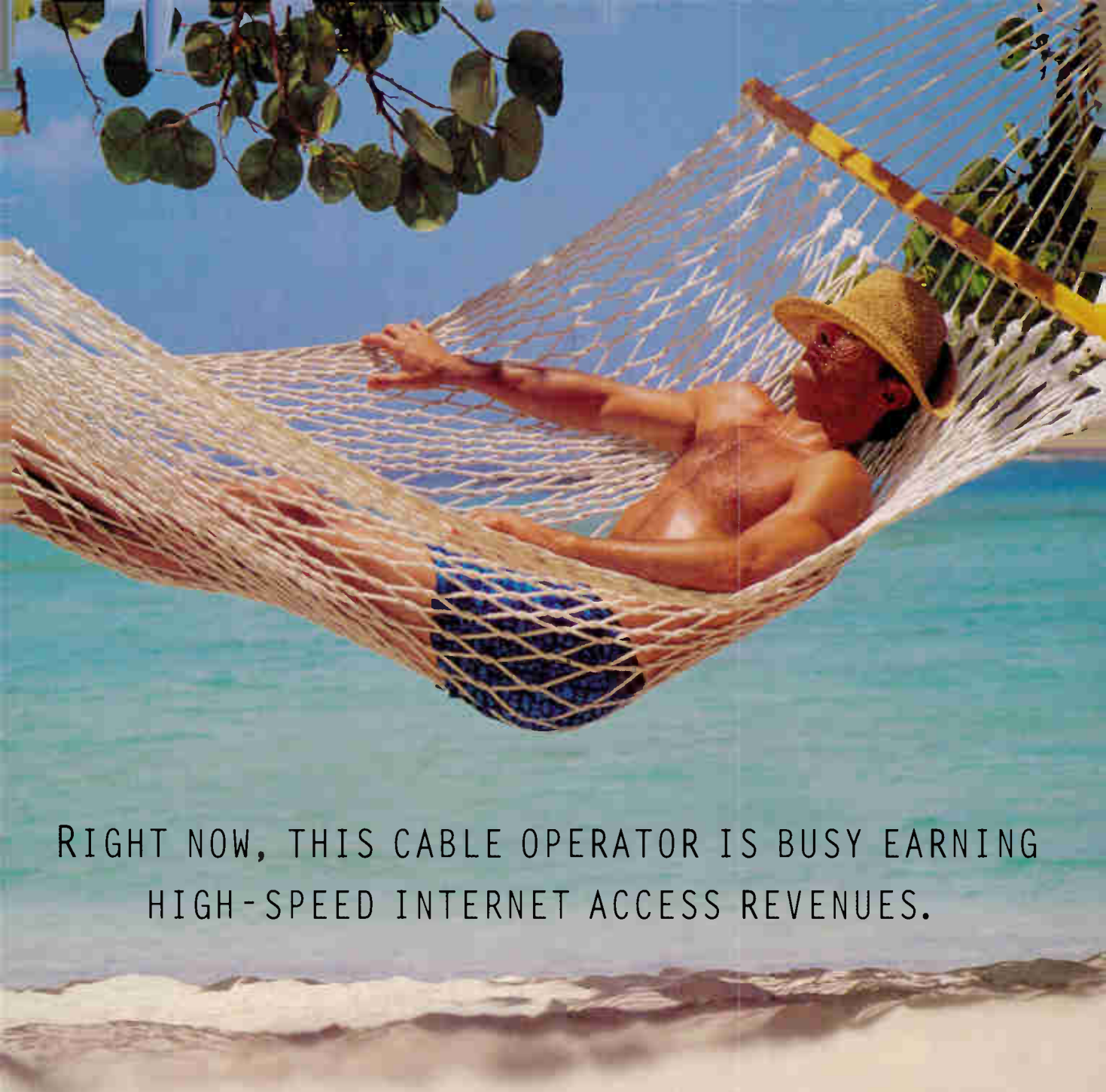
FEC: The DOCSIS flexible upstream FEC coding enables the system operator to set the size of the error-protected data blocks and to set the number of correctable errors within each block.

In proprietary modem systems, when impairments in a data channel caused too many errors, the only solution was to abandon that frequency and hop the channel to a cleaner and unoccupied portion of the spectrum. While DOCSIS systems can operate this way, the FEC coding enables the system operator to stay on the same frequency by dynamically adding error protection on that channel. Adding error protection reduces the channel information rate a small amount.

Transmission convergence protocol (MPEG-2)

A TC protocol allows multiple services to share the same RF carrier. For DOCSIS, the TC layer is MPEG-2, which is used widely in cable TV networks. MPEG-2 enables cable operators to send voice, video and data in the same forward path channel as long as all three traffic types are encapsulated with MPEG-2.

MPEG-2 enables a modem or set-top to identify individual packets within



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Current and Future Directions

Data Over Cable Service Interface Specification (DOCSIS) 1.0 is stable and supported by a wide array of networking companies, consumer electronic companies and traditional cable suppliers.

DOCSIS 1.1 includes extensions to the protocol for enhanced services over cable data networks, such as voice over Internet protocol (VoIP), video over IP, and guaranteed, differentiated levels of service for such applications as Web browsing, e-mail, news reading and so on. In addition, baseline privacy is planned to be extended to offer certificate-based (X.500) authentication of modems. Finally, DOCSIS is pursuing additional return path modulation formats.

Quality of service (QoS) extensions: DOCSIS 1.0 QoS provides for tiered "best effort" service. Data through each modem can be throttled to maximum upstream and downstream rates. These maximum rates are not guaranteed; they are only upper limits. Also, all data through a modem are combined and are subject to these limits. There is no way to differentiate one type of data and give it different traffic characteristics. All data through the modem are treated the same.

DOCSIS 1.1 provides extensions for additional QoS functionality such as packet classification and identification, service flows, flow scheduling, and dynamic service establishment.

These extensions allow data to be given differentiated traffic services within the system. For a given modem, traffic can be given differentiated priority based on the type, origin and destination. This work is aligned with the IP QoS traffic models currently being developed by the Internet Engineering Task Force.

Media access control (MAC) layer fragmentation: QoS, as discussed previously, provides a method to offer differentiated services to cable data users. But in a heavily loaded network, an additional tool is needed to ensure that all service guarantees are met.

When loads are heavy, it makes sense to control the size of data packets on the return path to ensure the cable modem termination system (CMTS) can schedule transmit opportunities for certain modems when those opportunities are needed to maintain differentiated service.

To control the size of upstream data packets, MAC layer fragmentation enables the CMTS to instruct a modem to fragment a large upstream frame into several smaller frames. Each of the smaller frames is then scheduled individual transmit times. By breaking up large upstream data packets, the CMTS allows itself more flexibility when scheduling return path transmissions for other modems.

Baseline privacy (BPI) extensions: The original BPI specification had limited service protection because the BPI protocol did not authenticate modems. BPI+ strengthens this service protection by adding digital certificate (X.500) modem authentication.

Under BPI+, the CMTS protects against unauthorized access to data services by enforcing encryption of the associated traffic flows across the RF network. BPI+ employs an authenticated client/server key management protocol in which the CMTS controls distribution of keying material to client modems. This work is part of DOCSIS 1.1.

Upstream modulation extensions: DOCSIS 1.0 includes time division multiple access (TDMA) frame format using both quadrature phase shift keying (QPSK) and 16-QAM (quadrature amplitude modulation) as the upstream modulation formats. In conjunction with the Society of Cable Telecommunications Engineers Data Standards Subcommittee and the Institute of Electrical and Electronics Engineers 802.14 committee, DOCSIS is working to standardize additional return path formats. These planned formats include advanced TDMA technology; synchronous code division multiple access (S-CDMA); and adding 8-QAM, 32-QAM, 64-QAM and 128-QAM modulation formats.

These formats provide both higher capacity upstream channels for clean plant and more robust coding techniques for marginal plant. This work is expected to be completed during 1999.

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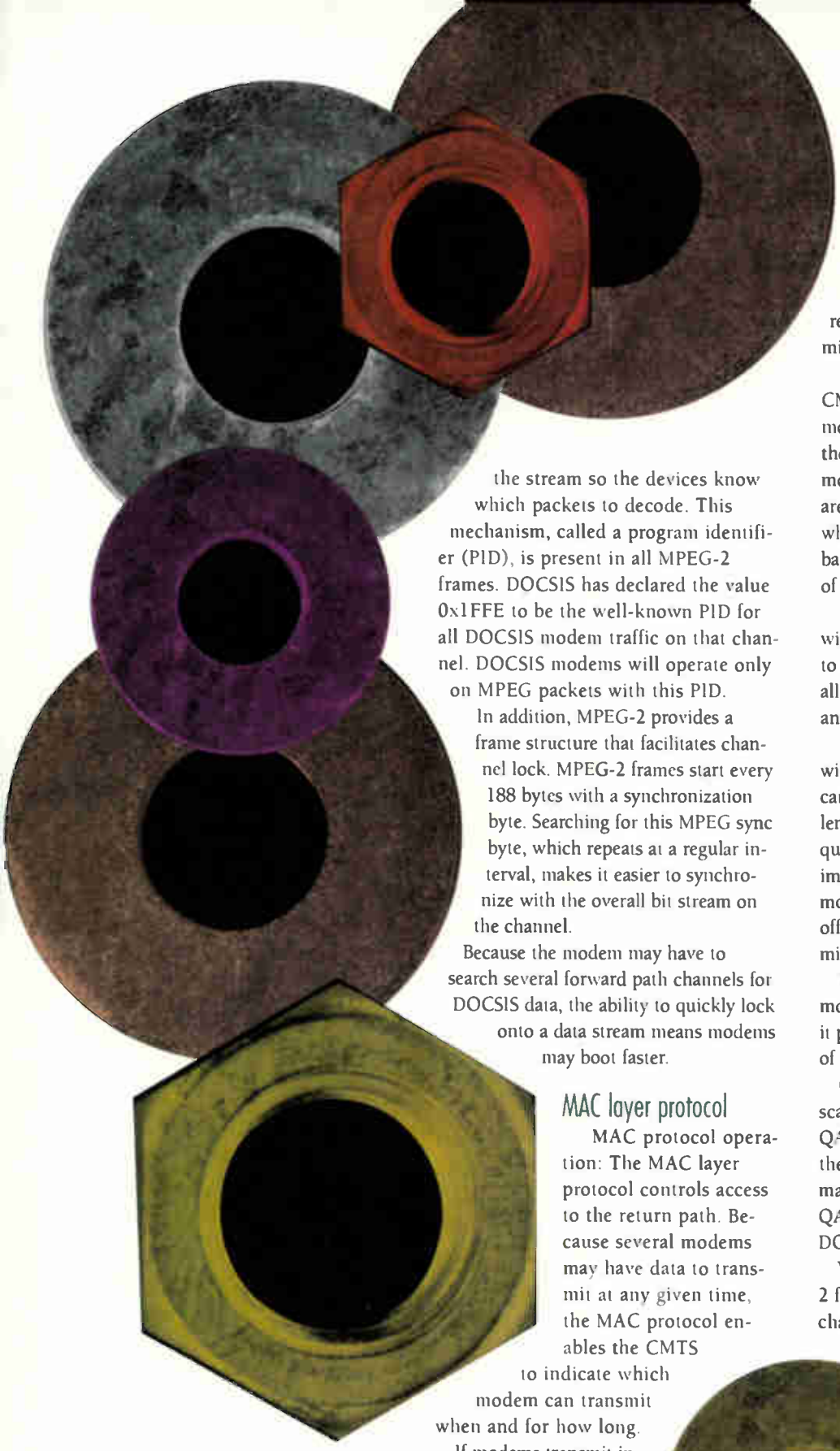

the stream so the devices know which packets to decode. This mechanism, called a program identifier (PID), is present in all MPEG-2 frames. DOCSIS has declared the value 0x1FFE to be the well-known PID for all DOCSIS modem traffic on that channel. DOCSIS modems will operate only on MPEG packets with this PID.

In addition, MPEG-2 provides a frame structure that facilitates channel lock. MPEG-2 frames start every 188 bytes with a synchronization byte. Searching for this MPEG sync byte, which repeats at a regular interval, makes it easier to synchronize with the overall bit stream on the channel.

Because the modem may have to search several forward path channels for DOCSIS data, the ability to quickly lock onto a data stream means modems may boot faster.

MAC layer protocol

MAC protocol operation: The MAC layer protocol controls access to the return path. Because several modems may have data to transmit at any given time, the MAC protocol enables the CMTS to indicate which modem can transmit when and for how long.

If modems transmit individually, data collisions won't occur on the return path, and the system will operate efficiently. When collisions occur, modems have to retransmit that data, which is an inefficient usage of the return path.

The DOCSIS MAC protocol provides a request/grant mechanism. A modem requests from the CMTS an opportunity to transmit a certain amount of data. As the CMTS receives requests from all the modems, it reserves mini-slots on the return path.

Periodically (every few msecs), the CMTS broadcasts a message to the modems over the forward path indicating the specific mini-slots granted to each modem. By reserving bandwidth, modems are guaranteed a collision-free interval in which to transmit. The CMTS allocates bandwidth to modems based on the types of service the user subscribes to.

For a modem to request bandwidth without first having been allocated a time to send a message, the CMTS periodically allocates part of the return channel for any modem to send a request.

A request from one modem may collide with a request from another. The CMTS can detect this and can vary both the length and frequency of the contention request intervals to keep collisions to a minimum. In the event of a collision, the modems that sent the messages will back off at random intervals and then retransmit their requests.

Modem registration process: As a modem boots on the cable data network, it performs many functions. Descriptions of each follow.

Channel acquisition: The modem scans for a downstream channel, obtains QAM lock and finds MPEG packets with the DOCSIS well-known PID. A modem may have to search several downstream QAM channels before finding one with DOCSIS data.

When the modem is decoding MPEG-2 frames that bear the DOCSIS PID, channel acquisition is successful. The MPEG-2 framing will be stripped away and the resultant MAC frames passed to the MAC layer for processing.

Obtain upstream parameters: The modem waits to receive three MAC messages that the

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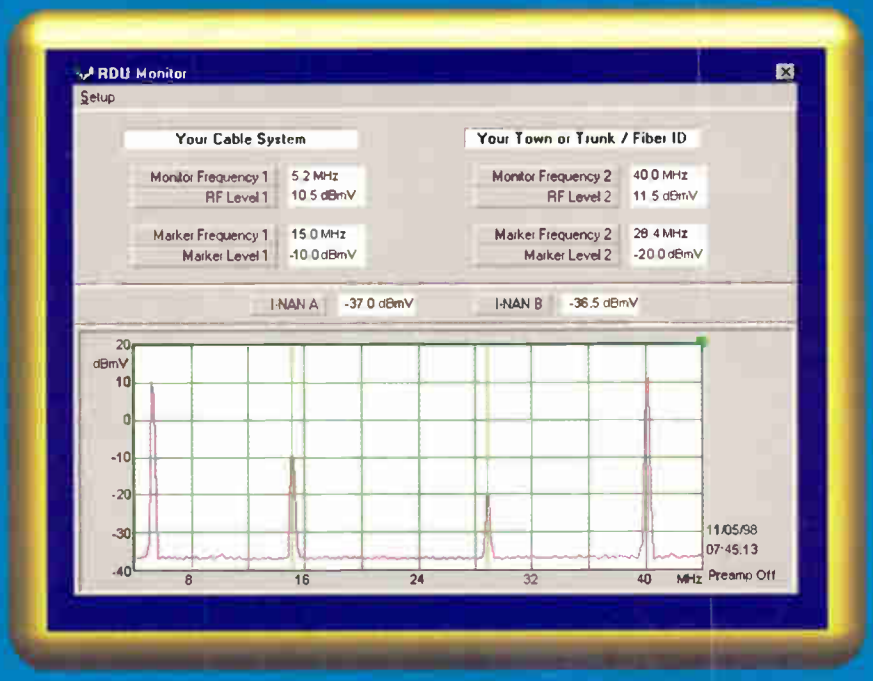

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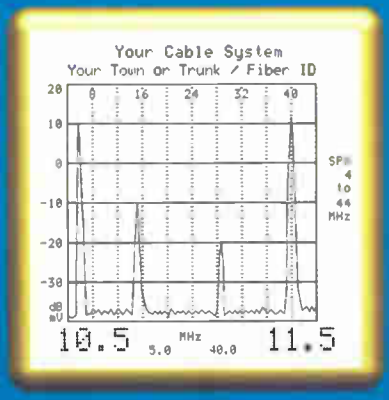

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CMTS repeatedly sends on all DOCSIS downstream channels.

The first message is the time synchronization (SYNC) message, which the CMTS sends to provide a common time reference to all modems.

The next message is the upstream channel descriptor (UCD). The modem must find a UCD that describes an upstream channel that matches that modem's capabilities. If the modem can transmit only at certain symbol rates or is limited in its frequency range and modulation, the modem may not be able to transmit on that channel.

The final message is a bandwidth allocation map (MAP) that describes transmit opportunities on the upstream channel referred to in the UCD. The MAP message contains the mini-slot information that indicates when a modem can transmit and for how long. (The SYNC provides the time reference for these transmissions, and the UCD describes the modulation format.)

For its initial transmission, the modem will look in the MAP for a transmit opportunity reserved for modems just connecting to the network, called the initial maintenance transmit opportunity.

After decoding these three messages, the modem will discover a suitable upstream channel for transmission. The modem will have a rough time reference, the modulation format of the upstream channel and knowledge of initial maintenance transmit opportunities for newly connected modems on that upstream channel.

These three pieces of information are used for the next process.

Ranging: During ranging, the modem must fine adjust the time reference, fine tune the transmit frequency, and fine adjust the transmit power. Because each modem is a unique distance from the CMTS, each modem will have unique settings for these parameters.

To begin the ranging process, the modem transmits a ranging request message to the CMTS during an initial maintenance opportunity (as described by MAP messages) on an upstream channel. The modem begins transmitting this message at the starting boundary of the initial maintenance opportunity, based on its rough time SYNC and its interpretation of the MAP. Upon receipt of this message, the CMTS sends a ranging response message addressed to that modem.

If the modem does not receive a ranging response message from the CMTS within a time-out period, one of two things may have happened. First, ranging request messages from multiple modems may collide. Second, the power level the modem is transmitting at may be too low to be detected at the CMTS.

Therefore, if the modem does not receive a ranging response message, it will both increase transmit power and wait a random number of initial maintenance opportunities before sending another request.

CMTS response: In preparing the ranging response message back to the modem, the CMTS notes the time offset from when it received the ranging request to

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the beginning of the initial maintenance transmit opportunity, the exact frequency of the transmission and the incoming power level.

Based on these data, the CMTS determines corrections and sends them back to the modem in a ranging response message. In addition, once the CMTS receives the first ranging request, the modem then can complete the ranging process by transmitting in its own mini-slots, without the chance of a collision.

Upon receipt of the ranging response, the modem adjusts its parameters based on the corrections and transmits a second ranging request to the CMTS. The CMTS again returns a ranging response with time, frequency and power corrections.

This process continues until the CMTS is satisfied with the timing, frequency and power settings being used by that modem. When finished, the timing is synchronized to within less than 1 µsec, transmit frequency to within 10 Hz and transmit power to within 0.5 dB.

The ranging process is first performed during an initial maintenance transmit opportunity when a modem connects to the network. Once booted, the ranging process is repeated for each modem at regular intervals during periodic maintenance opportunities that the CMTS schedules. Periodic tuning of timing, frequency and power ensures continued reliable communications between the modems and the CMTS even with daytime variations in the plant.

SYNC is critical to the function of the MAC protocol. SYNC requires that the two-way round trip transmission delay be negated because all upstream transmissions must align with the mini-slot timing as viewed at the CMTS.

Communication is delayed in the downstream direction by latency, downstream propagation delay and processing overhead. When the modem sends a transmission upstream, it is delayed by upstream propagation and processing overhead.

The sum of these delays is removed by the ranging process. The timing offset causes the modem to transmit earlier than the assigned mini-slot time (as measured at the CMTS) in order to negate delays caused by interleaving latency in the downstream, propagation in the system, and fixed processing overhead in both the CMTS and modem. The result is efficient use of return path bandwidth.

All further transmissions on the return path take place based on requests from the modem to the CMTS and grants from the CMTS to the modem. Whenever a modem has data to send, it will request bandwidth on the return path during a request region (as defined on a MAP). The CMTS will grant this request and schedule that modem a unique opportunity to transmit the data.

Initial ranging can be considered the DOCSIS analog to AutoDiscovery. While this term is not used by DOCSIS, AutoDiscovery is the modem being given an opportunity to transmit without first being given a grant to transmit.

The DOCSIS MAC protocol allows this by offering periodic initial

maintenance transmit opportunities on the return channel that can be used by any modem just connecting to the network. The CMTS does not have to know about these modems before they are allowed to transmit.

IP layer establishment: Once timing, frequency and power are set, the modem must establish IP connectivity. It does so by invoking the dynamic host configuration protocol (DHCP), which causes the modem to be assigned an IP address.

DHCP runs between the modem and a DHCP server administered by either the MSO or some other service provider. As long as that modem is active, it will be leased an IP address to use. After a period of inactivity, that IP address can be reclaimed and given out to another active modem, thereby conserving IP address space.

Once an IP address is obtained, the modem requests time of day (ToD) to get the real date and time. This differs from the SYNC message, which simply maintains a continuous 32-bit counter that reflects time ticks in the MAC layer. The ToD information is what a human would consider the true time and date; the modem maintains this time so it can timestamp certain messages and log files.

Registration: Registration begins with the modem downloading a configuration file. The IP address of a configuration file server and the name of the configuration file the modem is to download are both included in the DHCP response to the modem.

The modem uses the trivial file transfer protocol (TFTP) to download the configuration file from a server. The configuration file contains information such as how much bandwidth the modem is allowed to use and what services it is allowed to provide.

Your customer service agents take this information when the subscriber first calls in to request modem service. That information is fed into a back-end system to create the configuration file.

During the final registration phase, the modem sends a message to the CMTS confirming the configuration file it received. The CMTS also retrieves a copy of the configuration file from the configuration file server.

The CMTS compares the file from the server with the data from the modem to ensure the modem will be using only authorized services. Only after the configuration file data is cross-checked by the CMTS is the modem finally allowed to transmit real user data onto the network.

Data link encryption

Once the modem is registered and sending data, DOCSIS provides a method for data link encryption, called the baseline privacy interface (BPI). The BPI provides users with data privacy across the RF network by encrypting traffic flows between a modem and the CMTS.

Because data privacy is the principal service goal of BPI, the BPI encryption key distribution protocol does not

currently authenticate the modem via mechanisms such as passwords or digital signatures.

Even though BPI does not authenticate modems, other reliable methods are available to detect such clones in DOCSIS 1.0. Authentication is to be included in a future release of DOCSIS. BPI provides basic protection by ensuring that a modem, uniquely identified by its 48-bit IEEE MAC address, can obtain keying material only for services it is authorized to access.

The BPI key management protocol uses the Rivest-Shamir-Adelman (RSA) algorithm, a public-key encryption method, and the electronic code book (ECB) mode of the Data Encryption Standard (DES) (FIPS-81) to secure key exchanges between the modem and CMTS.

Modems must have factory-installed RSA private/public key pairs or provide an internal algorithm to generate such key pairs dynamically. The actual keys for encrypting data use the Cipher Block Chaining (CBC) mode of DES (FIPS-46, FIPS-46-1, FIPS-74, FIPS-81) to encrypt data in both upstream and downstream frames.

The BPI protocol supports periodic reauthorization and changing of the data encryption keys, which are single DES (1-DES). The frequency of change of the keys is an operator-determined parameter. These keys can be established for very long periods of time (months) or changed as often as every 30 seconds.

In BPI, the conditional access system (CAS) is based on public key and symmetric key cryptography. The content security is based on symmetric key cryptography. The algorithms, RSA public key encryption and DES symmetric key encryption, are widely used.

In a symmetric key system such as DES, both parties share the same key to communicate securely. Although symmetric key systems can be very secure, the difficulty is providing the key initially to the parties in a secure fashion.

In public key cryptography, any messages generated with the public key can be decrypted only by the private key. Likewise, any message generated with the private key can be decrypted only by the public key. Judicious use of public/private keys (with the private key uniquely assigned to a modem, headend or CAS) can provide secure communications between parties as well as secure distribution of symmetric keys.

DOCSIS telephone return

DOCSIS has a complete description available for modems that use the telephone network, instead of a cable network return path, for communication back to the CMTS. A DOCSIS telephone return modem system allows deployment of DOCSIS-compliant modems in areas where two-way plant is not available. CT

Doug Jones is a network architect for MediaOne Labs. He may be reached at (303) 404-8104 or dxjones@MediaOne.com.

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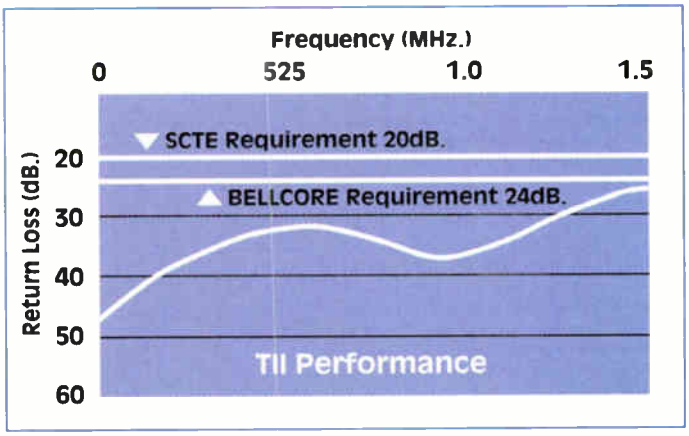

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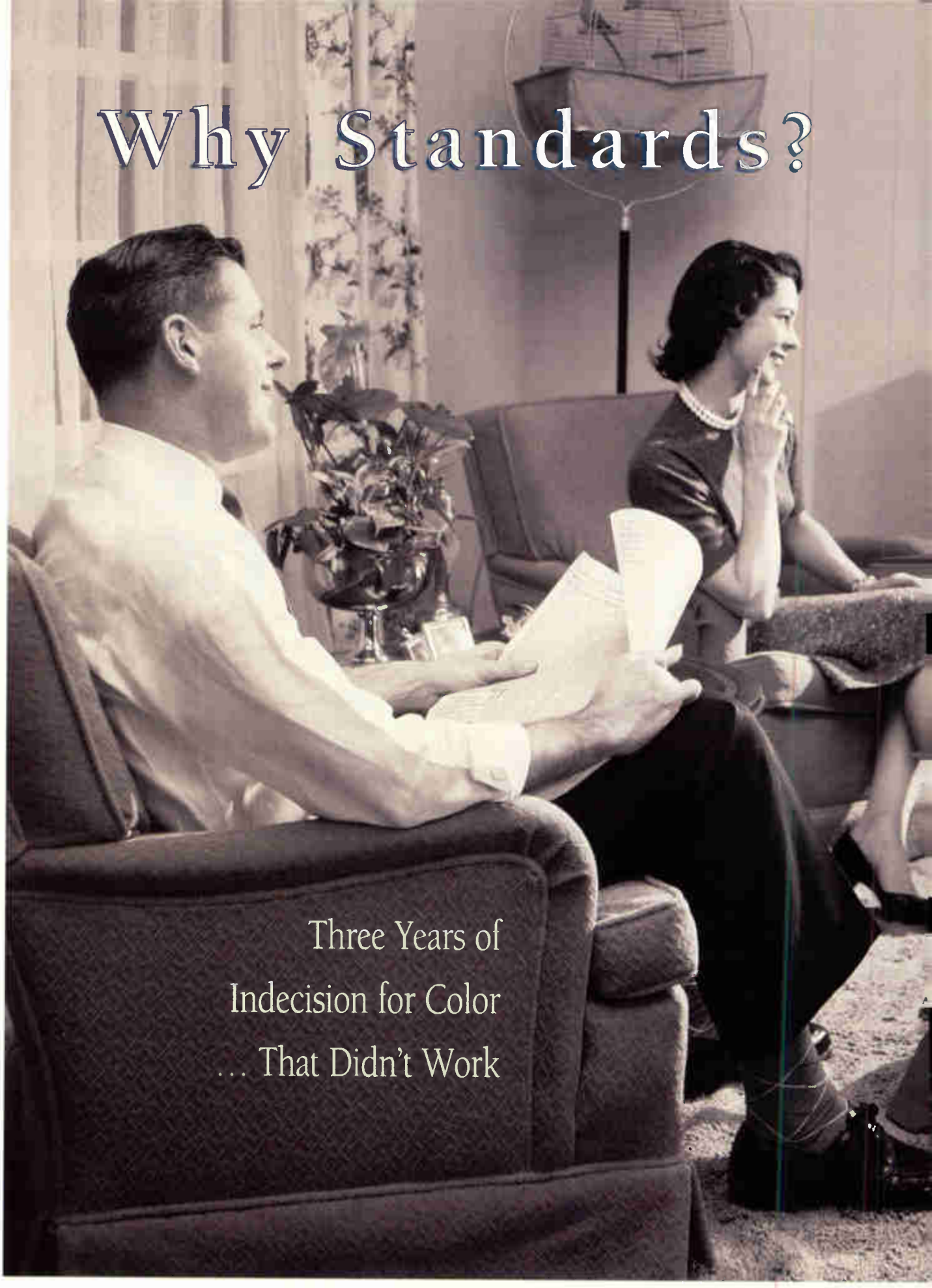
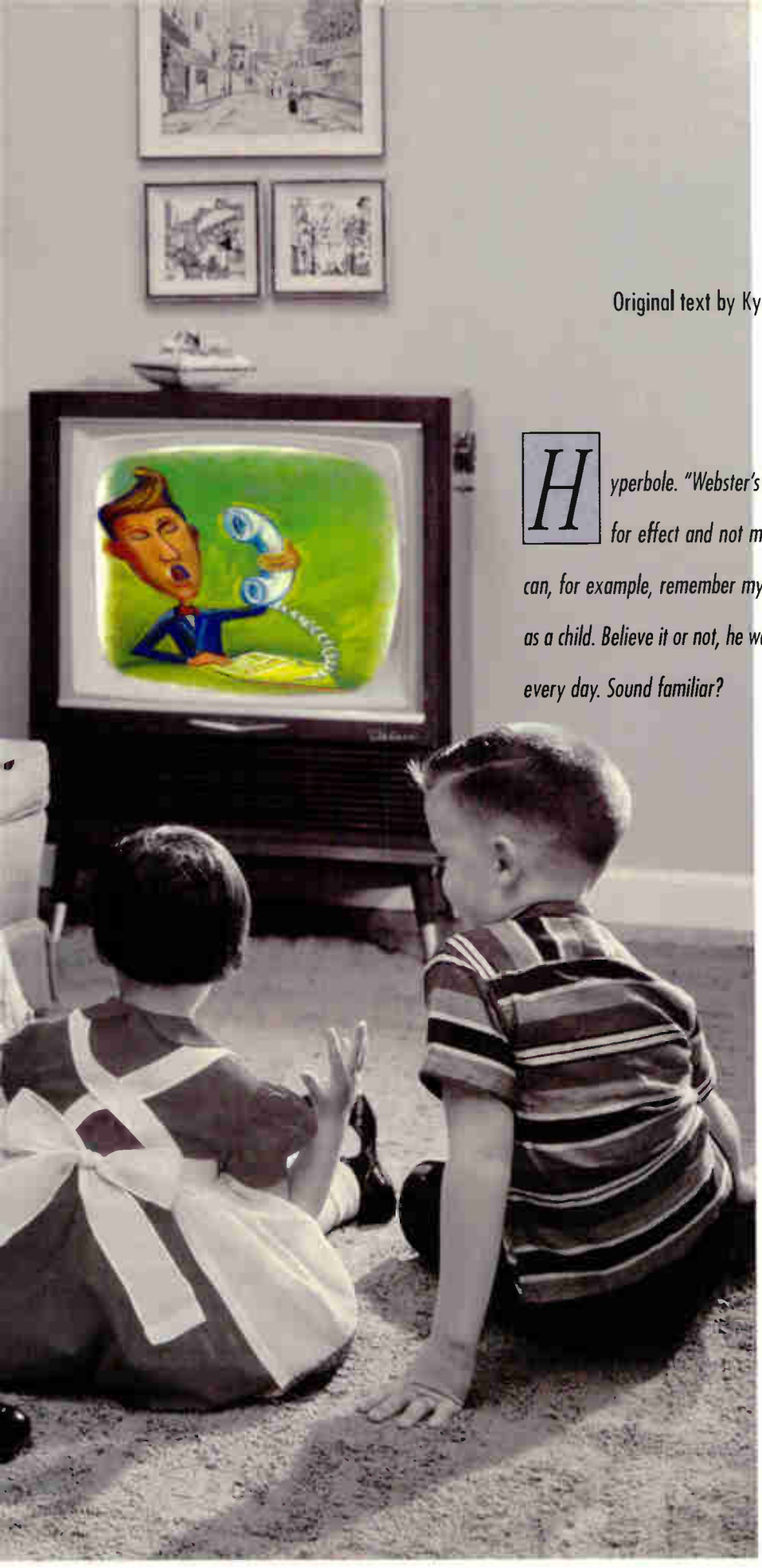


Three Years of Indecision for Color ... That Didn't Work



Original text by Kyle Moore; foreword by Doug Larson

Hyperbole. "Webster's New World Dictionary" defines it as "exaggeration for effect and not meant to be taken literally." My dad mastered it. I can, for example, remember my father relating tales of the hardships he suffered as a child. Believe it or not, he walked uphill in five feet of snow to and from school every day. Sound familiar?

He obviously was fibbing (he grew up in South Texas, after all), but his message was loud and clear: If you think you've got it hard, then take a walk in my shoes. This message is more relevant to us today than ever before. We have just celebrated our 50th anniversary as an industry and are now honoring the 30th anniversary of the Society of Cable Telecommunications Engineers. Establishing standards for our highly technical hybrid fiber/coax (HFC)-supported communications network remains one of our biggest goals, and it has not always been easy.

In March, CableLabs stamped its seal of approval on the first two Data Over Cable Service Interface Specification (DOCSIS)-compliant cable modems. Despite the fact that the process had taken less than three years—a record for any industry—and will rapidly accelerate operator deployment and consumer acceptance of cable modems, many still question the need for the process and the standards. ➤

If you're one of those skeptics, I invite you to take a walk down memory lane in the shoes of those who toiled to establish color TV standards. The article to follow, originally published in "CATJ" by Kyle Moore (then president of CATA) and edited for publication in "CT," provides a blow-by-blow account of how politicians and TV set manufacturers almost set television back on its heels. At times, this account might seem hard to believe, but it is no exaggeration. It brings to mind something else my dad was wont to say, "Nothing worth having is easy." That said, let's slip back into the late '40s and early '50s.

Why talk about color?

What possible lessons can be learned from the development of a national color TV policy, as relates to our present world of (cable TV) communications?

Simply put, the manner in which the Federal Communications Commission handled the establishment of a national color TV policy illustrates, perhaps even better than the subsequent handling of the UHF fiasco, how many grave errors a federal agency can make and still stay in business. Those who believe "right will prevail" or that "the issue(s) will be settled on the merits" probably will have their bubble burst after reading this chronology. In this report, you can almost feel the electricity that existed between the two giants CBS and RCA, and one wonders how RCA representatives managed to keep their cool when Commission decision after decision went against them. In spite of our concern about their power positions today, we have to admire the RCA staff's virtually complete control over their tempers in the crazy years of 1949-1951.

> "For nearly a year, the FCC would stage a sideshow, main show and after-the-stage show."

An editorial appearing in a popular trade magazine in 1950 asked the question, "Why the Mad Rush to Color?" It was a good question. At the time, the FCC allocations freeze was well entrenched. There were 107 operating TV stations in the United States, in 63 cities. The vast majority of the country had yet to see any television, and the FCC was holding up the approval of new channels for these areas, then unserved, while it wrestled with the color standards problem.

In all probability, FCC Chairman Wayne Coy never expected the color mess to become such a burden on himself and his staff. In complete fairness to the chairman, the Commission was under the blustery and frequent attacks of Colorado Sen. Edward Johnson, who constantly badgered the Commission to approve color (new channels and so on)—yesterday.

Not compatible

To understand fully the complexity of the color issues to follow, you must understand that in 1949, when color studies began, there were two proponents of systems, CBS and RCA. The RCA system was best described as experimental and, in 1949, incapable of producing satisfactory color. The CBS system had been around for nearly 10 years, but it had one considerable flaw: It could not transmit color programs so that existing black and white receivers could receive them in black and white.

On a present-day standard of 1 to 10 (with 10 being today's color standard and 1 being black and white), RCA produced a color quality with a scale rating of 2, and CBS produced color with a scale rating of 4, which made the CBS pictures twice as good as RCA's pictures for that time, but not half as good as today's average home color pictures.

As noted previously, during this period the allocations freeze was on. No new applications for stations were being considered, and as explained in the freeze-era report, the original premise of the freeze (how to straighten out the allocations table mess) was expanded in 1949 to include straightening out the color mess.

The two problems, sufficient channels

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and approving a national set of color technical standards, interwove because the original CBS "sequential field" color system would not fit into the then (and now) standard 6 MHz-wide channel assignment.

In fact, to produce acceptable (scale rating of 6) color, the CBS system required a 12 MHz-wide channel. Had that particular color format prevailed, today we would have half as many channels. Or to put it into 1949 vernacular, the 12 VHF channels then operating would have shrunk to 6 VHF channels, each twice as wide as present channels. Because fewer than 600 VHF channels (each 6 MHz wide) could be accommodated nationwide, it followed that fewer than 300 channels (each 12 MHz wide) could be allocated with the CBS color system.

If color required 12 MHz-wide channels (as the early CBS system did), it would force the FCC to plan a nationwide TV allocation program with only half as many channels and channel assignments available as we have today. This would have had a dramatic effect on the problem of ultimate allocation of new channels, which was the original reason for the freeze.

There was talk in 1949 of placing all colorcasts into the then unexplored and untried UHF region, where a spectrum more than 400 MHz wide (adequate to handle 35 new channels, each 12 MHz wide) existed. This talk was quickly discarded because not only would existing receivers not be able to receive the programs colorcast in black and white; the existing receivers could not receive them at all. Where relatively simple black and white converters (which would make black and white reception of colorcasts possible on existing receivers) could convert existing receivers to receive color in black and white, a much more elaborate converter (costing perhaps more than the original receiver) would have been required to convert the UHF 12 MHz-wide colorcasts into standard black and white pictures.

Battle lines are drawn

CBS offered to solve the problem with a "slight reduction" in color quality, and the battle began.

Sen. Edward C. Johnson was one of the early advocates of color. Some have said of the senator: "Johnson wanted to get television in Denver (a city without television when the freeze hit), and he viewed the color matter as an obstacle to getting television for his constituents. Consequently, he was quick to jump on anything the FCC did which threatened to put off television for his Colorado."

Later, because Johnson ran for and was elected as governor of Colorado, others would say in looking over his record that "Johnson wanted to run on a platform that he brought television to Colorado."

Whatever his reasons, he was (it appears in historical perspective) mostly nettlesome to the Commission and did not have a profound effect on television in the country (or his state) until years later as governor.

BOTTOM LINE

The Case for Standards

We have just celebrated our 50th anniversary as an industry and are now honoring the 30th anniversary of the Society of Cable Telecommunications Engineers. Establishing standards for our highly technical hybrid fiber/coax (HFC)-supported communications network remains one of our biggest goals, and it has never been easy.

In March, CableLabs stamped its seal of approval on the first two Data Over Cable Service Interface Specification (DOCSIS)-compliant cable modems. Despite the fact that the process had taken less than three years—a record for any industry—and will rapidly accelerate operator deployment and consumer acceptance of cable modems, many questioned the need for the process and the standards.

The experience of those who toiled to establish color TV standards is sure to make believers out of cynics and skeptics alike. The three-ring circus that was the color standards process revealed a critical need for standards, while at the same time exposing the unpleasant underbelly of one of the first TV standards processes.

Still, in the summer of 1949, Johnson already was fed up with the color indecision, even though the process had hardly begun. He therefore urged the influence-free high scientific community, represented by the highly esteemed National Bureau of Standards, to select a committee of experts to study the subject.

The senator said he wanted a "comprehensive and unbiased report from an independent group, so the public can be supplied, as soon as possible, with a true picture of what we have in color and can expect in the future."

There was some low-level scratching to form such a committee for a few weeks, but it eventually drifted into oblivion.

Early in the fall of 1949, the FCC got its color TV show on the road. It had decided that it would be the unbiased expert panel, all by itself, without any help from the National Bureau of Standards.

Held in the Commission's session room in the Department of Commerce building, reams of evidence and testimony were taken from virtually every area of electronics. Just as the hearings got underway, CBS did a razzle-dazzle bit of one-upmanship and staged a private demonstration of its color system in the Armory in Washington, D.C. The demonstration was attended by invitation only, and one of the invitees was Sen. Edward C. Johnson.

Immediately after seeing the demonstration, Johnson drafted a letter to FCC Commissioners Robert F. Jones and Paul A. Walker, in which he said: "The color show was magnificent and utterly convincing proof that color TV is here now, and that all that is necessary for it to sweep the nation is for the FCC to remove the roadblocks and promulgate standards for its operation."

Then the senator added a postscript to his letter and noted, "However, the reluctance to show the FCC the facts by those who know the most about color and who can most effectively demonstrate its development disturbs me."

After writing his glowing report, Johnson was upset and wondered why CBS had not made such a presentation to the Commission. Apparently, he realized after the fact that he may have been had by CBS.

Several days later, FCC Commissioner Jones wrote CBS President Frank Stanton: "Your zeal appears to have been tar-

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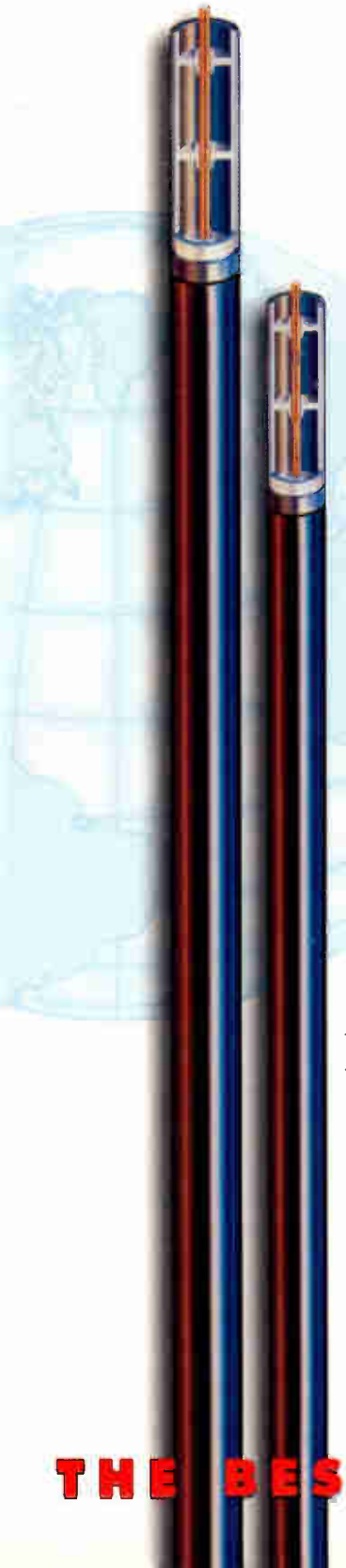

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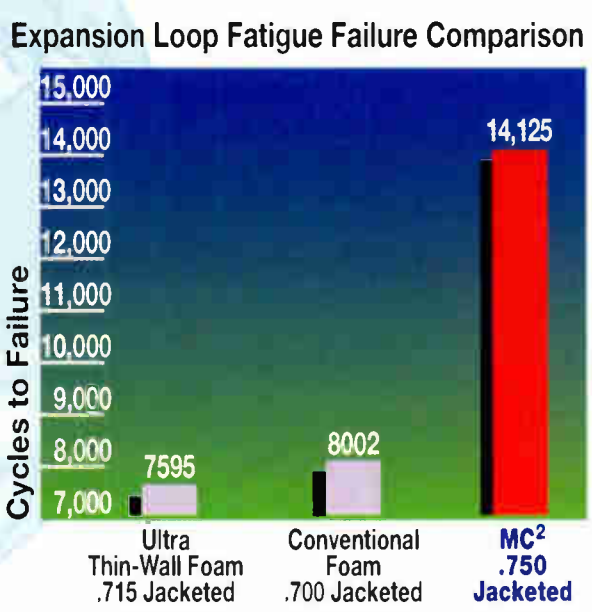

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nished. You insist on trying to promote your color system outside of the FCC hearing rooms, apparently because this Commission has taken the initiative in this matter. Your action in this matter might well lead one to the conclusion that while your company is anxious to transmit color TV, it is reluctant to permit others to operate color video receivers to appraise what you have transmitted. We must know whether laymen can operate the receivers, and we can learn this only by allowing laymen to operate the receivers under as many diverse conditions as are common in black and white."

The battle heats up

The gauntlet had been thrown down. The FCC had challenged CBS to "show off its color." After all, the commissioner reasoned, the FCC had begun hearings and was taking testimony. It would decide the fate of color. So show it the color—back up the testimony and claims.

For nearly a year, the FCC would stage a sideshow, main show and after-the-stage show. Millions would be spent by CBS, RCA and a few other latecomers as they built special sets, handcrafted color cameras and receivers, built special transmitters, and generally came in on-cue from the Commission.

Up to that time, most of the color tests had been conducted in New York. That was logical. Both CBS and RCA had headquarters and extensive production studios there.

(Virtually all TV programming originated in New York at that time, and microwave interconnection existed only between Boston and Washington, running through New York.)

However, to accommodate the FCC, CBS spent a large sum to convert Washington's WOIC (Ch. 9, now WTOP) to color, and RCA equipped both WNBW and an experimental UHF station they had operating in Washington for color.

The main arguments from October 1949 until a decision was reached in early fall of 1950 were these:

1) The CBS system started out requiring a 12 MHz-wide band (the equivalent to two TV channels) but converted to a 6 MHz-wide system when the CBS people saw that if they wanted to broadcast color on VHF, this would be a requirement.
2) The CBS system, called field sequential color, was a mechanical nightmare. At the studio, the cameras were equipped with large discs, which were equipped with blue, red and yellow filters. ➤

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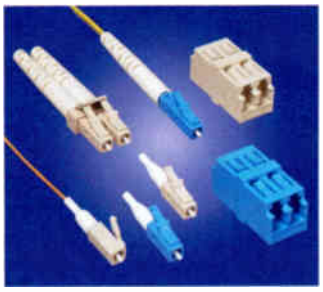

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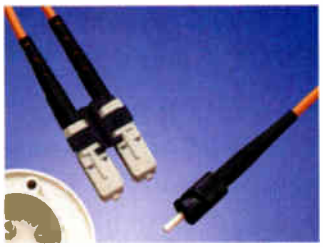

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clarity as regular black and white telecasts.

However, the RCA compatible color had failings at that time, and it was these failings on which the Commission focused:

1) The hues were unnatural and required almost constant viewer juggling of the receiver controls. (It later turned out that, for the most part, this aspect of the problem was being caused at the studio and that, as studio techniques improved, the user/viewer got to sit in his chair more of the time and play home-technician less of the time.)
2) The color smeared. That is, the colors tended to run. Bright colors, such as ruby red lips, tended to keep right on going past the lips into the face area beyond.
3) Color quality was unstable and changed drastically from minute to minute.

Clearly, RCA had a good oncept going, but it had more than a few bugs left to be worked out in 1949 and early 1950. Equally clear, CBS knew deep down that RCA could and would solve these problems, so it pushed extra hard to get its system accepted as "the national standard" before RCA could work out the bugs.

> "It was more than a matter of corporate pride. CBS had patent rights on its system."

It was more than a matter of corporate pride. CBS had patent rights on its system, and anyone constructing a CBS system color receiver would have to pay a patent royalty to CBS for their rights. A few bucks were involved.

CBS kept the pressure up on the Commission, and Johnson periodically reminded the Commission that he was satisfied with the quality of the CBS pictures, and he wanted television—now. (Perhaps because Colorado had no television, Johnson was not worried about his constituents badgering him about his approval of a system that would antiquate their TV receivers. After all they had none at the time.) CT

In our second installment next month, the standards race heats up as RCA and CBS demonstrate their systems to the FCC, in what one commissioner called "the darndest three-ring circus you ever saw." Stay tuned.

Doug Larson is senior editor at "Communications Technology." He may be reached via e-mail at dlarson@phillips.com.

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By Rick Marcotte and Tom Mays

Calcium Builds Better Bodies, Not Better Batteries

High-Purity Lead-Tin Batteries Live Longer

Batteries historically have been the Achilles' heel of cable network power backup systems. Performance irregularities, maintenance burdens and inconsistent operating practices have caused a high incidence of premature failures.

As cable TV operators enter the advanced services arena, they face the prospect of offering telephony, high-speed data and interactive entertainment across a network with inadequate battery backup capability. To avoid this scenario, you might want to consider high-purity (99.99 percent purity) lead-tin alloy batteries, a technology already used in outdoor subscriber loop carriers (SLC) deployed by American telecommunications companies.

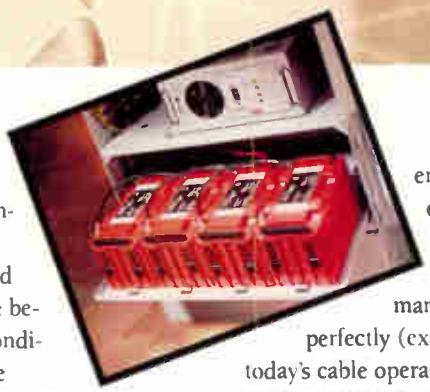
Most traditional valve-regulated lead-acid (VRLA) batteries employed in the cable TV market are made with lead-calcium grids and come in two varieties: gel cell and absorbed glass mat (AGM). Gel cells combine sulfuric acid with silica to form a gelatinous consistency between the plates. AGMs use a glass microfiber separator that absorbs liquid electrolyte. Calcium strengthens the lead plates, making them easier to handle and cheaper to make.

Calcium, however, increases grid corrosion and growth in the positive electrode, which eventually causes AGM and gel cell batteries to fail. These calcium-alloyed plates usually are thicker to offset the increase in positive grid corrosion and grid growth.

Temperature also influences battery performance and longevity. Higher temperatures reduce battery life by increasing chemical reactions within the battery, which contribute to cell dry-out and positive electrode grid corrosion.

Lower temperatures, on the other hand, reduce battery capacity (backup time), but can have a positive influence on battery life.

Photo of Claude Groulx provided courtesy of www.pumpmagazine.com



In a cable TV environment, temperature changes are especially significant because most cable power supplies must function outside, where they are constantly exposed to weather-driven temperature changes.

Calcium is out

Eliminating the calcium from the lead plates increases performance at all temperatures by slowing corrosion, which increases life expectancy and encourages the use of thinner plates. Thinner plates, and hence more of them, lower internal resistance without increasing the amount of active material, thus increasing total active surface area—and increasing power density—without increasing battery size or weight.

But eliminating calcium is only half the answer. Pure lead plates often have a limited and unpredictable cycle life because, under certain conditions, they promote the development of a resistive interfacial barrier between the positive grid and the active material. This resistive layer can impede the battery's recovery from deep discharges.

Adding a small amount of tin resolves these problems without increasing gas generation, which promotes dry-out. Tin increases the rate of grid corrosion slightly, but not nearly as much as calcium and not enough to preclude thin electrodes. High-purity lead-tin batteries balance optimum performance and optimum life perfectly (exactly the balance that today's cable operators require).

That makes high-purity lead-tin batteries especially well-suited to harsh outdoor environments. In cold weather, these batteries pack more punch than their lead-calcium cousins. As temperatures rise, corrosion-resistant plates and more efficient recombination prevent lead-tin batteries from wearing out as quickly. Lead-tin gives cable operators the performance and temperature

adaptability they need, without increasing battery size and weight.

The proof is in the performance

It's not enough to say high-purity lead-tin batteries work better and last longer. Such claims require proof—tests that objectively measure the performance of lead-tin batteries against traditional lead-calcium designs.

We subjected all three battery types—lead-calcium gel cell (Pb/Ca Gel), lead-calcium AGM (Pb/Ca AGM) and high-purity lead-tin AGM (Pb/Sn° AGM)—to rigorous testing to determine energy density by weight and volume, capacity degradation during float time, weight loss during float time, impedance gain during float time and the impact of lower temperatures on battery run time.

Figure 1: Gravimetric energy density vs. discharge rate

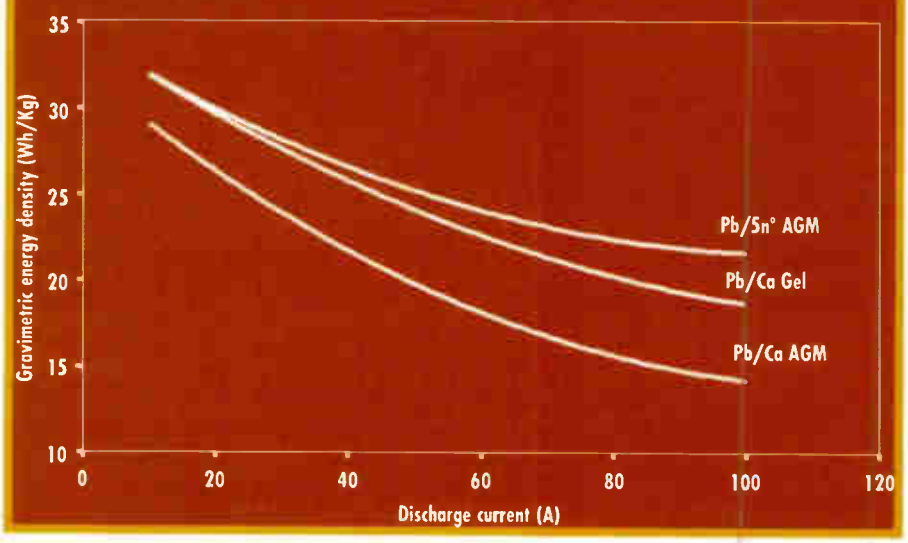
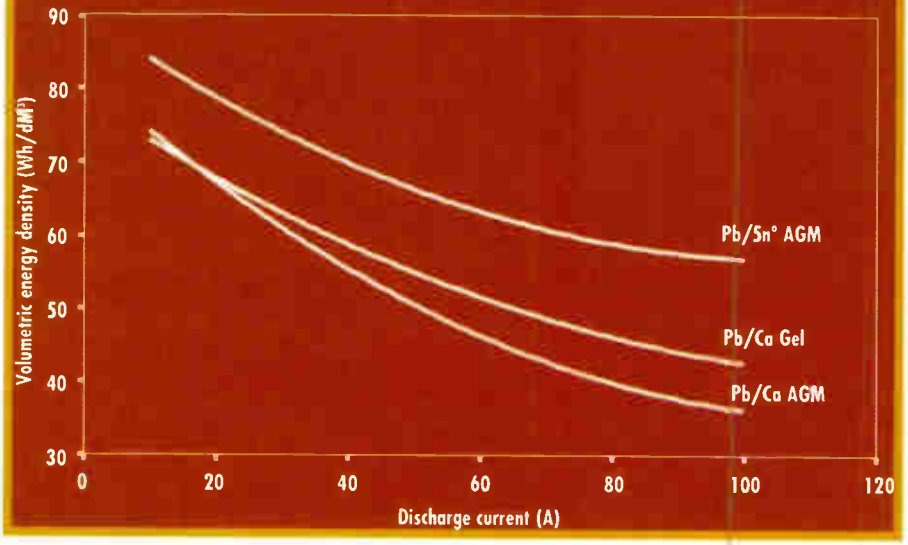


Figure 2: Volumetric energy density vs. discharge



Light, not lite

As a battery's discharge current rises, its specific energy density measured in watt-hours per kilogram (Wh/Kg) declines. Thin-plate lead-tin batteries, however, suffer less of a specific energy density decline, at higher rates of discharge, than equivalent lead-calcium batteries. Figure 1 shows the performance of each battery type.

The lead-calcium AGM battery delivered less energy by weight than the other two at all discharge rates. The lead-calcium gel cell battery delivered about the same watt-hours per kilogram as lead-tin at 15 amperes, but its energy density declined more rapidly. At 100 amps, the gel cell battery produced approximately 19 Wh/Kg, versus 22 Wh/Kg for lead-tin, an additional decline of 16 percent.

The superior energy density of lead-tin batteries is due to the thinner plates used. Thinner plates mean more plates can be used per kilogram, thereby increasing total reactive surface area, improving active material utilization and increasing power density.

BOTTOM LINE

Better Living Through Electrochemistry

As cable TV operators diversify their service offerings, they need reliable backup power. Because batteries play such a key role in providing backup power, a battery that performs well in cold weather and resists the life-shortening effects of hot weather can help cable TV operators lay a firmer foundation for the future.

By conducting a series of tests, we compared the performance of lead-tin batteries to two cable TV industry standards—lead-calcium absorbed glass mat (AGM) batteries and lead-calcium gel cell batteries. Pure lead-tin batteries delivered more energy for their weight and size as discharge rates increased, maintained energy capacity better during float time, lost less weight during float time, maintained the lowest impedance during float time and maintained a greater percentage of its run time as temperatures declined.

Put simply, lead-tin batteries live longer and deliver more energy for their size and weight throughout their lives (at all temperature levels) than traditional lead-calcium batteries.

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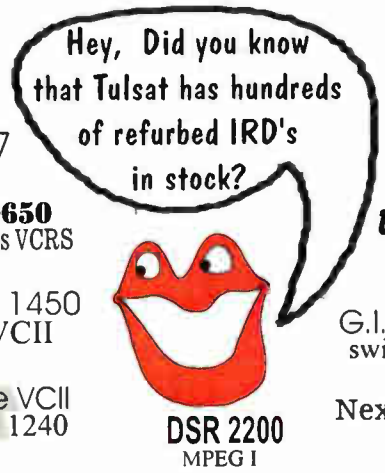

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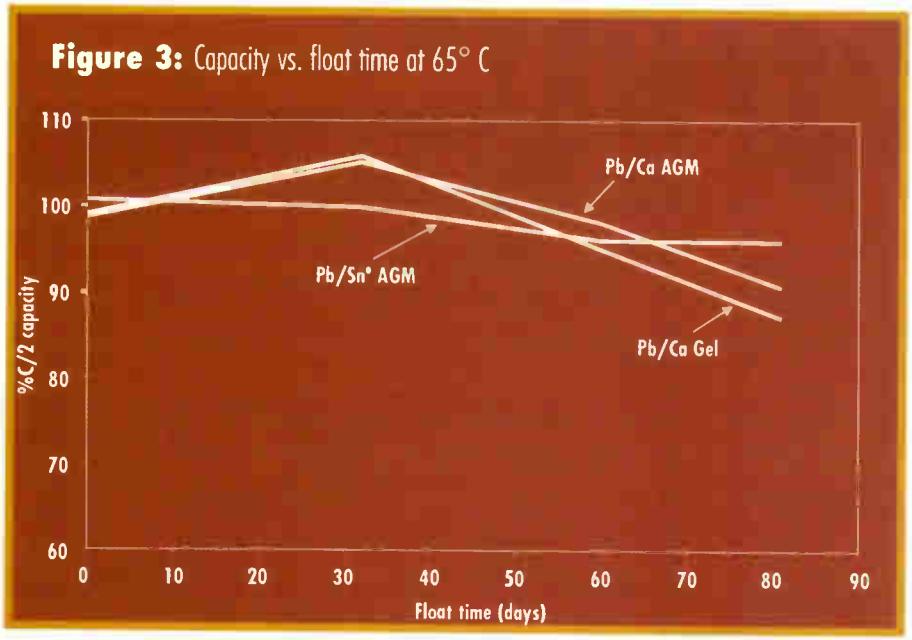


Similarly, the thinner electrodes of the lead-tin design also result in greater energy density by volume. More reactive surface area can be packed into a smaller space. Figure 2 (on page 170) shows the change in volumetric energy density at different discharge rates.

Lead-tin batteries produced significantly more power per cubic liter at all discharge levels. At 100 amps, the lead-calcium AGM battery produced 36 watt-hours per cubic liter. The lead-calcium gel cell generated 43 watt-hours per cubic liter. The lead-tin battery produced 57 watt-hours per cubic liter—33 percent more energy density than the gel cell battery and 58 percent more than the lead-calcium AGM.

A few volts float your boat

Even fully charged, batteries continue to draw a small amount of float current to compensate for standing/parasitic losses. This is especially true for lead-calcium designs because of an elevated corrosion rate.

A typical cable TV industry standard method for charging batteries involves the application of a float charge. This provides a constant supply of energy (milliamps) to the batteries in order to maintain maximum capacity.

Float charges maintain capacity, but over time capacity is diminished by loss of active material, evaporation and increased impedance.

When combined with high temperatures, battery life is greatly reduced. To

determine how float time affects each battery type, all three batteries were fully charged and baked for 80 days at 65° C, while maintaining a float (trickle) charge of 2.27 V per cell. Figure 3 shows how they performed.

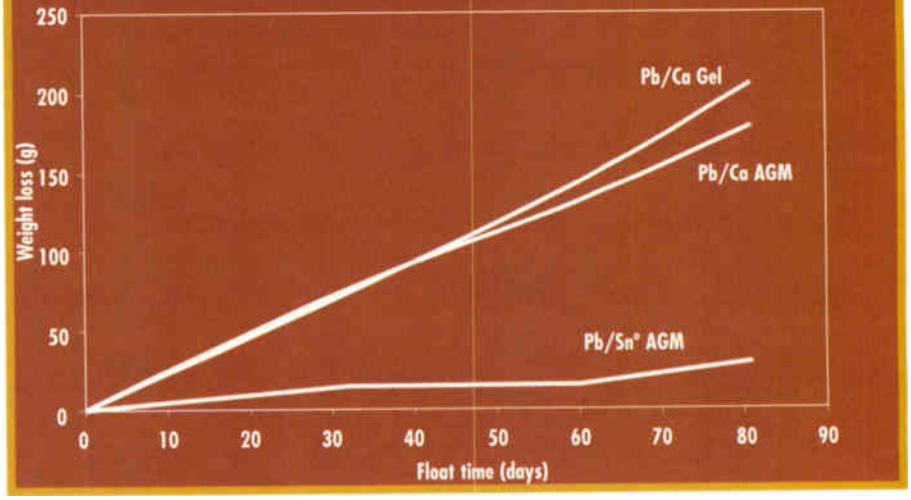
The lead-tin battery slowly lost capacity before leveling off at 96 percent of rated capacity on day 60. After 32 days, the lead-calcium batteries started to decline rapidly. After 80 days, the lead-calcium AGM produced at only 91 percent of rated capacity. The gel cell was down to 87 percent. One explanation for the accelerated energy loss is calcium-fostered corrosion of the positive electrode.

Liquid assets

Pure lead corrodes very slowly compared to a lead-calcium alloy. It also minimizes the amount of hydrogen and oxygen gas generated by electrolysis of water in the cell, preventing dry-out. Weight loss indicates that the battery is emitting gas and losing recombination efficiency.

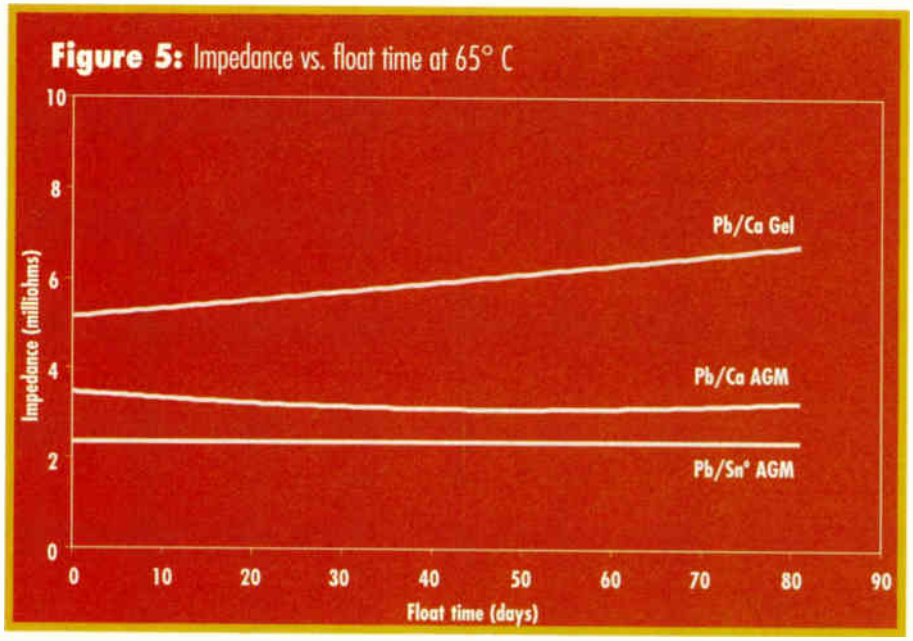
Figure 4 compares the weight loss during an 80-day float period at 2.27 V per cell and 65° C. The lead-tin battery lost 29 grams. The lead-calcium AGM battery lost more than six times that, 179 grams, and the gel cell lost 205 grams.

Figure 4: Weight loss vs. float time at 65° C



Similarly, as the grid corrodes, a battery's internal impedance increases, hindering energy flow within a battery and reducing capacity. Figure 5 (on page 174) shows changes in impedance for all three batteries during the accelerated temperature float test.

The lead-tin battery began with an



impedance of 2.4 milliohms and never increased. The lead-calcium AGM battery started with 3.5 milliohms and remained constant. The gel cell battery started at 5.2 milliohms and increased to 6.7 milliohms on day 80. The lead-tin battery's lower impedance allows it to discharge energy faster and recharge faster.

Out in the cold

A typical cable TV 36 VDC battery string provides 60 to 90 minutes of backup time at 25° C. But as temperatures drop, internal impedance increases, diminishing run time. Figure 6 shows run time reduction as ambient temperatures drop to -40° C.

As temperatures decrease significantly (below 15° F or -9.4° C), the difference between the battery types becomes apparent. Lead-tin batteries provide more of their rated capacity (backup minutes) than the other two types—a benefit with special value to telephony service providers.

Shelf life—a system reality

Because a typical cable TV system requires hundreds of batteries, cable operators often store spare batteries for fast, easy replacement.

Stored batteries eventually lose capacity via internal self-discharge reactions. Batteries with lower self-discharge rates survive the longest in storage.

Most manufacturers suggest storing at 25° C or lower and recharging every six months to keep batteries fit. These unde-

sirable self-discharges are accelerated by, among other things, impurities and alloying agents found within the cell. The high-purity lead-tin technology has a greatly reduced rate of self-discharge. Lead-tin batteries can be stored for two years without a refreshing charge under ambient conditions.

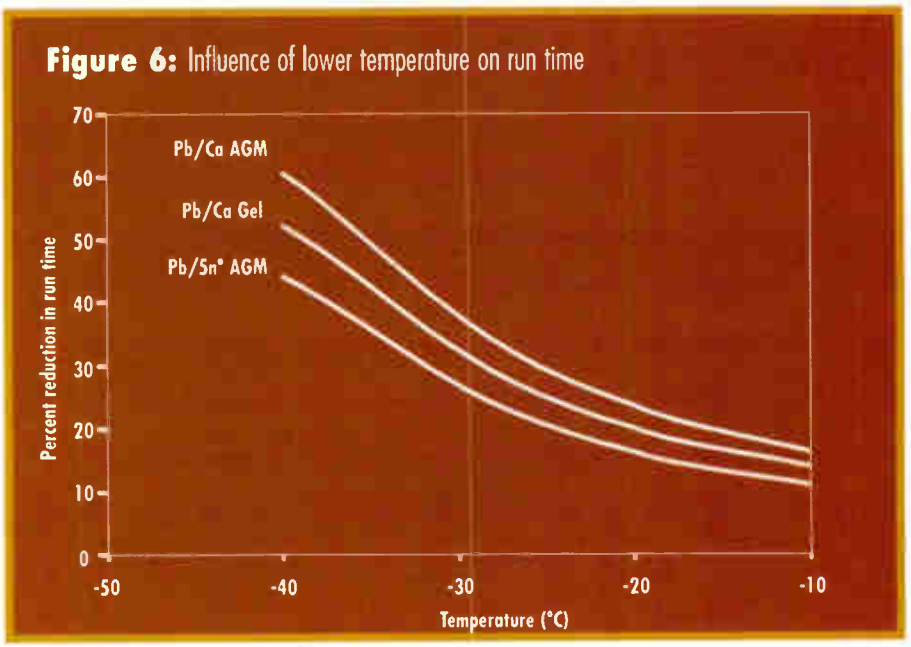
Optimized for cable TV applications

Lead-tin batteries performed significantly better than lead-calcium batteries in all areas.

They delivered more energy for their weight and size as discharge rates increased, retained their energy capacity better during accelerated float life tests, lost less weight and maintained the lowest impedance during accelerated float life tests, and preserved a greater percentage of their rated run time as temperatures declined.

Translation: Lead-tin batteries live longer and deliver more energy for their size and weight throughout their life than traditional lead-calcium batteries. Their ability to perform better in cold weather and withstand the life-reducing effects of hot weather makes them ideal for outdoor applications.

Figure 6: Influence of lower temperature on run time



Rick Marcotte is director of sales and marketing for the Communications Systems Group of Exide Electronics Group. Tom Mays is a cable TV product application engineer for Exide Electronics' Communications Systems Group. They can be reached either at (919) 713-5300 or via e-mail at lectro@email.exide.com.

The Hai

By Trav Neumann

Cable subscribers expect high quality, dependable service in today's two-way hybrid fiber/coax (HFC) networks. One of the challenges of maintaining a high-quality service is minimizing return path interference from within the home. This can be approached basically as an electromagnetic interference (EMI) problem.

Ferrite beads and toroids have long been used as a cost-effective method to suppress common-mode-based EMI in the computer industry. Early testing has shown ferrite core-based common-mode chokes can attenuate EMI produced in the home and reduce the likelihood of its getting into the return path.

Today's home is a complex electromagnetic environment. The sources of EMI are numerous, with the coupling of electromagnetic energy being random and unpredictable. There are three fundamental elements to the return path EMI problem: a source of interference (the house), a receiver of the interference (the cable distribution network), and a path between them (the drop).

There are two categories of coupling electromagnetic energy from a source to a receiver for this application: conducted and radiated. Within the home, the coupling paths will use a complex combination of these two methods, making a distinct path difficult to identify.

Conductive coupling is one common way an interference signal is transmitted into the return path via breaks in the cable shield, poorly shielded consumer equipment (TV sets and VCRs) and even the cable's transfer impedance. Wires and cables running through the house can act as antennas that pick up interference generated by numerous sources that ultimately end up as common-mode EMI, which flows to the house bond or even possibly the drop bond. This is one point, between the source and the receiver, to install a ferrite core common-mode choke to suppress unwanted interference. Early trials with ferrite chokes installed between the bonding block and the tap side of the drop cable have shown attenuation in the 2 dB to 5 dB range.

We need to focus on reducing interference using ferrite core common-mode

Dryer vs. The Return Path

Ferrites Knock Out Electromagnetic Interference

chokes. It is unrealistic to think cable operators will have the time, money and analysis capacity to address EMI source attenuation from within the home.

Transfer impedance

Drop cables are shielded cables with combination foil/braid shields designed to operate in two electromagnetic environments—one is the desired RF inside the cable, and the other is the ambient over-the-air environment. Transfer impedance, Z_t, is a means of characterizing how well the shielding works, or how electromagnetic energy transfers through the shield.

Transfer impedance relates the current flowing on the outside shield surface (such as the common mode interference signal) to the internal voltage it develops on the other side of the shield. Figure 1 (on page 180) shows how the center conductor is susceptible to the voltage on the inside of the shield produced by common-mode current on the shield's outer surface. This voltage is the result of a diffusion current through the shield.

Transfer impedance can be calculated mathematically. The accuracy of these calculations is very good for solid shields such as those used on trunk and feeder cables, but the accuracy is questionable for drop cables shielded with multiple tapes and braids.

Return path solutions

Current electromagnetic compatibility (EMC) practice recognizes four common methods to minimize EMI effects:

1) Eliminate the radiating source of interference.
2) Shield either the source or the receiver.
3) Increase the distance between the source and receiver.
4) Improve the circuit design.

> "Early trials with ferrite chokes installed between the bonding block and the tap side of the drop cable have shown attenuation in the 2 dB to 5 dB range."

Conductive and radiated EMI signals are classified into narrowband and broadband spectrum bandwidths. Narrowband signals are deterministic and occupy a very little bandwidth. However, modulation of a narrowband signal may generate sidebands of energy that may cover hundreds of kilohertz.

An example of a narrowband signal source in the 5-50 MHz range is a radio transceiver such as a citizens band (CB) or ham radio. Other communication systems in metropolitan areas operate with narrowband deterministic signals in the 10-20 MHz range.

Broadband interference signals have energy that may be spread over the entire 5-50 MHz frequency range. Intermittent narrow pulses with fast rise times, characteristic of motor brushes and computer clocking pulses, generate them. The steepness of these pulses causes problems because the fast rise times result in very high frequencies.

The table (on page 178) lists various sources of EMI (in "new" condition) from within the home that may couple to home wiring. The likelihood of addressing the return path EMI problem by eliminating sources (hair dryers, shavers, vacuum cleaners and such), shielding them or creating a greater distance between them and the receiver simply is not feasible.

Improve drop circuit design

That leaves the last option, which is to improve the drop circuit design. A ferrite common-mode choke for an HFC return path application improves the circuit by

Sources of electromagnetic interference within the home

Source	Strength in mGauss	Source	Strength in mGauss
Hair dryer	700	Electric shaver	600
Blender	100	Can opener	1,500
Coffee maker	10	Crock pot	9
Dishwasher	100	Food processor	130
Garbage disposal	100	Microwave oven	300
Mixer	600	Electric oven	20
Electric range	200	Refrigerator	40
Toaster	20	Washing machine	100
Iron	20	Portable heater	150
Vacuum cleaner	700	Ceiling fan	50
Window air conditioner	20	VCR	3
Color TV set	20	B&W TV set	20
Digital clock	8	Analog electric clock	30
Baby monitor	15	Battery charger	50
Drill	200	Power saw	1,000

adding impedance to the shield's outer surface and is specifically designed to suppress common-mode noise in the 5-50 MHz frequency range.

The properties of the ferrite material enable it to "absorb" the noise energy and dissipate it as quantities of heat rather than reflect it back into the system. Ferrites offer a convenient and inexpensive, yet very effective, means of RF noise decoupling without affecting the intentional RF signal.

The equivalent circuit of a ferrite bead is shown in Figure 2 (on page 181). The ferrite bead performs like an inductor in series with a resistor whose values depend on frequency. It is basically a lossy inductor. The ability to reduce interference signals, measured by insertion loss in dB, is influenced by the system source and load impedance.

With RF signals and data applications, the carried load and signal currents generally are balanced, and the net current is zero. In other words, the currents generate opposed fluxes of equal magnitude that cancel each other. (Known commonly as differential mode, these are the desired signals inside the cable.)

EMI noise, however, usually travels in the same direction on all conductors (common mode). The common-mode signal conducted along the cable shield's outer surface causes huge magnetic flux in the ferrite, which induces a voltage that opposes the flow of the noise current. In simple terms, the common-mode interference signal is "trapped" in the electrical and magnetic fields of the ferrite and is dissipated as heat.

Insertion loss of ferrites

It is most convenient to represent the impedance effectiveness of a ferrite as insertion loss (IL) expressed in decibels. IL is the ratio of the resulting voltage over the load impedance without and with a component:

$$IL = 20 \cdot \log (V/V_0)$$
$$IL = 20 \cdot \log \{Z_S + Z_L + Z_{ferrite}\} / \{Z_S + Z_L\}$$

where
V is the resulting load voltage with a ferrite
V_0 is the resulting load voltage without a ferrite
Z_S is circuit source impedance
$Z_{ferrite}$ is ferrite impedance
Z_L is circuit load impedance

For a 75-ohm (Z_S) / 75-ohm (Z_L) system with a ferrite that has an impedance of 225 ohms:

$$IL = 20 \log [(75 + 75 + 225)/(75 + 75)] \text{ dB}$$
$$IL = \sim 8 \text{ dB}$$

Ferrite placement

It's important to understand placement of the ferrite on the drop cable for the best performance. For optimal attenuation purposes, place a ferrite as close as possible to the source. Because the house is considered the source and the goal is to reduce interference noise entering the return portion of the plant, to suppress transfer impedance related interference, attach a ferrite to the drop cable on the plant side of the bonding block.

It's important to also note that research by CableLabs, Holtzman Inc. and others indicates that much of the conducted interference resulting in common-mode currents on drop cables enters the cables via breaks in the

BOTTOM LINE

Ferrites Solve Interference Problems

Cable subscribers expect high quality, dependable service in today's two-way hybrid fiber/coax (HFC) networks. One of the challenges of maintaining a high quality service is minimizing return path interference from within the home. This can be approached basically as an electromagnetic interference (EMI) problem caused by the use of household appliances.

Ferrite core common-mode chokes have long been used as a cost-effective method to suppress electromagnetic interference in the computer industry. Ferrite is a ceramic material with electromagnetic properties. It absorbs reactive power in its magnetic field, which induces a voltage that opposes the interference signal flow of current. Early trials with ferrite cable shields installed between the bonding block and the tap side of the drop cable have shown attenuation by 2 dB to 5 dB.

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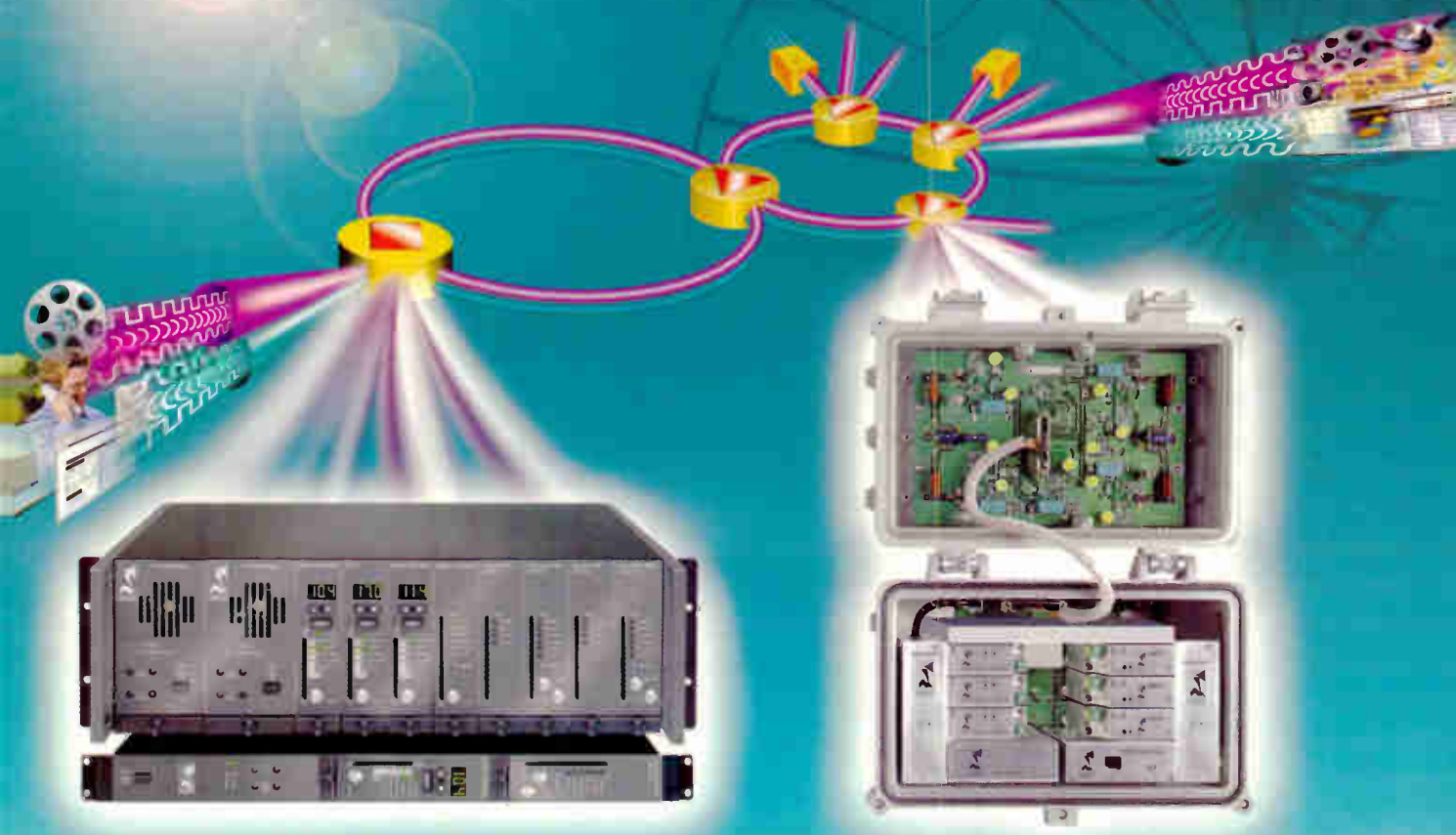

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Reader Service Number 103

What's Ferrite, and How Does it Work?

Ferrite is a type of ceramic material with useful electromagnetic properties. It has a cubic crystalline structure with the chemical formula AB Fe_2O_3 where Fe_2O_3 is an iron oxide and AB refers to a combination of two or more divalent metal oxides such as cobalt, nickel, manganese or zinc. These divalent metals have unique molecular properties that create high magnetic flux density in the presence of an electric field.

The most accurate expression of a ferrite's performance capability is in terms of permeability (μ). Permeability is the ratio of the magnitude of magnetic induction to magnetizing force and is variable as a function of frequency. Varying the permeability of the ferrite by adding metal oxides in various amounts enables a ferrite to be designed with frequency and attenuation characteristics unique to specific applications.

Ferrite absorbs reactive power in its magnetic field, which induces a voltage that opposes the interference signal flow of current. Classical return loss (RL) circuit analysis shows this forces the current to lag behind the voltage by 90°, dissipating trapped noise energy as heat rather than reflecting it into the system.

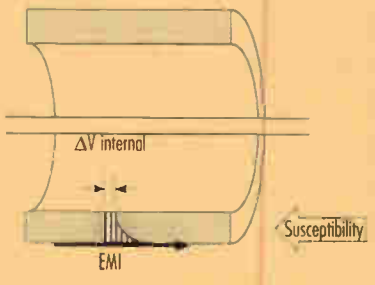
Sparing the rigors of complex variable equations, it suffices to state that at low frequencies, the inductive reactance equals the total impedance, while at high frequencies (above 1 MHz) the equivalent series resistance makes up the total impedance. As the frequency increases from a low value, the series resistance increases and starts to add to the series reactance to create the total impedance. A well-designed ferrite for hybrid fiber/coax (HFC) applications will allow the maximum amount of energy to be lost to heat per unit volume of the ferrite core.

shielding or poorly shielded TV sets, VCRs and similar equipment. With regard to the former, diligent leakage monitoring and repair and good installation craftsmanship will take care of most problems. The latter can be dealt with by placing common-mode chokes at the inputs to those devices, effectively suppressing common-mode currents before they enter the drop through the TV set, VCR or other in-home device.

Ideally, you'd place ferrites both at the bonding block and at any questionable devices, but time and financial considerations being what they are, a minimum deployment is to place a ferrite at the bonding block. You also could place a ferrite at the tap; however, because transfer impedance is a function of longitudinal voltage along the sheath, it is more effective to decouple the noise signal near the source. This location also is the easiest for retrofitting.

Bisected ferrites are available for mounting on existing drop cables. The two halves of the ferrite are mounted in a UV-rated plastic case with clips that clamp over the drop cable fore easy installation.

Figure 1: Susceptibility of center conductor to voltage on the inside of the shield

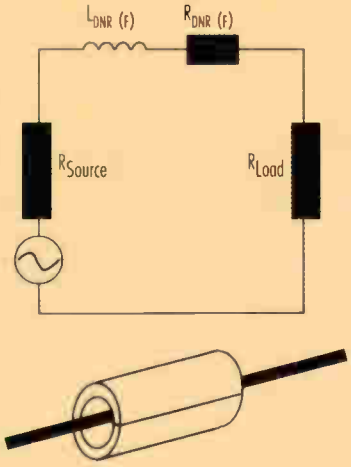


Note: From *Controlling Radiated Emissions by Design* by M. Mardiguan van Nostrand Reinhold, 1995, p. 241

Saturation and powered drops

Applications exist where current will pass down the drop to power in-home devices that require a few hundred

Figure 2: Equivalent circuit of the DNR ferrite bead



milli-amps. A strong current could induce a high field strength in the ferrite core, which can lead to saturation, a decrease in impedance and a loss of permeability. At low amperage and high frequency (50 MHz), the impedance loss from saturation is on the order of tenths of a percent. Concern over possible saturation of the ferrite core in the absence of bias currents is unwarranted, as most common-mode noises are relatively low voltages. One exception might be large transients caused by nearby lightning strikes or similar phenomena, which can induce substantial currents on the cable.

What's it mean?

Ferrites offer a cost-effective means of suppressing EMI in the return path by presenting a high impedance to common-mode interference specifically in the 5-50 MHz bandwidth. They adapt easily to existing drops, can be conveniently installed and will provide consistent attenuation performance. CT

Special thanks to Neil Phillips of Signal Vision for his contribution to this article.

Trav Neumann is vice president of Broadband Remarketing International. He may be reached via e-mail at tneumann@bri-online.com. Neil Phillips is president of Signal Vision and can be reached at (949) 586-3196 regarding field trial test results.

Safety: A Critical Issue for the SCTE

The Annual Safety Survey

By Ray C. Lehr

The Society of Cable Telecommunications Engineers' Safety Committee is made up of cable industry safety professionals and others interested in the safety, health and well-being of their employees. The committee meets formally once a year at the Cable-Tec Expo. This year's meeting will be held from 1 to 4 p.m. on May 24 in Orlando, Fla.

During the last year, the committee has been busy with several projects, including updating the SCTE Safety and Health Manual. Look for the new updated edition to be out in the near future. The committee also helped rewrite the Occupational Safety and Health Administration Safety Training seminar manual. One of the more exciting accomplishments was the development and implementation of an SCTE safety award program to recognize cable operations (and contractors starting this year) for superior safety performance. If you are not aware of this program and want to get more information, you can contact Ralph Haimowitz at (828) 264-8310 or e-mail him at rhaimowitz@scte.org.

We restructured the committee last year to focus better on issues that impact you, the cable employee. As part of this restructuring, we formed a new research committee chaired by Earl Bennett of RTK Corp. and a regulatory committee chaired by Harry Naugle of Comcast Corp.

The regulatory committee is charged with reviewing proposed and promulgated laws (such as OSHA regulations) to see what impact they have on our industry and how we can best comply with those laws that apply to us. At the May meeting in Orlando, the committee will detail the new forklift training standard, review the probable impact of the draft OSHA standard on ergonomics and discuss the new standard on communication tower construction.

The research committee is charged with discovering what the needs of our industry are, plus what we are doing well and not so well. This group also conducts research on various standard operating procedures (SOPs) for different cable operators and shares the information with the membership. Toward that end, we are conducting a study to determine the hot safety issues facing companies within the telecommunications industry.

The purpose of this survey is to pose questions about what safety issues are on the minds of your employees, supervisors, managers and upper management team. The committee will review the results of the survey and make recommendations to SCTE for future safety initiatives. Please take a few minutes to fill out the survey and return it. Your input is important to us.

Communications Technology will publish the results of this survey in a future issue. Information gathered from the surveys will help us identify specific safety issues that face our industry.

Please return completed surveys by June 1, 1999, to:
Alan Babcock, Director of Training Development, SCTE, 140 Philips Road, Exton, PA 19341-1318. Or fax the survey to: (610) 363-7133.

You also may complete the questionnaire online at www.cabletoday.com/ct. CT

Ray Lehr is chairman of the SCTE's Safety Committee. He can be reached at (303) 267-5253.

Telecommunications Safety Survey

Mail or fax survey by June 1 to: Alan Babcock, SCTE, 140 Philips Road, Exton, PA 19341-1318. Fax: (610) 363-7133.
Or complete the survey online at: www.cabletoday.com/ct.

1) Does your company/location have a formal disciplinary policy for violating basic safe work practices? (Please check one.)
- ❑ Yes
- ❑ No
- ❑ Don't know

2) Does your company/location provide safety training for any of the following safety issues? (Check all that apply.)
- ❑ Fall protection
- ❑ Pole climbing
- ❑ Ladder usage
- ❑ Aerial lift operation
- ❑ Working near power
- ❑ Forklift usage
- ❑ Personal protective equipment
- ❑ Respiratory protection
- ❑ Ergonomics
- ❑ Electrical
- ❑ Supervisory safety training

3) How often does your company/location have documented safety meetings?
- ❑ Weekly
- ❑ Biweekly
- ❑ Monthly
- ❑ Bimonthly
- ❑ We do not have safety meetings

4) Are your employees formally trained (documented or certificate-issued) on a new safety process when a potentially dangerous operation is introduced into the workplace?
- ❑ Yes
- ❑ No
- ❑ Don't know

5) Are your employees certified (certified defined as: attended formal class, written exam, practical testing), or is there any formal documentation collected for any of the following safe work procedures? (Check all that apply.)
- ❑ Pole climbing
- ❑ Aerial lift truck safety
- ❑ Working near power
- ❑ Forklift operation and safety
- ❑ Bloodborne pathogens
- ❑ First aid and CPR
- ❑ Fall protection
- ❑ Defensive driving
- ❑ Hazard communication
- ❑ Personal protective equipment usage
- ❑ Electrical safety

6) Which of the following accident types cause the most loss of time at your operation? (Check all that apply.)
- ❑ Vehicle
- ❑ Slips and trips
- ❑ Forklift
- ❑ Falls from heights
- ❑ Material handling
- ❑ Electrical contact

7) Of the following choices, on which safety topic would you like to see an article in *CT*? (Check all that apply.)
- ❑ 90 V practices
- ❑ Types of voltage detectors used
- ❑ Tree-trimming policy
- ❑ Respiratory protection practices within our industry
- ❑ Forklift training practices
- ❑ Fall protection equipment and usage

8) Do you believe the SCTE is doing enough to provide pertinent information about safe work practices within our industry?
- ❑ Yes
- ❑ No
- ❑ Don't know

9) Which of the following best describes your position within your operation?
- ❑ Installer
- ❑ Technician
- ❑ Line technician
- ❑ Operations supervisor
- ❑ Engineer
- ❑ Plant manager
- ❑ Operations manager/director
- ❑ System safety coordinator
- ❑ Safety manager
- ❑ Safety director
- ❑ Trainer
- ❑ Training manager
- ❑ Training director
- ❑ Other _____

10) On a scale of one to 10, with 10 being the highest importance and one being the lowest, rate how important safety is to your company's mission.
- ❑ 1
- ❑ 2
- ❑ 3
- ❑ 4
- ❑ 5
- ❑ 6
- ❑ 7
- ❑ 8
- ❑ 9
- ❑ 10

Survey completed by (optional):

_____

Company: _____ Title: _____

Telephone: _____ Fax: _____ E-mail: _____

Address: _____

City: _____ State: _____ Zip: _____

THE

Build

Training and Construction Strategies for Evolving Broadband Networks

DWDM Enters Cable Build Plans

By Reed Miller

As cable operators feel the bandwidth crunch, will they turn to dense wavelength division multiplexing (DWDM) for more capacity? Depends on who you ask.

Fiber-optic cable is being deployed at a rapid rate by cable operators. KMI Corp. projects 4.2 million kilometers of fiber will be installed in cable TV networks in the United States in 1999. (See the accompanying table on page 186.) This figure represents 30 percent of all 1999 fiber installations.

But that does not necessarily mean cable operators will want to boost the capacity of that fiber by splitting light into multiple wavelengths. Still, a few cable companies are investing in DWDM as part of their build and upgrade plans.

For instance, last June TCI bought wavelength division multiplexers from Harmonic Inc. and Antec Network Technologies. TCI initially planned to use the equipment in eight markets, including Denver; Dallas; Baton Rouge, La.; and Vancouver, Wash. However, following the merger with AT&T, the newly named AT&T Broadband & Internet Services has rolled out DWDM to an additional 15 to 16 markets and signed on General Instrument and Scientific-Atlanta to provide additional DWDM equipment.

Company execs see DWDM as an integral part of their cable network plans. "We are rolling out DWDM to any portion of our network where we have to deploy fiber," says Oleh Sniezko, vice president of engineering at AT&T B&IS. "There is really no limit to it. We are deploying DWDM in 23 or 24 markets that are larger than 100,000 homes, but we also are deploying it in smaller markets when the applications call for it."

AT&T has many reasons for installing DWDM. For example, TCI used to install synchronous optical networks (SONETs) from the headend of a cable system to a secondary hub on the system to carry video channels and data. But the secondary hubs were expensive to operate.

"The secondary hubs were essentially becoming (central offices)," Sniezko says. "SONET muxes had to be placed there, and routers had to be placed there, and technicians were having to be sent out to maintain this equipment. DWDM is much more simple. Everything is located at the headend."

AT&T execs also didn't like the way SONET multiplexers locked their network into a certain speed, such as optical carrier (OC)-3 or OC-12. To upgrade bandwidth, SONET multiplexers had to be changed. Conversely, transmitters (line cards) can simply be added to DWDM multiplexers to boost bandwidth in a network.

The bottom line for AT&T: As it rolls out cable modem services and cable telephony, it will need high-capacity bandwidth. The company sees DWDM as a more future-proof technology than SONET because of its scalability.

@Home taps DWDM

AT&T isn't the only cable player banking on DWDM. @Home Network has made a long-term investment in DWDM. And last month we reported that Comcast plans to deploy Harmonic's METROLink DWDM system in Sarasota, Fla.

The @Home purchase differs from those

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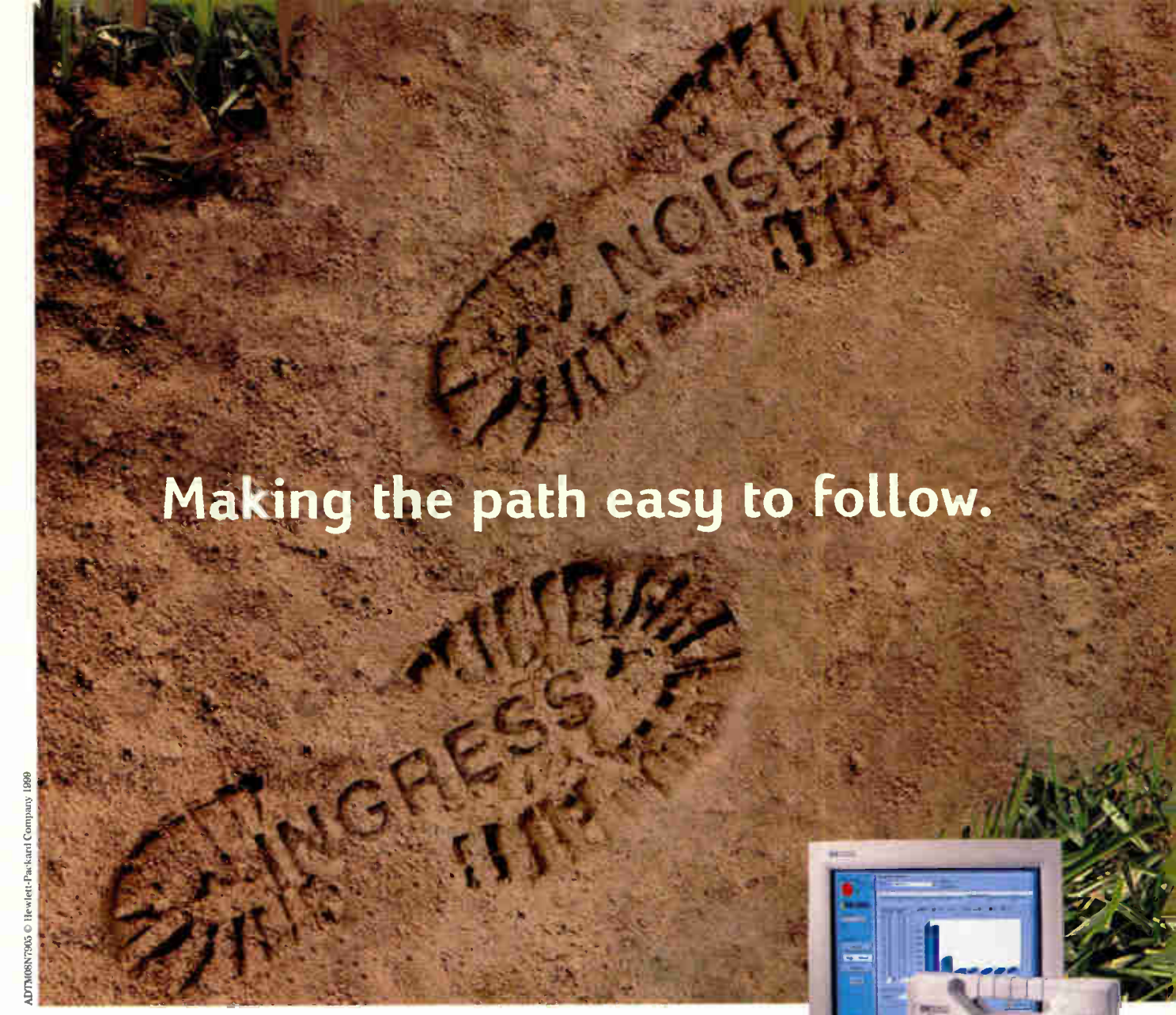

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Reader Service Number 107

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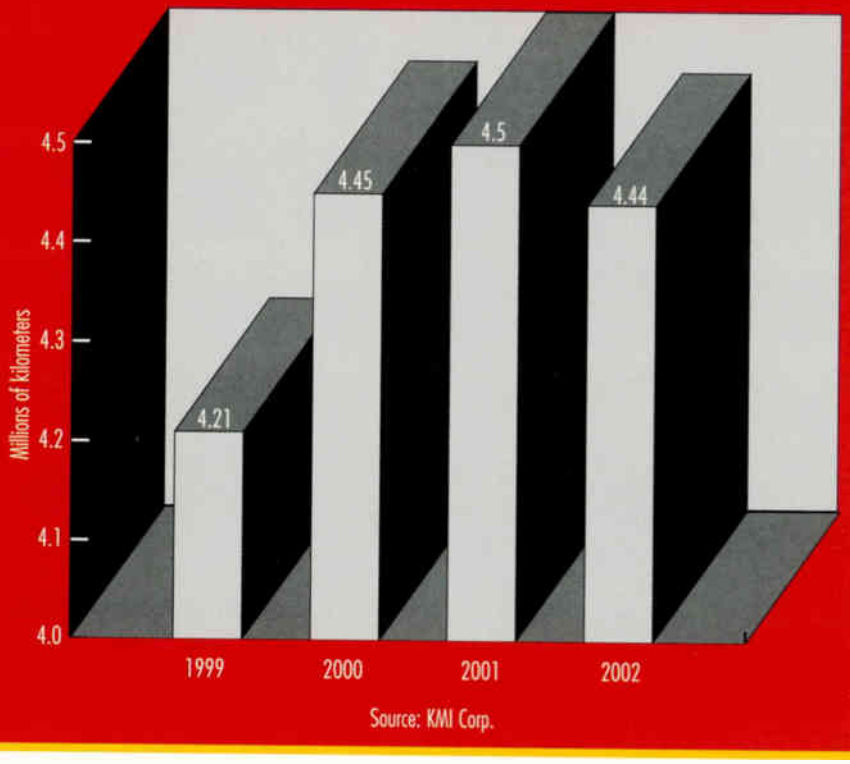
Expanding Possibilities

Figure 1: Fiber installations projections among U.S. cable TV operators: 1999-2001



Source: KMI Corp.

of AT&T B&IS and Comcast. @Home has signed a 20-year lease with AT&T for a DWDM backbone. But it is a services contract, not an equipment contract.

@Home plans to use the 15,000-route-mile backbone, which has two OC-48 DWDM channels, to connect cable operators' networks to the Internet.

"We were attracted to DWDM because it cut out the SONET layer," says Matt Wolfrom, director of public relations for @Home. "IP (Internet protocol) services can interface directly with DWDM, so we don't have to deploy SONET to increase capacity on our network."

The naysayers

Despite DWDM investments by two big-time cable operators and an IP backbone provider, many industry insiders fail to believe DWDM will rock among cable players.

Lawrence Gasman, president of Communications Industry Researchers, a firm that tracks DWDM and other communications technologies, says most cable operators will continue to rely on SONET or digital signal (DS)-3 lines to carry traffic from headends to secondary hubs. His reasoning? Because cable modem-based Internet access uses only one video channel in cable networks, most providers won't need to upgrade their networks with huge amounts of bandwidth.

And James Frodsham, vice president of OPTera solutions at Ontario, Canada-based Nortel Networks, says most cable operators will likely lay more fiber to meet their bandwidth needs, rather than installing DWDM. However, he adds DWDM has an obvious application in IP backbones such as the network @Home is developing.

The execs at Harmonic and Antec disagree with Gasman and Frodsham, however, because they currently are building businesses off DWDM sales to cable operators. "This is a pretty new technology, so it will take some time to establish a reputation," says Colin Boyd, vice president of North American sales at Harmonic. "But we are already getting interest from other providers than Comcast and (AT&T B&IS). Time Warner is interested in video-on-demand, and we have seen interest in DWDM from them." CT

Reed Miller is the editor of sister publication "Fiber Optics News." He can be reached at rmiller@phillips.com.

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Reader Service Number 109

Are Your Contractors Safe?

Get the Skinny Before Accepting Bids

By John Young

Why is it important for companies that do business with contractors to have a contractor safety evaluation program? Well, mainly because the Occupational Safety and Health Administration has noted that the general contractor shares responsibility for subcontractors' violations that could have been reasonably detected and corrected. ➤

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Expanding Possibilities

Is a contractor safety evaluation program really important? Read this, and decide for yourself.

It really happened

It was raining steadily. Visibility was about 20 feet, and rush hour traffic had not yet begun to slow down.

The dirty brown pickup must have had a hundred dents in it, and it was dragging the rear bumper as the lift operator leaned the bucket out over the back of the truck to reach the utility pole. The operator was not wearing fall protection gear. At one point, he was standing on the lip of the basket to get to equipment on the pole.

He was backed up to the pole and blocked one of two lanes on a rural street, about 100 yards from a major intersection and traffic light. He had one 18-inch cone placed by his front bumper and a sign reading "construction ahead" placed about 100 feet down the blocked lane.

Oncoming drivers could not see around the front end of the truck to determine if the lane was clear to proceed. There was no flagger. There were two "almost" accidents before we could get to the scene and move the truck. When we called the technician's supervisor out, he could not understand our annoyance. He felt that our concern for the operator's and the public's safety was ridiculous; after all, they had been doing this for months and had not had any accidents.

Could this be one of your contractors? It was one of ours four years ago. We terminated his contract for noncompliance with OSHA and Department of Transportation safety rules.

A better way

We then began to look for ways to ensure that our contractors had adequate safety programs and training. In the interim six-month period, OSHA cited and fined three other cable operators for not ensuring that their contractors had adequate programs and training. We were sued for not ensuring our contractors were providing adequate training to their employees and won the case because we had initiated safety training requirements for contractors.

We quickly recognized that this was not enough. What we decided to do was require a "pre-bid safety evaluation" by a third party prior to accepting bids. Contractors would have to meet certain minimum criteria before they could do business with us.

Why a third-party evaluation, you ask? The legal department tells us we have to maintain an "arm's length" relationship with contractors lest we end up liable for our contractor's employees; that is, otherwise they legally could be considered our employees.

Aside from shared responsibility, you must address regulatory, partnering and liability issues.

Regulatory issues apply to both customers and to contractors. Each must be in compliance. As long as we can show we made a reasonable effort to ensure our contractors comply, we will not be held accountable as a general contractor for injuries to our contractor's personnel. One of the most important regulations is the OSHA Telecommunications Standard 29 CFR 1910.268.

Partnering with contractors serves several valuable purposes. You can:

- Minimize cost through cooperative effort
- Set safety and health standards for the industry and specific types of work
- Consistently monitor regulations through enhancing compliance and training
- Plan jointly
- Improve quality of work

In terms of liability, too many cases on record point out that when contractors are involved in incidents, injured parties drag in the customer from a "deep pockets" point of view, if for no other reason.

The results

During the 18 months we have been actively using this program, we have discovered some interesting things.

Safety status: Of participating contractors, 48 percent had fewer than 50 employees. Of those, 33 percent had a full-time safety person assigned to handle safety matters. We found, however, that

many of the participating contractors were appointing secretaries or other nontechnical personnel as safety representatives.

Of participating contractors, 12 percent had between 50 and 99 employees. Half of those had a full-time safety person assigned to handle safety matters; the balance had supervisors assigned to handle safety as a second responsibility.

Also, 40 percent of participating contractors had more than 100 employees. Three-quarters of those had a full-time safety person. Usually, in this size contractor group, the safety person was a professional safety person or operations supervisor.

Training status: We can state unequivocally that none of the contractors reviewed had completed all of their required safety and health training. This category of the evaluation is the most often cited omission on the part of the contractors.

The program

Now that I have given some reasons for a contractor safety review program, let me share what we have done, including commissioning Envirosafe International Inc. to develop a contractor review and training program in response to our needs. The program—dubbed SMART (Safety Management Administrative Review & Training)—consists of four elements:

1) An administrative audit of safety management policies and practices
2) A review of regulatory training conducted by the contractor
3) An indexing system for contractors
4) An annual update and re-indexing of all contractors currently working for a cable company

Let's briefly review the four elements.

Administrative audit process: Cable company involvement is paramount. The company must initiate this program. The contractor must clearly understand that the program is mandatory and that the program goal is safety standardization and systematic improvement.

> "The cable operator may be held responsible for seeing that the contractor complies with all OSHA standards."

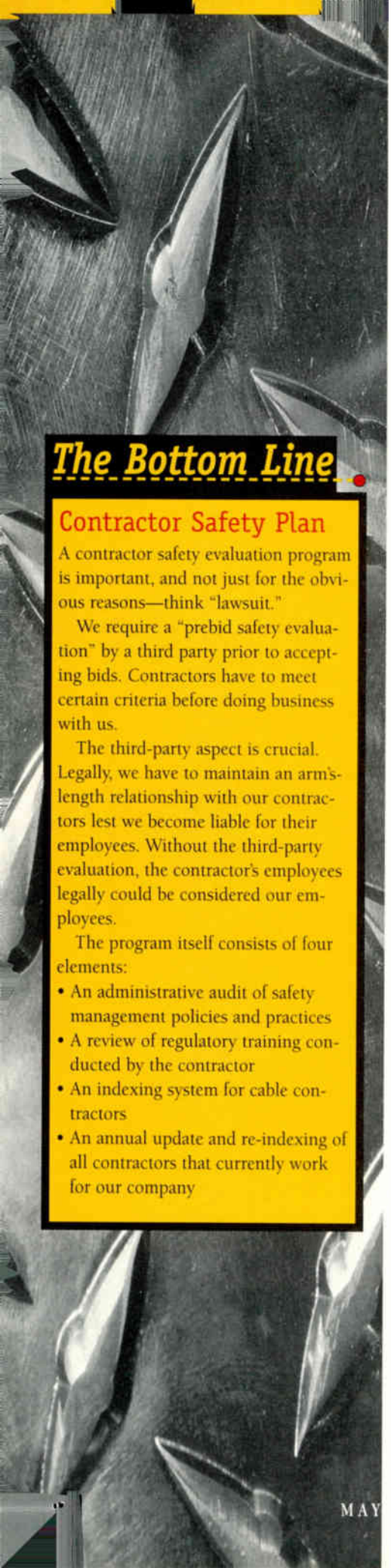
Once the audit starts, we send an audit questionnaire to the contractor. It contains a series of questions on safety practices, policies, procedures, programs and training at the contractor level. Answers given in the audit require support documentation.

The evaluators review the audit and support documentation and give the contractor points for each applicable area of compliance, with total points equaling the safety evaluation score. This in turn helps determine the contractor's index score. The audit or assessment provides several items:

- The administrative assessment provides a solid foundation from which the cable company can evaluate contractors and provide an even playing field for all contractors during the bid process. Here again, the goal is improvement, not "black listing."
- It is a systematic approach to all contractors.
- It provides for a strict protocol to be followed to avoid favoritism.
- It provides specific steps to follow during review for all contractors.
- It provides a systematic problem resolution path that permits the contractor to have its say with the reviewer and the cable company, with the final authority resting with the cable company.
- Finally, it provides for a tolerant "corrective action" process for contractors to use to update and improve safety and health programs.

Review of regulatory training: OSHA has adopted several standards and incorporated them into regulations in an ongoing effort to provide the highest level of protection possible in the workplace.

Although historically it has been the responsibility of the employer to ensure



The Bottom Line

Contractor Safety Plan

A contractor safety evaluation program is important, and not just for the obvious reasons—think "lawsuit."

We require a "prebid safety evaluation" by a third party prior to accepting bids. Contractors have to meet certain criteria before doing business with us.

The third-party aspect is crucial. Legally, we have to maintain an arm's-length relationship with our contractors lest we become liable for their employees. Without the third-party evaluation, the contractor's employees legally could be considered our employees.

The program itself consists of four elements:

- An administrative audit of safety management policies and practices
- A review of regulatory training conducted by the contractor
- An indexing system for cable contractors
- An annual update and re-indexing of all contractors that currently work for our company

regulatory compliance, in the case of companies that have contracted to perform services to the cable industry, the customer (in this case, the cable operator) also may be held responsible for seeing that the contractor complies with all OSHA standards, including standards that define training requirements.

By law, you and your contractors must comply if employees are involved in the kinds of activities addressed by the mandatory training requirements. Some examples can be found in OSHA regulations 1910.132-138 for personal protective equipment; 1910.178 for forklifts; 1910.26 for ladders; 1910.67 for vehicle-mounted elevating and rotating work platforms; and 1910.268 for telecommunications standards.

Remember—OSHA is not the only regulatory authority we deal with in our industry; for example, DOT requirements in the Manual for Uniform Traffic Control Devices (MUTCD), Section VI deals with work zone safety when working on streets and highways. Size of the company has no bearing—it simply means you have fewer people to train.

Indexing system: First, the evaluator determines the safety evaluation score for input to the program by reviewing answers and supporting documents on:

- Injuries and experience
- Workers compensation experience
- Management policy
- Procedures and safety rules
- Accident reporting criteria
- New employee orientation requirements
- Safety meetings
- Safety inspections
- Staff safety support
- Alcohol and drug program
- Incentive program
- Safety training

Second, the evaluator enters "Total Recordable Injury Rate" for the most recently completed 3-year period.

Third, the evaluator computes the index using a weighted formula to accommodate contractor size differences. It's noteworthy that contractors are compared only to competition in their own industry.

Our contractor review revealed that 43 percent were certified "approved," 47 percent were "acceptable—on probation," and 10 percent were "disapproved." The evaluator based the ratings on a bell curve with standard deviations determining approved and acceptable ratings.

We then send a certificate and letter to the contractor, local project manager where he is working, regional director, and division safety manager. The letter outlined areas in which the contractor is weak or deficient so the contractor can bring his program up to speed. Both parties set goals and agree upon completion dates.

Contractors in the "approved" status are certified to perform work for one year. Each year after that, we work with our evaluator to re-index our contractors and issue new certificates. Contractors in the "acceptable—on probation" status are certified to perform work for six months, and as long as they continue to make efforts to correct deficiencies, we renew this certification. Contractors who are "disapproved" are notified of their deficiencies and informed that because of the inadequacy of their safety programs they have been eliminated from the bid process. They also are encouraged to make corrections and additions to their programs and bid again when these changes have been made.

Annual update and re-indexing: Annually, a one-page questionnaire goes out to all contractors who have been certified, asking for updated information in specific areas. The evaluator enters this information into the program and re-indexes all contractors. We note any new deficiencies and relay that information to the same distribution list mentioned previously. Where necessary, additional steps address these deficiencies.

The benefits

All contractors are reviewed using the same systematic approach. This gives them equal opportunity to bid on projects if their safety and health programs

Field Safety Inspection Report

Project: _____ # _____

Date: _____ Street: _____ TWC ☐ Contractor ☐

Vehicle number: _____ Weather: _____ Contractor _____

Location/node: _____ Type of work: _____ Subcontractor _____

Safety Observations

1	Traffic cone placement:	YES	NO	N/A	
	Vehicle	YES	NO	N/A	Number _____ Size _____
	Trailer	YES	NO	N/A	Number _____ Size _____
	Flag person in use	YES	NO	N/A	_____
2	Proper sign placement:	YES	NO	N/A	Number _____ Size _____
3	Traffic control method:	YES	NO	N/A	_____
4	Signal flashers working/on:	YES	NO	N/A	_____
5	Beacon lights working/on:	YES	NO	N/A	_____
6	Safety vests in use:	YES	NO	N/A	_____
7	Electric gloves worn:	YES	NO	N/A	_____
8	Hard hats worn:	YES	NO	N/A	_____
9	Work gloves/electric gloves worn:	YES	NO	N/A	_____
10	Proper work shoes worn:	YES	NO	N/A	_____
11	Safety glasses worn:	YES	NO	N/A	_____
12	First aid kit on vehicle:	YES	NO	N/A	_____
13	5/10 lbs. fire extinguisher on vehicle:	YES	NO	N/A	_____
14	Engine running:	YES	NO	N/A	_____
15	Safety harness & lanyard in use:	YES	NO	N/A	_____
16	Vehicle appearance:	PASS	FAIL	–	_____
17	Safety items accessible:	YES	NO	N/A	_____
18	Traveling ground in use:	YES	NO	N/A	_____
19	Wheel chocks in use:	YES	NO	N/A	_____
20	Man – on pole – in bucket:	YES	NO	N/A	_____
a.	Hearing protection being used:	YES	NO	N/A	_____
b.	Uniform shirt worn/neat:	YES	NO	N/A	_____

21	Work performed in accordance with safety practices?	YES	NO
22	Is at least one person on crew first aid and CPR certified?	YES	NO
23	Is climbing equipment inspected?:	YES	NO
a.	Gaff condition	PASS	FAIL
b.	Pole inspected	YES	NO
c.	Voltage tester used	YES	NO
d.	Proper tools used	YES	NO
24	Is vehicle inspected?	YES	NO
25	Copy of permit on site? (if required)	YES NO	N/A
26	Utilities locate performed	YES	NO
27	Ladders: condition – Pass/Fail; Angle (4-1) YES/NO; Secured YES/NO; Employee secured YES/NO		
28	Vehicle in motion – Seatbelts, Speed/Courteous, Turn signals, etc. _____	PASS	FAIL

Corrective action taken/comments: _____

_____

_____

_____

_____

_____

Rating: ☐ Pass – Safety Policy/Procedures Followed; ☐ Fail – Please correct, counseled on site.

Observer: _____ (SIGNATURE) Contractor/TWC employee: _____ (SIGNATURE)

Print _____ Print _____

Project manager signature _____

white – file copy yellow – directory copy pink – contractor copy

Revised 4/6/99

are acceptable. If they are not, the contractors get a fair amount of time to improve and update their program.

The review process has educated contractors on regulatory requirements that previously were overlooked or disregarded. The result is better quality safety and operation programs as well as increased awareness on the part of both contractors and cable companies.

Reducing liability is a real concern. As a result of this program, a recent event proved to us that our evaluation program was worthwhile and "cheap insurance." OSHA inspected one of our contractors and was about to fine both them and us. We showed OSHA this program and our field audits as proof of "due diligence" with our contractors, and OSHA eliminated the fine.

Field safety audits

The second major part of the program involves creating a Field Safety Inspection form (see sample on page 193), which our field supervisors use to monitor both our in-house crews and contractor crews in the field. One of our supervisors audits each contractor once a day when they are working on our plant. Copies of the audit sheet go to the contractor field personnel on the spot.

If we discover a situation during an audit that is "immediately dangerous to life and health," supervisors can stop all work until the problem is resolved. The second copy goes to the contractor's home office. The third copy of the audit sheet stays at the project level until the contractor corrects problems, and then it goes to division safety for review and trend monitoring.

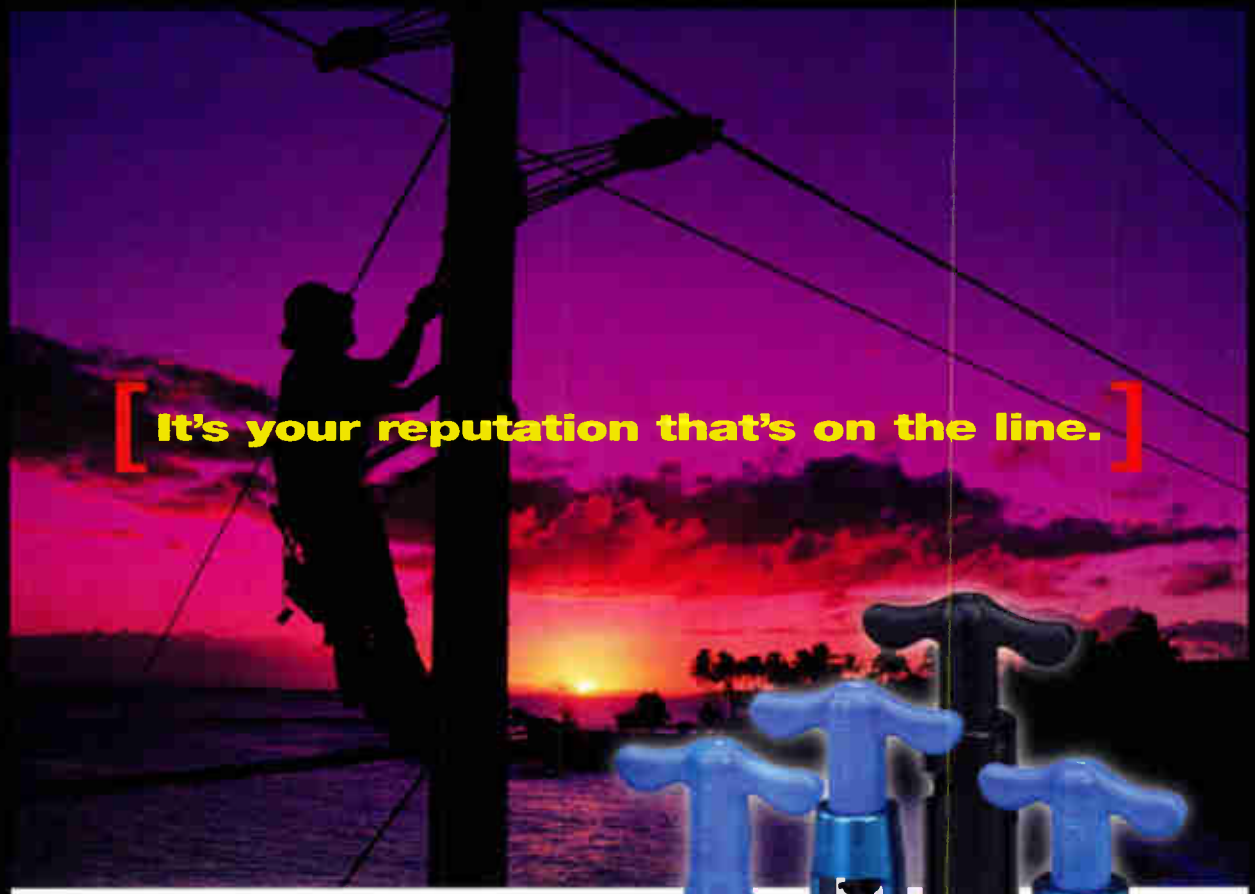
In conjunction with this, the division safety manager performs contractor field office safety audits to check documentation of training, availability of forms such as the OSHA 200 and 2203, and ensure that written safety programs are available.

Industry specific training

The final piece of this program began in 1998 when we trained all of our personnel in OSHA Telecommunications Standard 29 CFR 1910.268. Part two of this piece will be industry-specific training for contractors. For this training, we commissioned an outside firm to develop a one-day course on understanding the 29 CFR 1910.268. This program contains lectures, workshops, overheads, videos and tests to document "proof of understanding" of participants. This course is being scheduled throughout the country. Late in 1999, a "Train the Trainer" course, which is under development, will become available to in-house and contractor personnel.

This program has worked for us, and I encourage you to implement such a program for your company. It works for any industry because it can be customized to fit each industry's specific safety and health requirements, and costs are borne by the contractor. Don't let that sleeping liability wake up and become a bear. TB

John Young is safety and fleet manager for the construction division at Time Warner Cable in Englewood, CO. He can be reached at (303) 705-4576.



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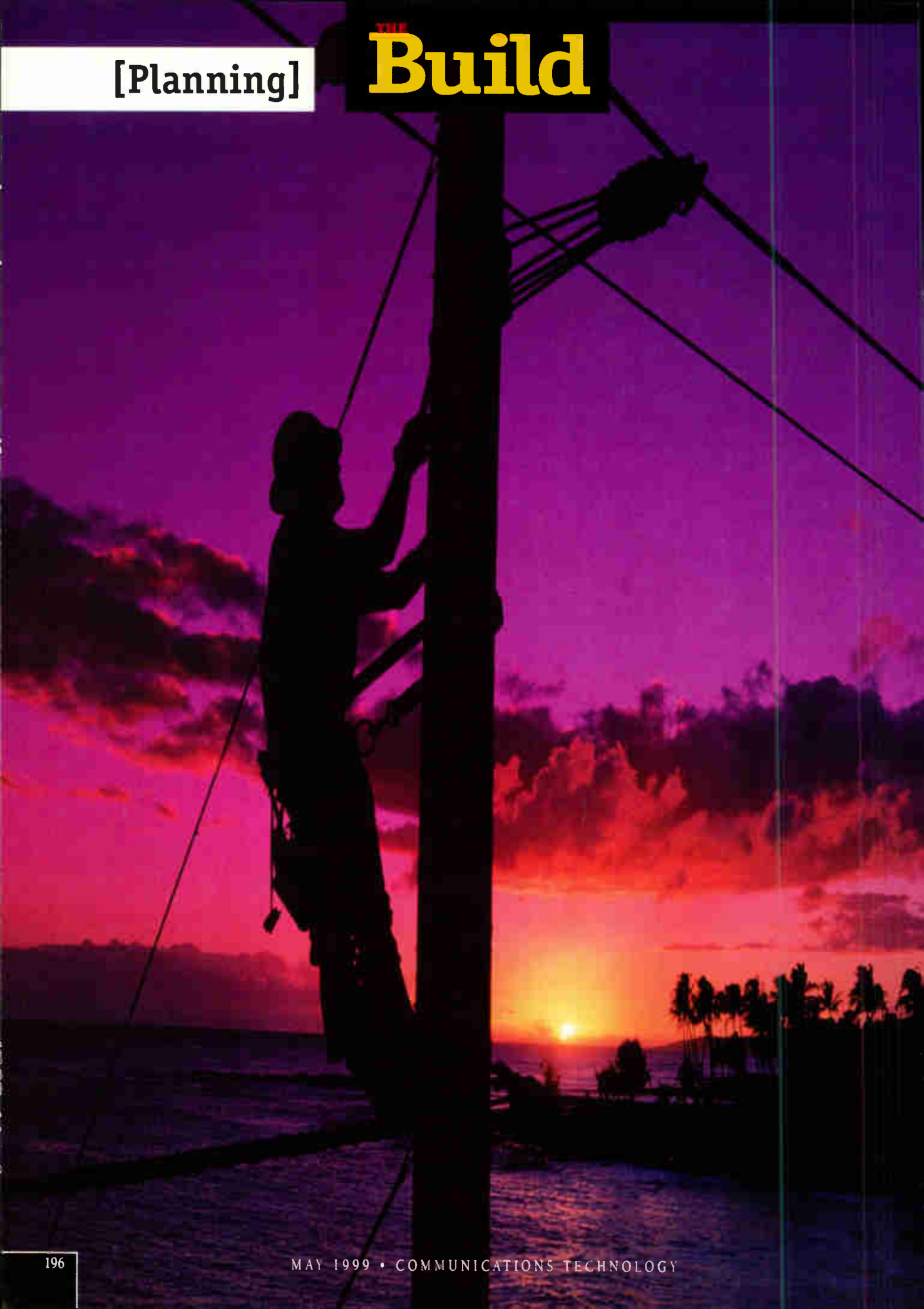
[Planning]

THE Build



Contractors in Paradise

Cable Opportunities for the Next Decade

By Jennifer Whalen

With business booming in the cable contracting market, it may seem like an odd time to plan for the future, but that's exactly what members of the Power and Communications Contractors Association did during their recent meeting in Maui, Hawaii. Between mai tais, the contractors examined opportunities in cable after the upgrades are complete, the impact of change on a construction site, and advances in fiber-optic placing equipment. ➤

Incoming President Richard Scoggins (left), presents the PCCA's Distinguished Service Award to outgoing President Gary Akin (right).

PCCA 1999 officers
President: Richard Scoggins, Chapman Construction
President Elect: Ken Trawick, Trawick Construction
1st Vice President: Guy Fugal, Niels Fugal Sons
2nd Vice President: Charles Duff, Mastec-Telecom/Burnup and Sims
Treasurer: Steve Spears, Bonneville Construction
Secretary: Bill Schroeder, Flowers Construction

Contractor council steering groups
Cable Television Group Leader: Austin Shanfelter, Mastec-Broadband/Burnup and Sims
Telephone Group Leader: Ken Trawick, Trawick Construction
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Keith Burkley, vice president of construction for Time Warner Cable, advised the contractors to be flexible in their approaches to new work opportunities. While cable builds and upgrades continue now, he cautioned that work will slow.

"The lion's share of cable activity will end around 2001," Burkley predicted.

So, what happens after that? Work will be available "upgrading the upgrade." "There will be a lot of opportunities if people can look forward and plan," Burkley said.

One area where contractors can expect future work is adding network power. Cable operators will need additional power supplies as well as standby power to support new, advanced services.

"We didn't put in standby powering unless the franchise required it," Burkley explained. Of course, adequate powering is an essential ingredient for network reliability.

Burkley also anticipated that as cable operators roll out high-speed data and voice services, they may need to take another look at node sizes.

"With new services like cable modems, the current node sizes may not work. We just don't know. It depends on usage rates," he said. Burkley predicted node contraction from 500 homes per node to 250 nodes or fewer, depending on traffic patterns. For contractors, this means the opportunity to add more fiber to the network and rework the existing coax plant.

Regional interconnection

Cable operators are expected to begin building regional fiber interconnects in the future as well.

"Economics support them when multiple telecom services are being delivered," Burkley explained. "We're starting to link all of our operations together to support Road Runner and telephony."

Time Warner Cable is building regional fiber interconnects in New York, North Carolina, Texas and Florida.

"Eventually you'll see cooperative regional fiber interconnects between smaller systems," he added. Burkley predicted cable operators will build 50,000 miles or more of regional fiber interconnects by 2010.

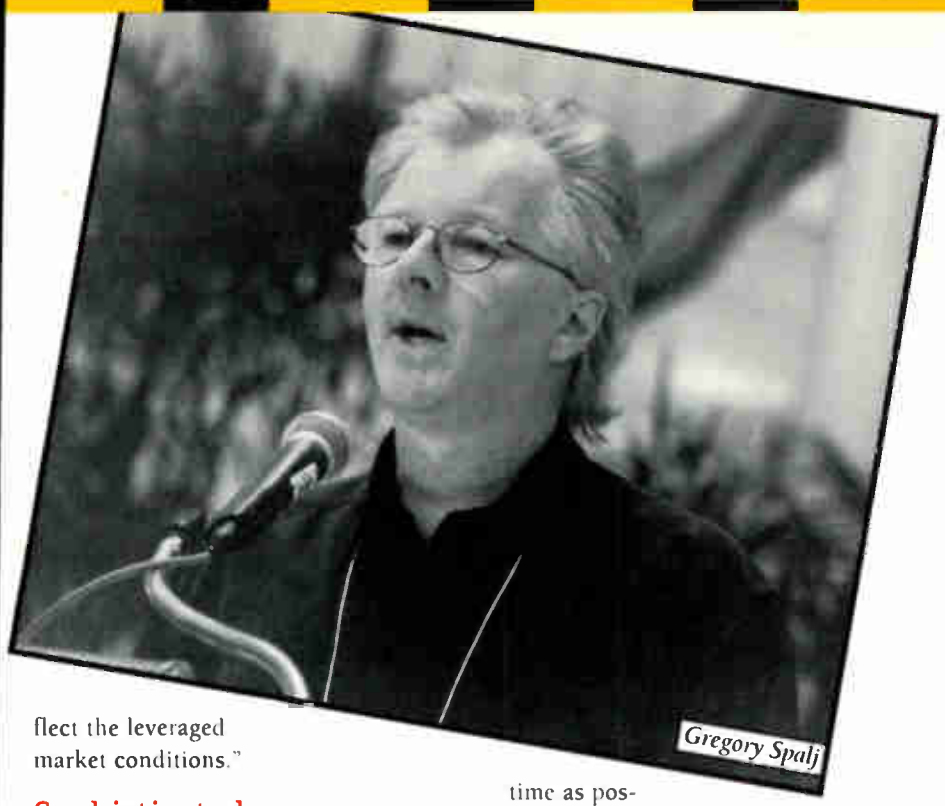
Outsourced maintenance

Burkley also made a case for contractors to get involved in outsourced system maintenance. Capital improvement projects offer the largest opportunity. Such work could include road widening, aerial-to-underground initiatives from local governments, bridge work, urban renewal efforts and other projects that would require the operator to change the configuration of its plant. Contractors could also aid with replacement of bad cable caused by environmental conditions, aging, initial poor craftsmanship and so on.

"The incumbent upgrade contractor in a large clustered market should never leave," he advised. "With the investment they've made in assets, people and the community, the opportunity should exist for a maintenance contract."

However, Burkley cautioned the contractors on the need to adjust prices to reflect the new work.

"I don't think you will be able to bring the same pricing structure to outsourced maintenance activity as you did to new build activity," he said. "Prices and services need to re-


Gregory Spalj

flect the leveraged market conditions."

Sophisticated workforce needed

With cable operators actively adding cable modems, digital TV (DTV), and telephony to their service offerings comes a need for a workforce trained in sophisticated communications technologies. Burkley outlined two areas—inside plant and subscriber premise—where contractors could help provide such a workforce.

"More sophisticated services mean more headends, hubs, central offices and server banks," said Burkley. Contractors could help build and maintain those inside plant facilities. "There is a significant scarcity of resources in that area."

He added that while contractors may face downward pricing pressures to perform maintenance services, the scarcity of qualified personnel for inside plant work will drive prices up for those services.

Operators also may need help at the subscriber premise to install high-speed Internet services, such as Road Runner and @Home, and add cable telephony.

"The cable telephony projections are enormous—millions of installations between 2000 and 2005 and beyond," Burkley said, adding that with AT&T aggressively involved in cable telephony, the need for such installations will ramp up dramatically. "My sense is that AT&T will want to do this in as short a time as possible to grab as much of the market as it can."

Burkley's final advice to the PCCA: "Look beyond today's busy schedule, and develop a three- to five-year business plan."

Coping with changes

Today's busy schedule is, of course, what's on the top of every contractor's mind. With intense pressure to complete projects as quickly as possible, some communications companies are asking PCCA members to begin cable construction without a written contract in hand. Also, changes are flying fast and furiously to the job site.

"The project that you bid is not the project that you'll build," warned Gregory Spalj, an attorney with Fabyanske, Westra and Hart.

Spalj cautioned the contractors to recognize that multiple project changes can significantly slow productivity at the site. Whether you use contractors or your own crews to build and upgrade your systems, you need to understand this fact as well.

"You need to consider what's the impact of the change on the work that's not being changed," Spalj said. "Will there be overtime for the crews? Will you need more supervisors?" He cited one project that received more than 600 change orders, which transformed the project from a $6

million job into an $11 million job. "After 600 changes, productivity was in the hole," Spalj added.

For example, assume that the project owner asks the contractor to add another 50 miles of cable to a job that originally was 150 miles. The contractor may need more personnel to get the extra work done, which means he has to hire new people or take crews from other work. Productivity goes down because the contractor has pulled crews and equipment from other parts of the job to complete the changed work.

The same thing is true of permitting delays and the like. If you're building a 150-mile fiber link and you don't get all of your permits lined up in time, this means your crews or contractor will have to hopscotch around to various parts of the build, rather than doing the work in a linear fashion. Each time you have to start and stop work and move crews or equipment back and forth, productivity slows.

"Your crews start to slow down because they know another stop is coming," Spalj explained.

There's also a price impact. The contractor may have negotiated a unit price for cable installation and guaranteed a completion date based on the amount of manpower and equipment needed for the original 150-mile job. Now the owner wants the same unit price for the additional 50 miles. But costs are higher because the contractor has to spend time and money finding additional people and moving more equipment to the site.

"Standard communications contracts require that the contractor receive change orders in writing before proceeding."

Get it in writing

Spalj advised the contractors to insist on receiving every change order in writing, no matter what pressure the on-site representative for the owner is putting on the job foreman.

"If you start getting changes, you need to immediately send in written notices that the change is impacting the job, or you will lose the chance for more money," Spalj said.

He also reminded attendees that standard communications contracts require that the contractor receive change orders in writing before proceeding.

"Chances are you won't have been given written changes, and the person in the field won't have the authority to

make changes," he said. He advised the PCCA members to find out who has contractual authority to make changes; if the contract requires written change orders before proceeding, he said, "Demand them in writing."

Aerial construction

With pressure increasing to improve job-site productivity—even without 600 change orders flying in your face—contractors are seeking new and efficient construction methods. Some of the PCCA's associate members, including Brad Radichel, president of Condux International, outlined equipment advances that may benefit contractors.

Condux, which specializes in fiber blowing and pulling equipment, is expanding its business to include aerial cable installation.

"We're developing aerial products to speed the installation process and protect the cable," explained Radichel.

Among those products is a new aerial lasher designed to handle up to 3.5-inch diameter cable and provide one wrap per linear foot. Radichel also noted that the lasher will be lighter than others in its class and that you'll be able to transfer it around a pole with just one hand. Condux is testing the prototype now and expects to begin shipping the lasher some time in the second quarter.

Protecting the fiber inside the cable is a key design goal of the new aerial products. If your crews or contractors damage the cable during installation, you've got a very expensive clothesline on your hands. There's also a warranty issue.

"If the manufacturer can prove that the cable was not installed properly, the warranty is void," Radichel explained.

Also in the new lineup are hanging cable blocks designed for multiple cables.

These cable blocks provide temporary support, minimize oscillation and help ensure that cables are in the correct position prior to lashing. Condux also is working on a corner cable block that would reduce pulling friction at corners, guide the cable and ensure that the fiber does not exceed the maximum bend radius, which would damage the fiber.

All work and no play?

The meeting wasn't all work—after all, the PCCA was in Hawaii. The contractors continued their discussions out on the surrounding Wailea golf courses, and more than 90 souls braved the 38-mile bike ride down the volcano Haleakala. The PCCA heads next to Santa Fe, N.M., for its summer meeting July 22-24. Come the new year, the contractors will be in Santa Barbara, Calif., March 11-15, 2000. For information, call (800) 542-7222. CT

Jennifer Whalen is the editor of "Communications Technology." You can reach her at (301) 340-7788, ext. 2057 or via e-mail at jwhalen@phillips.com.

THE SPLICE IS RIGHT

Mechanical or Fusion: What's Your Bid?

By Todd Rhyne and Jason Arnold

In the outside plant or commercial building and campus environment, the installer often can avoid the requirement of fiber-to-fiber splicing by installing a continuous length of fiber cable.

This is normally the most economical and convenient solution. However, because of the cable plant layout, length, raceway congestion, or requirements to transition between nonlisted cable types at the building entrance point, sometimes splices are necessary.

When that happens, it's critical that you choose the best splicing technique for your application. Field splicing methods for optical fibers can be grouped into two major categories: fusion and mechanical.

There are advantages and disadvantages for both methods, but the choice depends upon the application, customer's preference, volume of fiber splicing, as well as the installer's equipment, preference and level of training. Both methods are field-proven and have long-term reliability.

Fusion splicing

Fusion splicing consists of aligning two clean (stripped of coating), cleaved fibers, then joining and fusing the ends together with an electric arc. The fiber ends are positioned and aligned using various methods, including fixed V-groove, profile alignment, or light injection and detection.

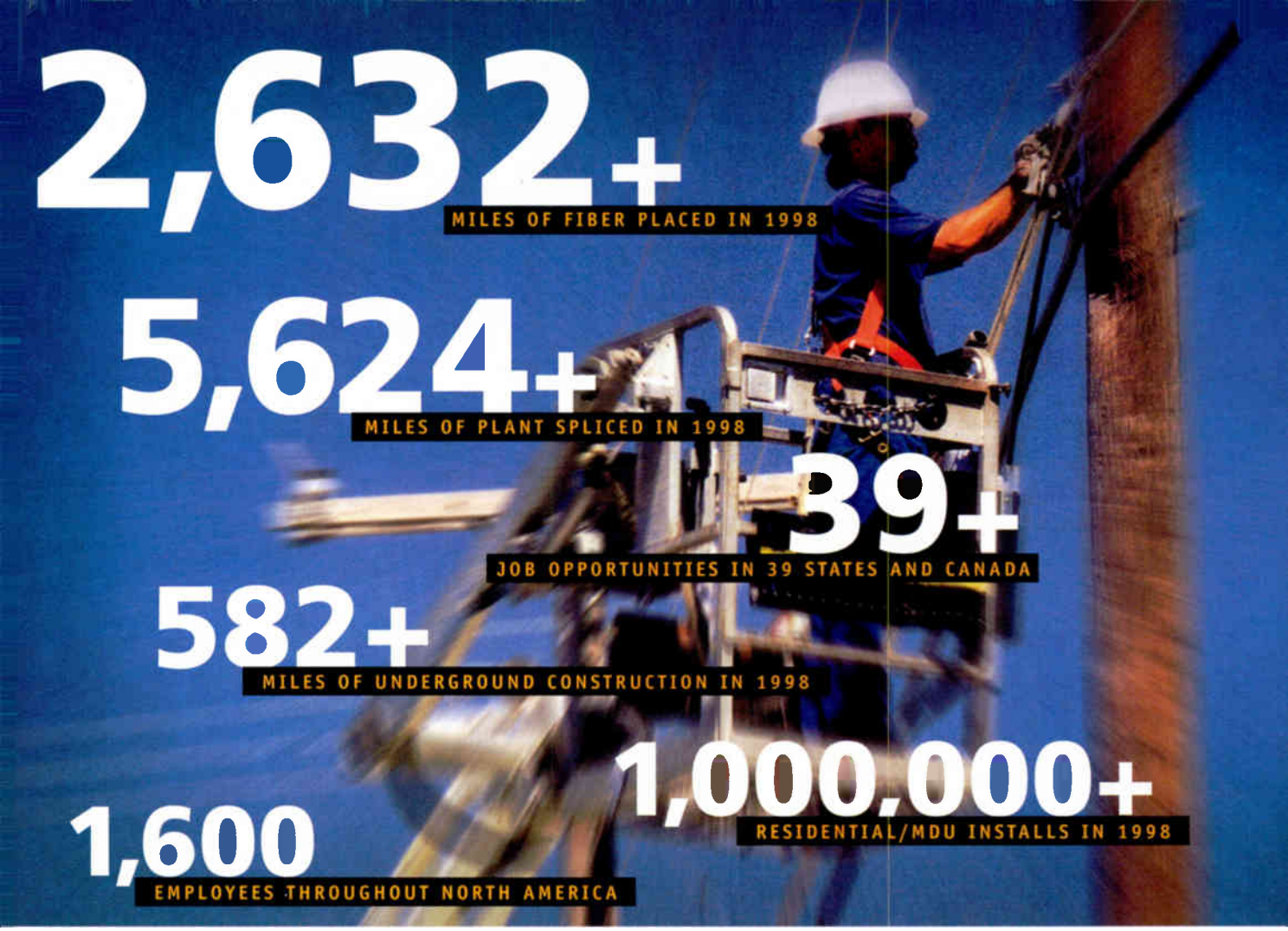
> "The economics of each type of splice depend largely upon the number of crews, volume of splicing per crew and the labor rate."

This alignment can be manual or automatic and normally is accomplished with the aid of a viewing scope, video camera, or a specialized type of optical power meter for local injection and detection of light.

High voltage applied to the electrodes in the splicer generates an arc across the fiber ends as the fibers move together, thus fusing the fibers. (See the accompanying figure on page 208.) The splicer can verify maximum core alignment prior to splicing and can estimate splice loss after the fusion process by using local detection devices and profile alignment devices. Currently, fusion splicers are available in a wide range of prices and features.

The high-end machines typically come with a fiber cleaver, a liquid crystal display (LCD), built-in batteries for field use and automated functions that align the fibers using local injection detection devices. Not only do these fusion splicers automatically align fibers, determine cleave quality and fuse the fibers, they also offer splice optimization and verification systems and provide accurate splice loss estimates.

Medium-range splicers generally align fibers by means of video cameras, known as profile alignment systems. They sacrifice splice optimization, but offer automat-



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When choosing a splicer, be sure to evaluate its field loss, which indicates expected performance under actual field conditions, allowing for variations in climate, cleanliness, cleaving and operator training. Both photos are courtesy of Siecor.

Most splicing problems usually stem from simple things such as dirty equipment or improperly cleaved fibers.

ic operation and splice loss estimation critical for low splice loss. They cost less than the high-end machines, but still are capable of producing low splice loss results.

Low-cost splicers typically are designed around fixed V-groove technology. They offer the low-reflection characteristics inherent in fusion splicing with good splice loss and productivity.

Mechanical splicing

A mechanical splice, by comparison, is an optical junction where two or more optical fibers are aligned and held in place by a self-contained assembly approximately two inches in length. Single-fiber mechanical splices rely upon the alignment of the outer diameter of the fibers, making the accuracy of core/cladding concentricity (CCC) critical to achieving low splice losses.

This method aligns the two fiber ends to a common centerline, thereby aligning the cores. The cleaned fiber ends are cleaved, inserted into an alignment tube and butted together. The tube has factory-installed index matching gel to reduce reflections and loss at the splice point. Usually, the fibers are held together by compression or friction, although some older methods rely on epoxy to permanently secure the fibers.

Mass splicing

For high fiber-count applications, an increasingly popular method is mass splicing. Mass splicing can be fusion or mechanical. The term mass indicates that multiple fibers are being spliced at once, typically in a ribbon configuration. Most common today are 12-fiber ribbons.

The chief advantage of mass splicing is speed. Mass splicing typically is four to five times faster than single-fiber splicing.

The principles of mass splicing are the same as for single-fiber fusion and mechanical splicing. However, precision is even more important because one bad fiber can be enough cause to remake an entire 12-fiber splice. Proper fiber preparation and cleaving, in particular, become much more important with mass splicing.

The system designer needs to understand the loss requirements of the fiber system and the capabilities of the various types of splice equipment under field conditions to manage splicing trade-offs of productivity and splice loss when choosing between single-fiber or mass splicing.

You do not necessarily need ribbon fiber to take advantage of mass splicing. Sometimes it's necessary to splice loose tube cable to ribbon cable. One method is to break out the individual fibers in the ribbon cable for single-fiber splicing, or ribbonize the fibers from the loose tube cable.

Four Tips for Better Splices

Fiber-optic splicing is light-years ahead of where it was a decade ago. While the underlying technologies have not changed drastically in that time, manufacturers continue to make their fusion splicers easier to use with each new generation. The technology behind mechanical splicing also has changed little. Current mechanical splices and fusion splicers are both so user-friendly that most users can produce acceptable splices with very little training.

The methods are not foolproof, though. There still are several things necessary to make splicing work proceed smoothly. Here are four tips to consider when splicing fiber-optic cable:

1) **Clean your splicing tools thoroughly and frequently.**

This topic often is slighted in discussions of splicing. When there is a problem, it is easy to fault the product at hand, be it a fusion splicer or a mechanical splice, instead of searching for the true trouble, which often is just dirt. Keep in mind that fiber specifications are measured in terms of microns, or millionths of a meter. Particles invisible to the naked eye can wreak havoc on a splice.

To avoid cleanliness problems, simply clean components per the manufacturer's instructions until you think they are acceptable. Then clean them again. This may seem excessive, but time spent up front cleaning your fibers and tools will pay off—you won't have to stop in the middle of a job to troubleshoot what turns out to be a simple cleaning issue.

2) **Operate and maintain your cleaver properly.**

This variable can affect your splice regardless of the fusion splicer or mechanical splice that you are using. Mechanical splices require a certain angle on the fiber endfaces, or too much light will escape in the air gap between the two fibers. Index matching gel helps to couple the light from one fiber to another, but it cannot overcome a low-quality cleave.

Fusion splicers need even better cleaves to achieve their exceptionally low losses (0.05 dB and less). Unless the cleaves are within a few degrees of perpendicular, the two fibers might not melt together properly.

The best way to obtain a good cleave is to follow the manufacturer's instructions, especially in two areas. First, clean the cleaver regularly, and replace the blade when necessary. Second, remember the precision involved in this process, and operate the cleaver accordingly. Do not pound on it like a stapler or use it in a hurry. Always use slow, smooth actions to operate the cleaver. Using this tool properly will reduce trouble during the splicing process.

3) **Adjust fusion parameters minimally and methodically (fusion splicing only).**

The two factors that most affect a fusion splice are fusion current and fusion time. Different variations of these two factors can produce the same splice results; that is, a low fusion current and a high fusion time can sometimes produce the same result as a high fusion current and low fusion time. Most fusion splicers have preset programs that already have these parameters (and others) optimized for the most common fiber types. In the majority of situations, these parameters work fine.

Many splicing technicians begin adjusting these parameters as soon as there is a hint of a problem. In reality, problems usually stem from something simple, such as dirty equipment. Eliminate the simple possibilities before fiddling with the fusion parameters.

If you must change a parameter on the splicer, work first with fusion current or fusion time. Change only one of them at a time, and see what effect the change has. Changing two parameters at once can mislead you as to which change actually had the desired effect. Once you have "optimized" your parameters, save them in a user-created program (an option available on many splicers) for future use.

4) **Compensate for poor core/cladding concentricity (CCC) with a core-aligning splicer.**

CCC is often touted by fiber manufacturers, but is rarely heard in the field. CCC refers to how the core is centered inside the cladding of an optical fiber. As the core gets further off center, it becomes more and more difficult to passively align that fiber with another one.

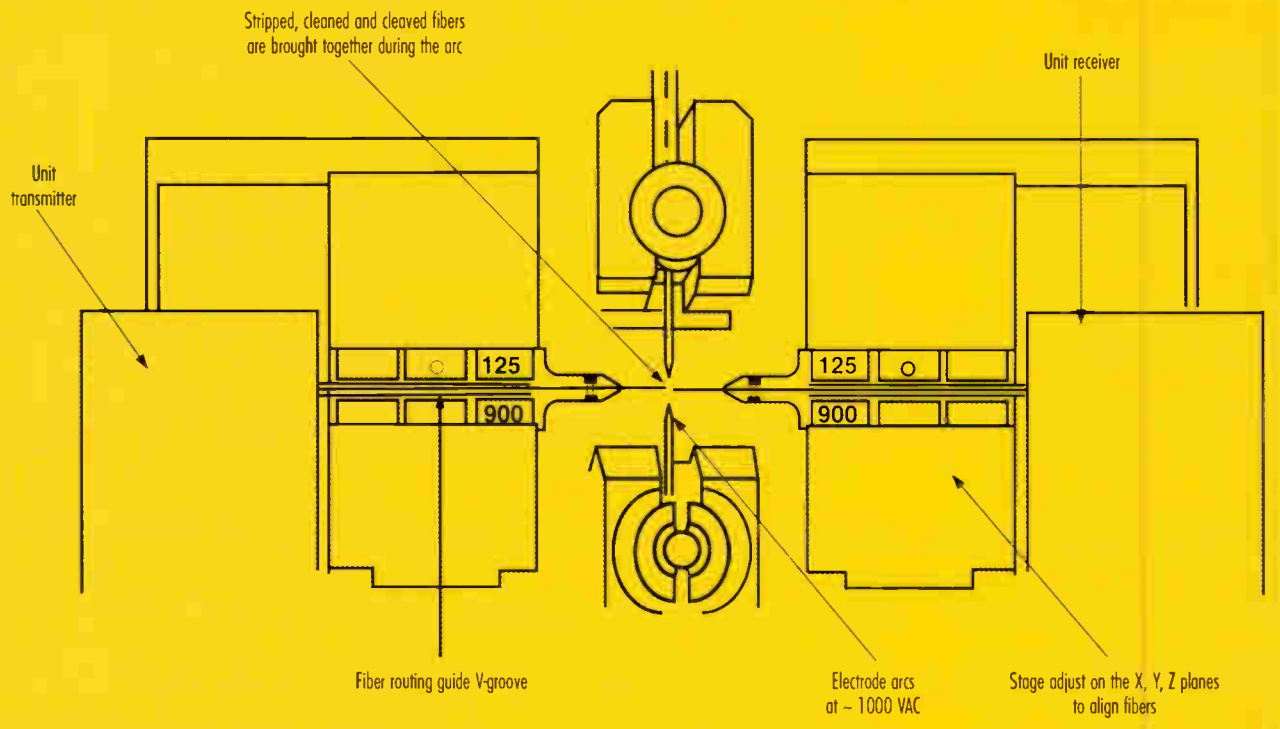
The difficulty increases if the second fiber has an off-center core as well. Fibers with poor CCC typically are found in older cables produced before 1990 and in some cables produced "offshore" by less experienced manufacturers.

Fiber with poor CCC requires special attention. The problems that technicians encounter when splicing this type of fiber are mostly due to using the wrong technology. Passive alignment techniques don't always work in this situation. Mechanical splices and fusion splicers using fixed v-groove technology (non-core aligning technology) will have difficulty with this fiber because they require excellent fiber geometry.

The only way to achieve consistently good splices on fiber with poor CCC is to use a fusion splicer with some type of active alignment that focuses on aligning the fiber cores regardless of their position within the cladding.

While fiber-optic splicing has grown easier over the years, remembering a few basic concepts can make it even simpler. Keep everything clean, cleave properly, adjust your parameters sparingly and always choose the right technology for the job. Follow these tips, and fiber-optic splicing will be easier than you ever would have thought possible.

How a fusion splicer works



Splice protection

Fusion and mechanical splicing are reliable and suitable for indoor and outdoor use when the splices are completed in accordance with the manufacturer's instructions and allow for adequate protection.

When splicing outdoors, typically the splices and stripped cable should be protected by a splice closure. When the cable is installed in a splice closure, there are various methods of providing strain-relief and protection of the stripped fiber splice.

All fiber splices are housed in splice trays or organizers inside a closure. The proper splice tray must be selected based on the type of protection required by the splice. For example, mechanical splices have a form of strain-relief and fiber protection built in, which are then secured in a splice tray or organizer.

Fusion splices, however, require additional protection and strain-relief. You can provide this protection with heat-shrink sleeves, crimp protectors or silicone sealant. Heat-shrink and mechanical crimp connectors are the most common methods.

When splicing inside a building, you can use a splice center when rack or wall space is available. Additionally, most termination patch panels have built-in or accompanying splice centers that allow you to perform fiber termination and through-splicing when required. ➤

The Bottom Line

Fiber Splicing Options

Field splicing methods for optical fibers fall into two major categories: fusion and mechanical. There are advantages and disadvantages to both methods, but both are field-proven and reliable.

Fusion splicing consists of aligning two clean (stripped of coating), cleaved fibers, then joining and fusing the ends together with an electric arc. The fiber ends are positioned and aligned using various methods. This alignment can be manual or automatic and is normally accomplished with the aid of a viewing scope, video camera or an optical power meter.

A mechanical splice is an optical junction where two or more fibers are aligned and held in place by a self-contained assembly. Single-fiber mechanical splices rely upon the alignment of the outer diameter of the fibers, making the accuracy of core/cladding concentricity (CCC) critical to achieving low splice losses.

The cleaned fiber ends are cleaved, inserted into an alignment tube, and butted together. The tube has factory-installed index matching gel to reduce reflections and loss at the splice point. Usually, the fibers are held together by compression or friction, although some methods rely on epoxy.

General considerations

While fiber splicing has been performed for several years, the technology is quite dynamic, with the introduction of faster, simpler, and less expensive splicing equipment and consumables. This is especially true for multimode fibers in the commercial building and campus markets.

The chosen splicing method affects both equipment (fusion splicer, mechanical splice fixtures and so on) and hardware requirements (splice trays, splice closures, and centers to store and protect the splices).

The primary considerations for an installer when determining the most appropriate method are:

- Capital or rental expense vs. consumable expense
- Loss requirement
- Volume of splices per crew (annually)
- Number of crews being deployed simultaneously
- Labor costs
- Customer preference
- Training
- Reliability
- Reflection requirement

If fusion is your chosen method, think about attenuation or loss performance when selecting a splicer. Manufacturers generally list field loss and laboratory loss. Typical loss in the field indicates expected performance under actual field conditions, allowing for variations in climate, cleanliness, cleaving and operator training. The laboratory specification indicates best-case performance under ideal conditions. Specification sheets always reference this value unless otherwise stated.

An installer faces a capital investment or rental charge for fusion splicers, depending on the type of machine. The mechanical splice requires a nominal charge initially. However, mechanical splicing requires a per-splice consumables cost, whereas fusion splicing essentially has none.

For an installer who owns a fusion splicer, fusion splicing is the most economical method. The economics of each type of splice depend largely upon the number of crews, volume of splicing per crew and the labor rate. The time required to perform each type of splice depends somewhat upon the experience of the worker. Fusion splicing ranges from 2 to 3 minutes per splice once setup and preparation are complete.

The installer also must consider how the fiber will terminate and whether field connectorization or pigtail splicing are necessary. It usually makes sense to use the same splicing technology, if possible, for through-splicing and pigtail termination splicing. Also, think about training. Fusion splicing is a technical skill that must be acquired through an initial training period. Mechanical splicing, however, requires little training, and many crews can be trained and equipped quickly.

Keep splice loss in mind

Splice loss values are comparable between mass fusion and mechanical means, while high- and medium-range single-fiber fusion splicers offer better loss values. When designing a system, a designer needs to allow sufficient loss margin for the aggregate splice loss.

Though TIA/EIA-568A Commercial Building Telecommunications Cabling Standard allows for a maximum individual splice loss of 0.30 dB for multimode fibers, today's technology makes average losses of 0.10 dB or better possible.

Lastly, installers must consider the preference of the customer. For example, many customers, including long-distance carriers and cable TV companies, specify fusion splicing because of the low reflectivity needed for transmitting analog video signals.

For the majority of local area networks (LANs) and digital applications, reflections at splice points are insignificant. In those cases, it is preferable that the end-user specify end-to-end system attenuation and splice loss criteria and let the installation contractor choose the splice method. CB

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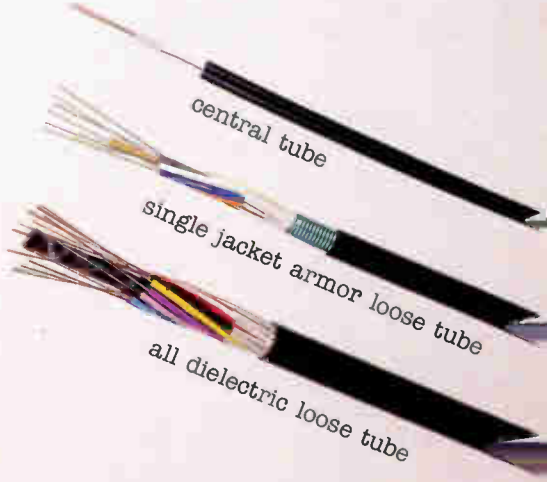

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Reader Service Number 124

By Curt Harler,
Jennifer Rampey Paire
and Gerald W. Johnson, Jr.

Trenching Tools Tackle Tough Turf

Modern Gear, Techniques Reduce Digs' Disruptions

Laser guidance systems, complicated fuel mixes, running blind but providing pinpoint accuracy—this is not rocket science, but the world of cable trenching.

Whether operating a walk-behind unit or running one of the larger trenchers, you need to know what is going on above and below ground at all times. With the digging speeds and cutting capabilities of today's machines, you can't afford to make a mistake.

The industry has come a long way since Ed Malzahn invented the world's first compact trenching machine about a half-century ago. Expectations and demands are high.

Manufacturers have focused on improving the efficiency and productivity of their trenchers in the past few years, according to Yengst & Associates (Cyengst007@aol.com), a consulting and research company in Wilton, Conn.

One area of focus is operator comfort. Today, practically every trencher with a cab not only has heat, but also air conditioning. Seats are adjustable, and most swivel, so you can see all around a job without having to get up.

Case, Ditch Witch and Vermeer offer some of their models with auto-type steering and foot pedals for easier operation than levers.

Vermeer's trencher electronic control system (TEC 2000) automatically adjusts the machine to changing conditions, monitors operation and displays useful data.

Ditch Witch has power steering on some of its trenchers and makes four-wheel drive available on certain models.

Typically, trenches for transfer utilities are about 8 to 12 inches wide and run 36 to 60 inches deep. For telecom applications, you need wire and cable trenches that are more shallow, notes Rich Nathenson, president of Concept

Engineering Group, based in Verona, Penn.

There's been a fair amount of variance in the width and depth of the trenches in recent years. Tom Clapper, who works in Grapevine, Texas, as Trencor's field sales manager for the United States and western Canada, says the greatest change he's seen is in the number of cables in each trench.

"The typical amount we used to run was one conduit—maybe two or three in a trench. One would be filled with fiber, and the other two would be saved for expansion," he says.

As each major telephone player begins to roll out service, each wants to have its own little empire.

"Now we're doing 16 conduits in one trench," Clapper says. As a result, trenches that used to be 4 to 6 inches wide with 48 inches of cover now run 16 inches wide and at least 48 inches deep. "You have to go deeper and wider to hold the extra conduit," he says.

Also, as rights-of-way become more congested, you have less space available in which to work. "You may be running down a right-of-way that parallels three or four services," Clapper points out.

> "The industry has come a long way since Ed Malzahn invented the world's first compact trenching machine about a half-century ago."

Offset trenching, which allows you to move the wheel or chain to either side of the machine, makes it easier to trench when the job requires working close to buildings.

As the business practices become more challenging, manufacturers are doing their best to roll out technology that meets the demands of workers in the field.

Market overview

According to Jon Lenz, market analyst with Yengst & Associates, the trencher market in North America grew from 8,500 units sold in 1993 to more than 12,000 in 1997.

"We're looking for things to slow down slightly in 1999, probably dropping back to just over 11,000 units," he continues. "By 2002, we're forecasting just over 13,000."

That number is in line with an expected slower economy. While there may be some sense of market saturation, Lenz says the market is simply taking a breather and not heading into a recession.

Plus, new technology seems to come along every few years that requires opening up new trenches. For instance, upgrading copper telephone lines led to fiber-optic installations.

Right about the time things slowed in the telephony industry, cable TV became busy. In the background is a steady flow of other uses for trenchers, such as installing irrigation and drainage lines. Repair work is a constant in all of these areas.

There are two major categories of trenchers. Most of the major players build ladder-type trenchers. Another category, bucket wheel trenchers, is quite specialized and rather small. The major oil and gas distribution pipelines contract out most bucket wheel trenching. Instead of calculating requirements in feet or meters, these machines take on jobs measured in miles or hundreds of miles.

Mini-trenchers

Lenz notes the rise in sales of small, walk-behind trenchers, or mini-trenchers, reaching about 3,550 units in 1996. Mini-trencher manufacturers target phone, power, satellite and cable installers, lighting companies, and other applications where you need only light trenching.

Where the typical walk-behind unit can weigh up to half a ton, a mini-trencher generally weighs about 100 pounds. In most cases, you can use them for shallow placement—usually 6 to 12 inches deep, although some units can go as deep as 24 inches.

The typical "mini" unit's lower weight and compact size means that

The Bottom Line

A New Age in Trenching

No longer is trenching a simple matter of digging a long, skinny hole of consistent depth.

Today's high-tech trenching systems can dig right next to buildings, keep dirt right next to the hole to reduce property disruptions and increase operator comfort and safety via car-type controls.

The two major categories of trenchers are ladder-type trenchers and bucket wheel trenchers. Another option for those who require only light trenching, not more than 24 inches deep, are small walk-behind mini-trenchers. Their chief virtues stem from their relatively small size and weight—one worker can transport and operate the unit, without need for a trailer or dump truck support.

When buying trenching equipment, make sure the dealership or supplier is close by and can provide a good stockpile of spare parts, well-trained mechanics, training programs and tech support for problems that you may encounter in the field.

Most importantly, call before you dig. Most state governments have a locator service to let you know whether there's a chance that your trenching operation will cut someone else's lines.

Find Those Buried Lines

Field locators work in a life-and-death industry. Most often, it isn't their lives that are in jeopardy, but those of backhoe operators, laborers in a trench, bore-rig operators or passersby. Many people get more training programming their VCRs than technicians do using a locating device. Utility companies and their locating firms must be committed to providing locators with the best possible training, not just what is available, convenient or cost-effective.

There are some factors to consider when training field technicians in the art and science of locating:

Commit to the locate training process. It looks like lost time and money on paper, but the rewards in safety, liability, reduced service outages and reputation will pay back tenfold.

Be prepared with a written, outlined, structured program. A hit-and-miss approach to training will just waste valuable time and money, and it will confuse the trainee.

Success is proportional to the amount of time trainees spend with an experienced, knowledgeable trainer. One trainer teaching four to six locators should be able to complete a comprehensive program over four to five weeks for one utility (add one week for each additional utility).

The art of locating is achieved only through understanding and application of the sciences that govern it. It's not easy learning the use of frequencies, current measurements, electromagnetic field distortions, and continuity without a degree in physics. Paint visual pictures, give lots of anecdotes, and use plenty of examples to illustrate your ideas.

Give trainees plenty of supervised practice. Better to make a mistake in front of you than when out on their own. Fifty supervised locates over a five-week period sprinkled with some of the hardest locate scenarios should prepare them well. The real world will prove intimidating if classroom practice was nothing but a cake walk.

Teach them to gather all information possible. Current measurements, field distortions, utility records, structure placements and more all play a part in the decision as to where a facility is placed. You must always be looking for the piece of information that doesn't fit.

Have an expected level of performance. Do not release people from training unless they can meet the expectation, which means you have to be accountable for their success. Be sure to give feedback and performance checks throughout training. When they first hit the field, audit their work for accuracy.

Be sure they understand the worst thing that could happen is that someone could die or be financially ruined as a result of their work. If that's not enough to motivate you to go to work everyday, you're probably in the wrong business. —*GWJ*

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you won't need a tow-behind trailer to get to a job site. Minis usually are small enough to carry in a pickup truck or inside a van.

It also means that you'll probably need only one person to transport, unload and operate the trencher—a real savings in payroll. Some units have steerable rear wheels, which give greater maneuverability.

Where full-sized trenchers generally can tackle any kind of ground, minis are more suited to improved properties, which means you can move gently across lawns.

Wide, pneumatic tires minimize lawn marks and keep compaction to a minimum, Lenz notes. In addition, the machines throw dirt very close to the actual opening. This clean trench makes it easier for you to backfill after you lay the cable.

Buying decisions

There are two further areas of consideration when purchasing trenching equipment. The first is the availability of a nearby dealership or supplier who can provide a good stockpile of spare parts.

If your company is like most others, it can afford to stock the common filters and links. However, when a major breakdown occurs, it is vital to have a trained mechanic available at a conve-

Three Options in Trenching

Hard, Dry Ground Tests Trencher

S&N Construction put some heat on Vermeer's V-8550 Hydrostatic Trencher/Plow last summer.

The dry ground was a challenge for communications network construction, but Crawford Smith, S&N's president, said the machine plowed right through.

"This summer especially, the ground was very tough to get through," Smith said, "but the strength of the 8550 does a super job. We put it to the test this year."

S&N, of Walkertown, N.C., and its subsidiary Pyramid Construction of Charlottesville, Va., do a great deal of network construction for telephone and cable companies.Smith said it handles full-service contracting for companies such as Sprint, GTE and other independents. Its services include putting in cable and conduit systems, splicing and placing fiber and coax, and engineering services.

Vermeer's V-8550 is a staple in Smith's fleet, with about a dozen in North Carolina, about double that in Virginia and a few in Pennsylvania. Vermeer has introduced a newer model, the V-8550A, which boasts approximately 30 percent more power.

"We use them every day on routine projects as well as bid jobs," Smith said. "We found them cost-competitive."

The machine's strength is part of its strong suit, too. Smith said crews use both the plowing and trenching options.

"It's a stout machine for doing the jobs we needed to have done," Smith said. "It's just a very strong machine. It will do the job easily, in very hard ground situations.

Slim Slit Saves Street, Stifles Suits

Schenck Communications' crews are moving through residential areas fast without leaving a trail of torn yards.

Using the Ditch Witch 8020T Turbo Trencher and its wheel trencher on back, the company cuts into streets where it can, avoiding the damage to residential yards that can be a hassle. Imel Wheat Jr., Schenck's vice president of operations, said using this method the company's production went up from 200 feet in yard construction per crew per day to 1,000 feet in yard construction per crew per day.

The combination of wheel trenching and a conveyor system that carries the dirt removed straight into a dump truck allows Schenck's crews to move through neighborhoods quickly.

"It only leaves a strip in the street," Wheat said. "There's no damage to front yards. It alleviates lawsuits. The only downside is getting the county's and city's permission to cut streets. For some of them, it's like cutting their heart out."

Schenck, which has its national headquarters in Woodinville, Wash., performs cable TV upgrades, long-haul fiber work, telephone and power installations throughout the United States. The company owns about 30 trenchers, including two of the Ditch Witch 8020Ts, which the company prefers for residential work.

Rock-Solid Trenching

Faced with 10 miles of intermittent rock—mainly granite—C.R. Fedrick Inc. pulled out its rock saw.

The Novato, Calif.-based company was installing a 23-mile, six-way duct and conduit system for GST Telecom California between Bakersfield and Tehachapi. Rock density ranged from 8,000 to 12,000 pounds per square inch. The company used Trencor's 860B rock saw, and it cut right through.

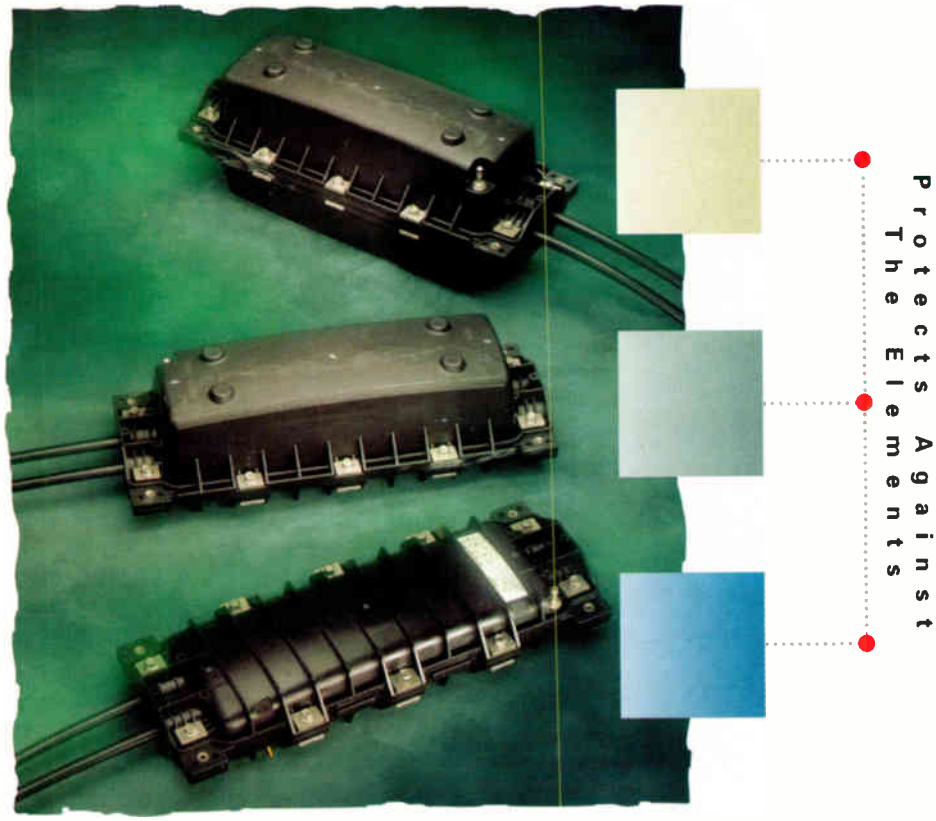
Todd West, C.R. Fedrick's vice president, said the rock saw took the company's trenching efforts one step further by focusing more horsepower in a precise area.

"You are able to cut easier because you are putting less of a surface area on the rock," West said. "It's a nice rock saw. It's done a wonderful job for us."

Fedrick installed water pipelines recently and has introduced telecom construction as a core business. Having powerful equipment is essential.

"We like to tackle the tougher projects," West said. "We feel our expertise is well-suited for those kinds of work, and it cuts down on competition. Not everybody had the machines to handle the effort, so we find that market niche pretty successful for us."

The 860B is capable of cutting into solid rock to depths of +8 in. —*JRP*



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nient, well-equipped location to handle the problem.

Local dealers can be a key source of early news on training programs from the manufacturer. They also have knowledgeable people on hand to discuss techniques and equipment to handle particular kinds of problems that you may encounter in the field.

Likewise, look at other equipment that can make your life on the job easier.

Locating gear

Most major manufacturers either produce or sell some sort of cable-locating or fault-finding equipment. The former is handy for locating buried cable, whether placed by your own crews or buried by another utility.

Fault finders allow technicians to detect cable faults. These instruments generally work by measuring voltage differences in the earth and translating that to pinpoint leakage.

Time domain reflectometers (TDRs) are used to locate cable faults by transmitting a pulse through the cable, measuring the time it takes for some of the pulse's energy to be reflected back to the TDR, and converting that information to distance.

Be sure that this equipment is simple enough to operate and that it can be read effectively by even the greenest member of the crew.

It will cost you money to have a trained equipment operator walking around trying to decide where you should begin digging instead of simply operating the heavy equipment.

Call before you dig

The No. 1 reason for failure of buried lines of whatever sort is inadvertent cuts, so utility companies are understandably nervous whenever anyone digs near their lines. Many states have enacted laws requiring you to call your local notification center before digging. You can find the phone numbers for your state's center in the first few pages of your phone book. TB

Curt Harler and Jennifer Rampey Paire are contributing editors specializing in communications. Gerald W. Johnson is quality assurance manager at SM&P Utility Resources. He can be reached via e-mail at geraldjohnson@sm-p.com.

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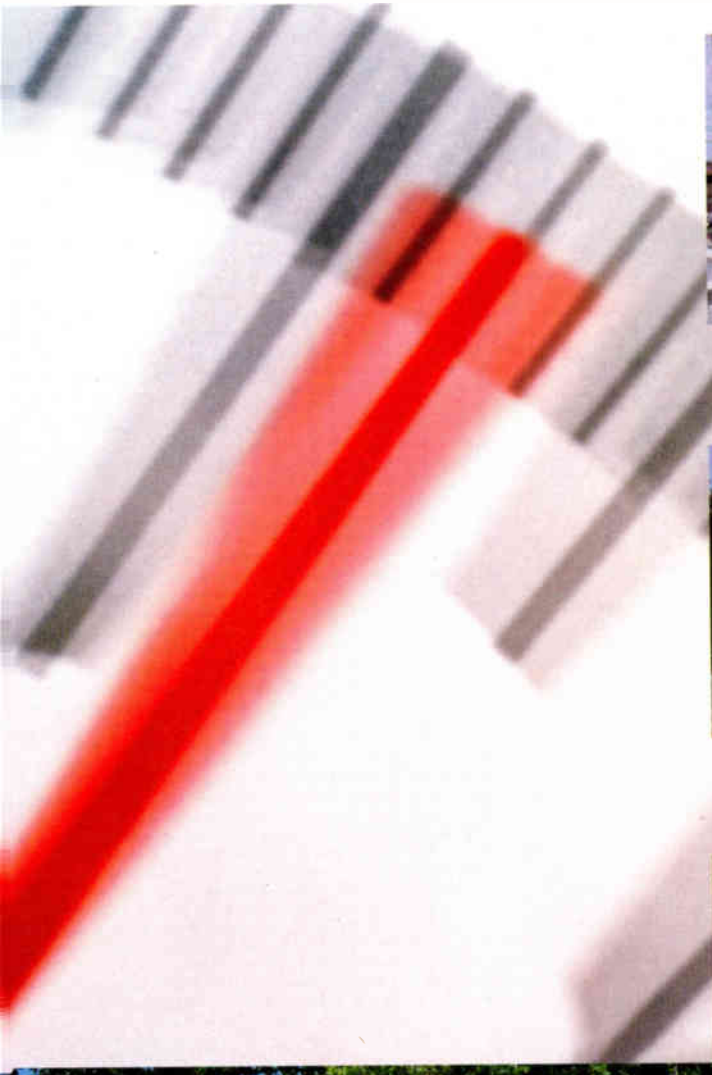

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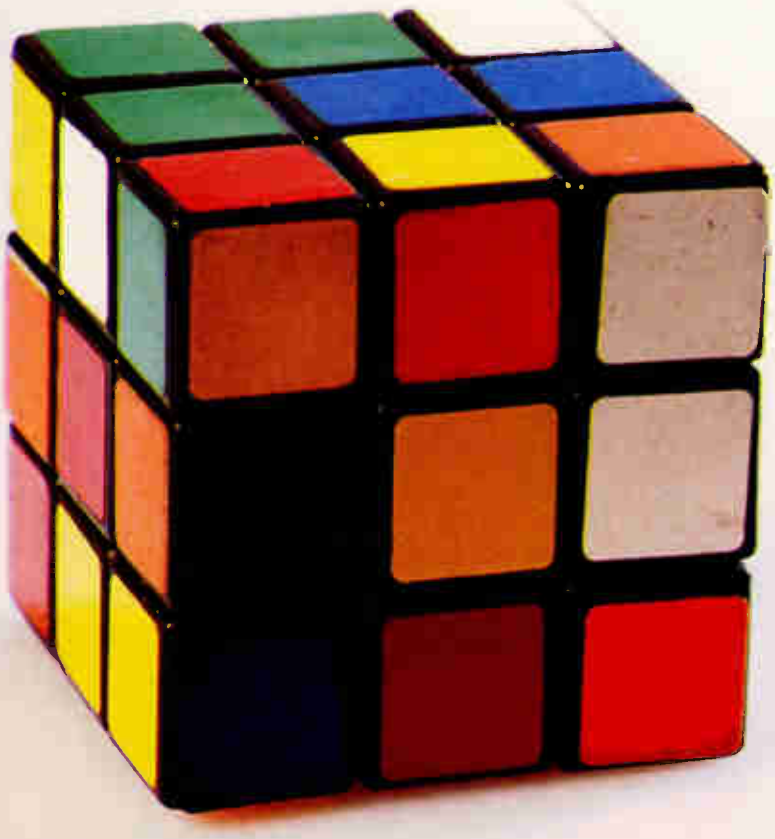

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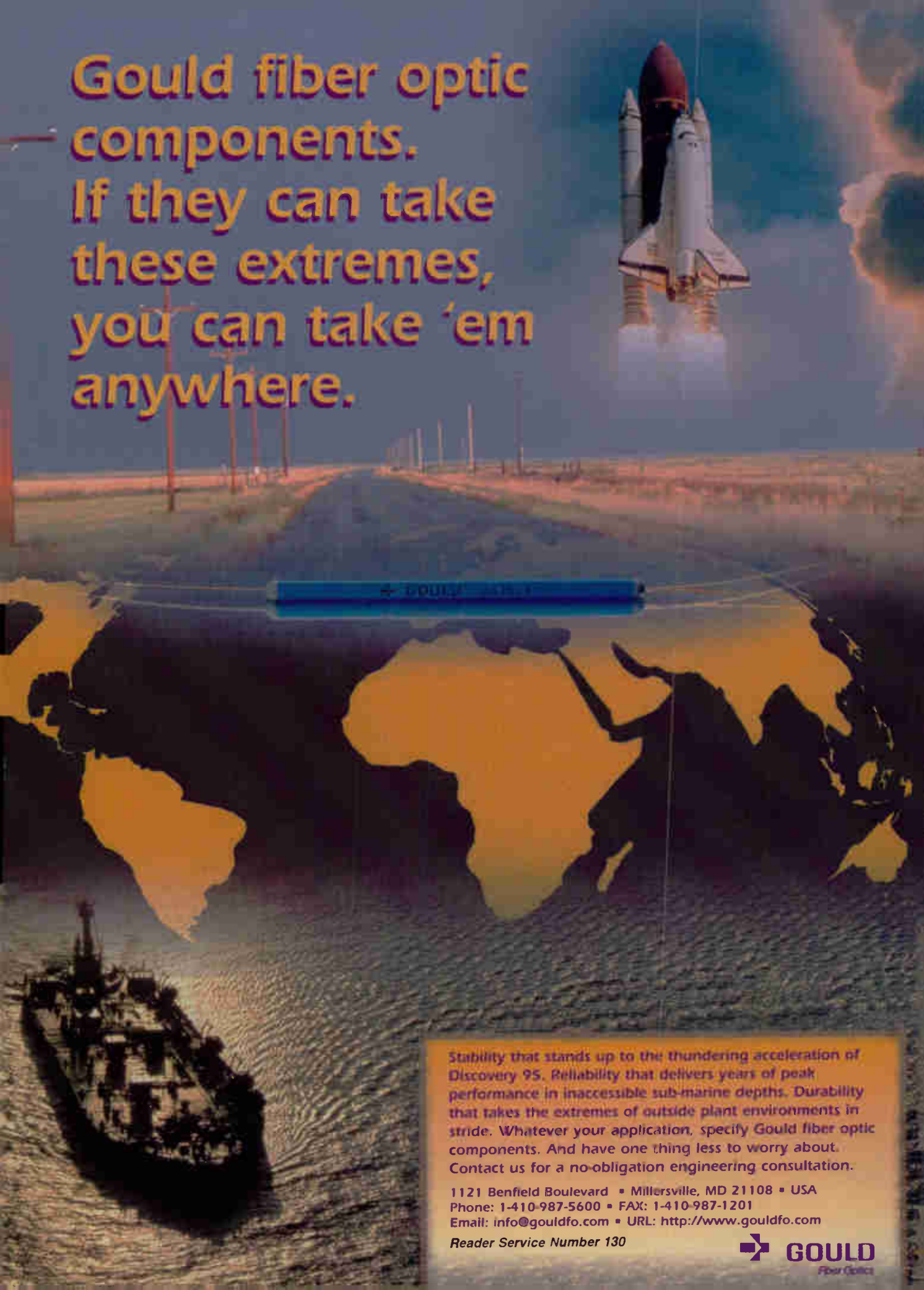
The Start of the Quality Quest, Not the End

By Daniel Callaghan

It began simply enough—we wanted to improve the format and content of our customer-training program. We planned to organize the curriculum, produce a top-quality media presentation, schedule training seminars by invitation throughout the United States and Canada, and charge for this improved training product to emphasize its added value. This unexpectedly led to ISO 9000 certification. ➤



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What seemed like a straightforward project quickly became complex. Once we finalized the format and content, we found our sales managers needed training on the software and use of the presentation equipment, as well as a general honing their presentation skills.

Once the sales managers were trained, other training issues came up. We needed to go through the same training process with our resellers. The logistics of scheduling and putting on a professional traveling seminar series demanded new skills from the marketing department. The sales order desk had increased (and welcome) contact with end users, requiring answers to new questions. Sales managers needed feedback on the training to handle action items proactively.

National Sales Manager Casey Pelton recalls, "It was an almost comical scenario, like finding gophers in your lawn. Just when you think you have it taken care of, another one pops up that needs attention."

When we began the training project, we weren't thinking about ISO 9000 certification at all. We just wanted to make a good thing better. But the team quickly learned that any improvement required training at all levels and in all dimensions.

In a way, quality improvement is in itself a form of continuing education for a company, its employees, its partners and its customers. We just happened to figure it out by working on a

The Bottom Line

Not as Easy as It Looks

Nothing worth having is easy to get, as we quickly found when we started what we thought would be a simple series of improvements to our customer-training program.

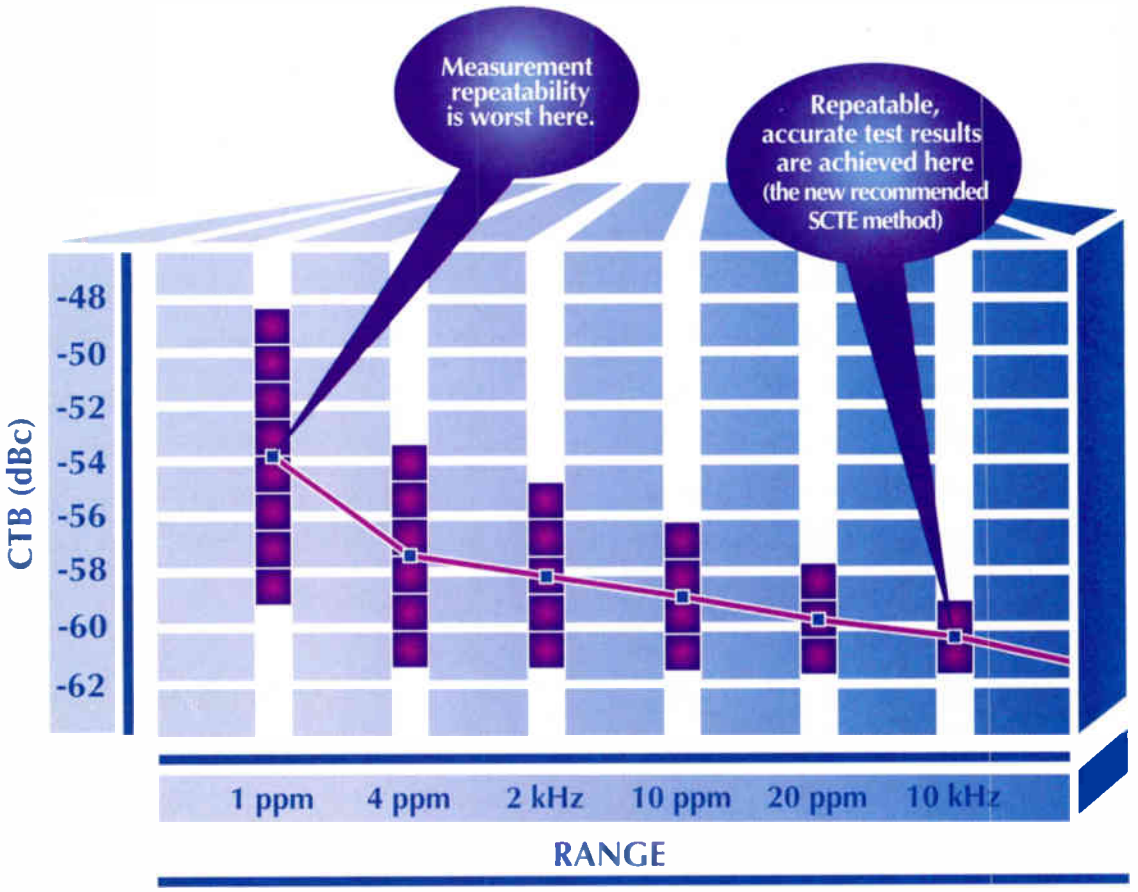
This simple project soon took on a life of its own, requiring resolution of myriad unforeseen training issues. It culminated in our obtaining ISO 9000 certification, and we learned a lot along the way.

We think of training and quality improvement as a Rubik's Cube block puzzle. Everyone, including the customer, occupies a side of the cube, and improvement can originate on any face, or any row, of the cube. But the puzzle never comes together without all parties acting in concert.

Turning this analogy into reality requires continual focus on developing our organization, employees, tech support, distribution channels and end user skills.

Too often, receiving ISO certification is seen as the end of a long journey. In truth, it's the beginning of a lifetime commitment to learning. If you live up to the standards, the learning will never end.

The SCTE has just made CTB, CSO, and cross modulation tests repeatable...



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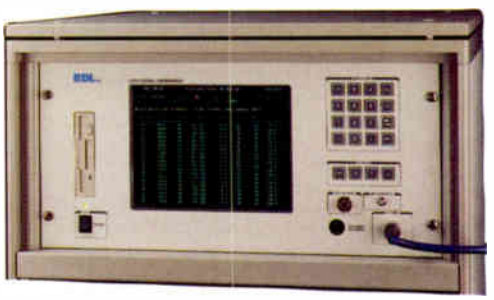

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Reader Service Number 132

training program, so we concluded that training at all levels can drive improvement. This revelation made training the cornerstone of the quality improvement process.

Rubik's Cube approach

We liken training and quality improvement to a Rubik's Cube block puzzle with everyone on a side, including the customer. The theory behind the analogy is that improvement can be driven from any face or any row of the cube. We learned that anyone—the end user, a value-added reseller, someone within the manufacturing company, or one of our suppliers—can initiate improvement in any area. But the puzzle never comes together without all parties acting in concert. Like the Rubik's Cube, each "turn" highlights new areas needing improvement. And just when perfection seems only a turn away, it points you in a direction you hadn't thought of before.

Many companies undergo months of rigorous preparation, inspection and evaluation to qualify for ISO 9000 certification. At the end of the process, they often express a certain emptiness. "It's just a big paper drill," or "certification isn't bringing in more sales," are common refrains.

These comments miss the true spirit of the ISO process. For us, embracing ISO standards includes treating all learning and training as part and parcel of our continuous improvement. The company has progressed well beyond the days of its simple training seminar upgrade.

Educational plans

Incorporating the Rubik's Cube approach into our business structure meant creating educational plans and learning procedures, detailing the contribution of each, and then continually monitoring success. Merging this into the Rubik's Cube approach, we view each training procedure as a separate "turn of the cube" that leads the company closer to its goals of perfection.

Focus on development

The organization: To create solutions that continue to fit the needs of customers requires input from those closest to the product. The organization as a whole must listen to the needs of customers and commit to continuously meeting them. This can help pinpoint areas of needed improvement that may have been previously unknown. When an organization is committed to listening and meeting the needs of its customers, all aspects of the organization improve.

- Customer visits—Customers who visit their suppliers have the opportunity to personally describe their specifications for product and manufacturing requirements. This also gives the organization an opportunity to gain a clearer perspective on their products and company procedures and how they are perceived. This insight helps all departments within the organization develop improvement strategies.
- Customer satisfaction surveys—Regularly sent surveys help organizations gain

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information on areas of both satisfaction and dissatisfaction from a large, more diverse audience. Information gained often encompasses finished product, manuals, training, technical advice and invoicing.

- Corporate communication—Consistent corporate communication not only demonstrates that improvement processes are in place and working, but also is vital to keeping communication lines open between the corporation and its customers.
- Web site—This can disseminate a large amount of information to a worldwide audience quickly and inexpensively. Information collected through the Web site can provide a multicultural perspective that the organization might not otherwise acquire.

Employees: To continue to be perceived as industry experts, each employee of an organization needs to be thoroughly trained in the industry, the product and all internal company processes. Empowering each employee with experience and knowledge on the product, service and company gives each team member responsibility for assuring quality.

Technical support: Technical support information is vital to help customers in the proper use of products, and it must be shared with customers and distribution channels to be effective. But what is the best avenue to share this vital information?

- Interactive Web sites that include audio and video are a cost-effective means of sharing information. Web sites can provide easy access to software downloads, downloadable repair/operations manuals, specification sheets, changes to product specification, training, warranty and repair information, and can help to answer frequently asked questions (FAQs).
- Instructional media also are effective in conveying information. Training and service videos or CD-ROMs provide customers the convenience of learning at their own speed and within their own time constraints. It also can be a refresher course when difficult situations arise.
- Technical support personnel are great resources for end users when questions or difficult operation issues arise.

Distribution channels: Distribution channels properly educated and trained on the supplier, its products and the industry as a whole help to increase customer satisfaction and sales. Continuous training programs help to keep distributors updated with the latest information, which they in turn can accurately pass on to customers.

End-user skills: End user participation in training and educational programs is vital in the learning process. Educating end users can reduce risk of damage and increase safety when operating any piece of equipment, whether it's a computer or an underground cable locator.

Mastery over the product and different applications can be achieved only if more companies involve their employees in end user training and seminars. But with time constraints and budget cuts, finding affordable, quality training and educational courses is difficult.

Many suppliers today accept the responsibility for proper training and provide cost-effective training courses nationwide. Supplier-sponsored training courses and seminars designed to help eliminate danger and promote proper skills can be found on most suppliers' Web sites. For instance, we provide underground cable locator training courses held throughout the United States and Canada.

The point

Obtaining ISO certification reinforces the value placed on high-quality design, manufacture and service. However, unless it's completely embraced throughout all departments within an organization, ISO certification becomes only a certificate on the wall. Too often, receiving ISO certification is seen as the end of a long journey. For continuous quality improvement, the organization needs to view certification as the beginning of its lifetime commitment to learning. If you live up to the standards, the learning will never end. CT

Daniel Callaghan is vice president of sales and marketing for Metrotech Corp. He can be reached at (408) 734-1400.

WE KEEP GETTING BETTER*

During the February 1999 sweeps, the audience for basic cable television grew by 2.9 million homes while viewership of the four major networks declined by more than 2.8 million. Even Monica's interview couldn't help.

{* *Refer to headline* }

In 1998, cable advertising revenue grew by $1.2 billion from previous years, and it's expected that in 1999 revenues will increase another $1 billion.

{* *Refer to headline* }

During last year's NCTA convention, more than 29,000 attendees discovered the cutting-edge changes taking place in the cable television industry.

{* *Refer to headline* }

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{* *Refer to headline* }

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Evaluating Multiple Outlet Requirements, Part 2

This month's installment continues a series on evaluating the requirements for multiple outlets. The material is adapted from a lesson in NCTI's Installer Course. © NCTI.

The following selection provides approximate worst-case signal loss values for three-, four- and eight-way splitters. Technicians and installers can use this information to easily make rough loss estimates in the field.

Estimating loss effects Of three-way splitters

Three-way splitters are available in two types of configurations: balanced and unbalanced.

All three output ports of a balanced three-way splitter have the same insertion loss, about 7 dB down from the input signal level. (See Figure 1.)

An unbalanced three-way splitter is rather similar to a two-way splitter with one of the output legs split again, making a total of three output ports. (See Figure 2.)

The leg that is not split a second time has an approximate insertion loss of 4 dB at its output port (that is, the high output port), while the other two ports each exhibit an approximate loss of 8 dB.

Remember, these loss values are rounded off to easily make rough estimates of expected cable outlet/wall plate signal levels.

Estimating loss effects Of a four-way splitter

A four-way splitter is similar to a two-way splitter with each of its 4 dB loss legs split again. As shown in Figure 3, the two 4 dB split losses combine for a total insertion loss of approximately 8 dB at each output port of the four-way splitter.

Estimating loss effects Of an eight-way splitter

After the four-way splitter, the next available splitter is an eight-way splitter. Usually, a splitter with eight or more output ports is used in multiple dwelling units (MDUs), but it is becoming increasingly more common in single dwelling units (SDUs).

An eight-way splitter is similar to a four-way splitter with each of its 8 dB loss output legs split again. (See Figure 4.) The two split losses combine for a total insertion loss of approximately 12 dB at each output port of the eight-way splitter.

The next installment will provide approximate insertion losses for combining splitters to customize the number of output ports. TB

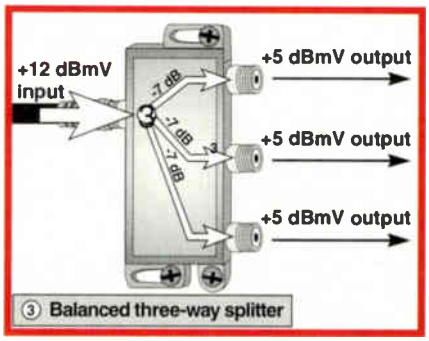

Figure 1: Approximate insertion loss effects of balanced three-way splitters

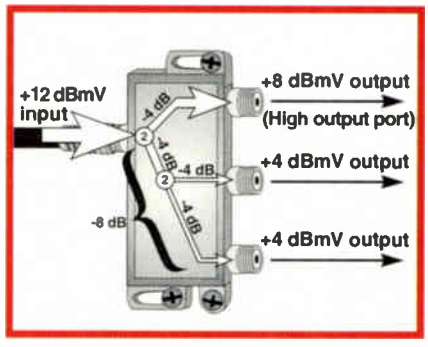

Figure 2: Approximate insertion loss effects of unbalanced three-way splitters

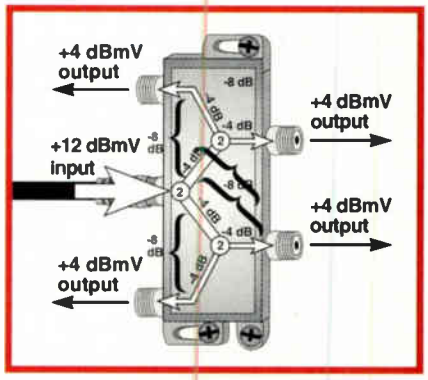

Figure 3: Approximate insertion loss effects of four-way splitters

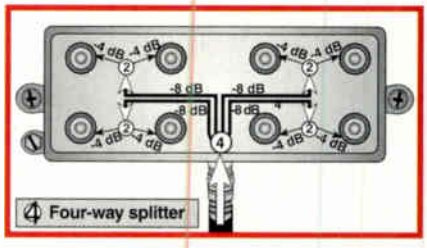

Figure 4: Approximate insertion loss effects of eight-way splitters

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Reader Service Number 137

Digital Transport System

Philips Broadband Networks has introduced the 600DXT multichannel digital interconnect system, a fiber-optic solution that enables hybrid fiber/coax (HFC) system operators to consolidate their manned headends and centralize network control activities. The 600DXT noncompressed digital transport system is available in an NTSC eight-channel version and a phase alteration line (PAL) six-channel version. The unit allows operators to interconnect regional or statewide networks driven by a single master headend and accommodate custom channel line-ups, local programming and targeted advertising. The 600DXT digital transport system features high signal quality, high capacity and the capability to mix video and telecommunications services on the same fiber strand.

Reader Service #312

Expanded Descrambler Line

Multichannel Communication Sciences has announced a multiple dwelling unit (MDU) version and an indoor version of its OmniBand broadband descrambler subscriber devices. It enables the simultaneous descrambling of multiple individually selected scrambled TV channels at the subscriber location. The company has said that service allows subscribers full-feature use of their TV sets, videocassette recorders (VCRs) and the remote controls packaged with their sets. According to the company, one broadband descrambling device can provide simultaneously clear, addressable service to all outlets within the home without the need for a set-top on every set.

Reader Service #307

Set-Tops Geared for Internet

WorldGate Communications is commercially deploying WorldGate Service, the company's Internet Access service, for the first time on cable systems that use Scientific-Atlanta advanced analog set-top boxes. WorldGate provides cable subscribers with connection to the Internet and e-mail without a personal computer (PC) or a phone line. The service uses a standard analog or digital cable converter connected at the cable headend server.

Reader Service #311

Cooling System

United CoolAir has developed the Easy Mount cooling system to provide low-maintenance temperature control in remote facilities and temporary shelters. The cooling system provides up to 5 tons of cooling capacity using scroll compressors. Its slide-out condenser fan and removable access panels were designed for isolated operation where routine service is inconvenient or unavailable. All components are serviceable from outside the enclosure. Easy Mount units may be specified as inexpensive cooling systems for less critical shelters or configured with optional features such as heat, lead/lag control and economizer for maximum environmental control.

Reader Service #309

Automated Customer Service

CableData's customized WebCSR (customer service representative) product for WebTV is programmed to know that the customer is always right.

WebCSR, which is an adaptation of CableData's CyberCSR, leverages the potential of e-commerce and provides users with direct access to account information over the Internet. The product is designed to eliminate time constraints and other inconveniences often associated with contacting a call center.

Reader Service #310

Underground Plant Line

TeleWire Supply is shipping a line of underground plant products for broadband communications applications. Manufactured and marketed under TeleWire's Monarch brand name, the line consists of plastic pedestals, duct, vaults and accessories.

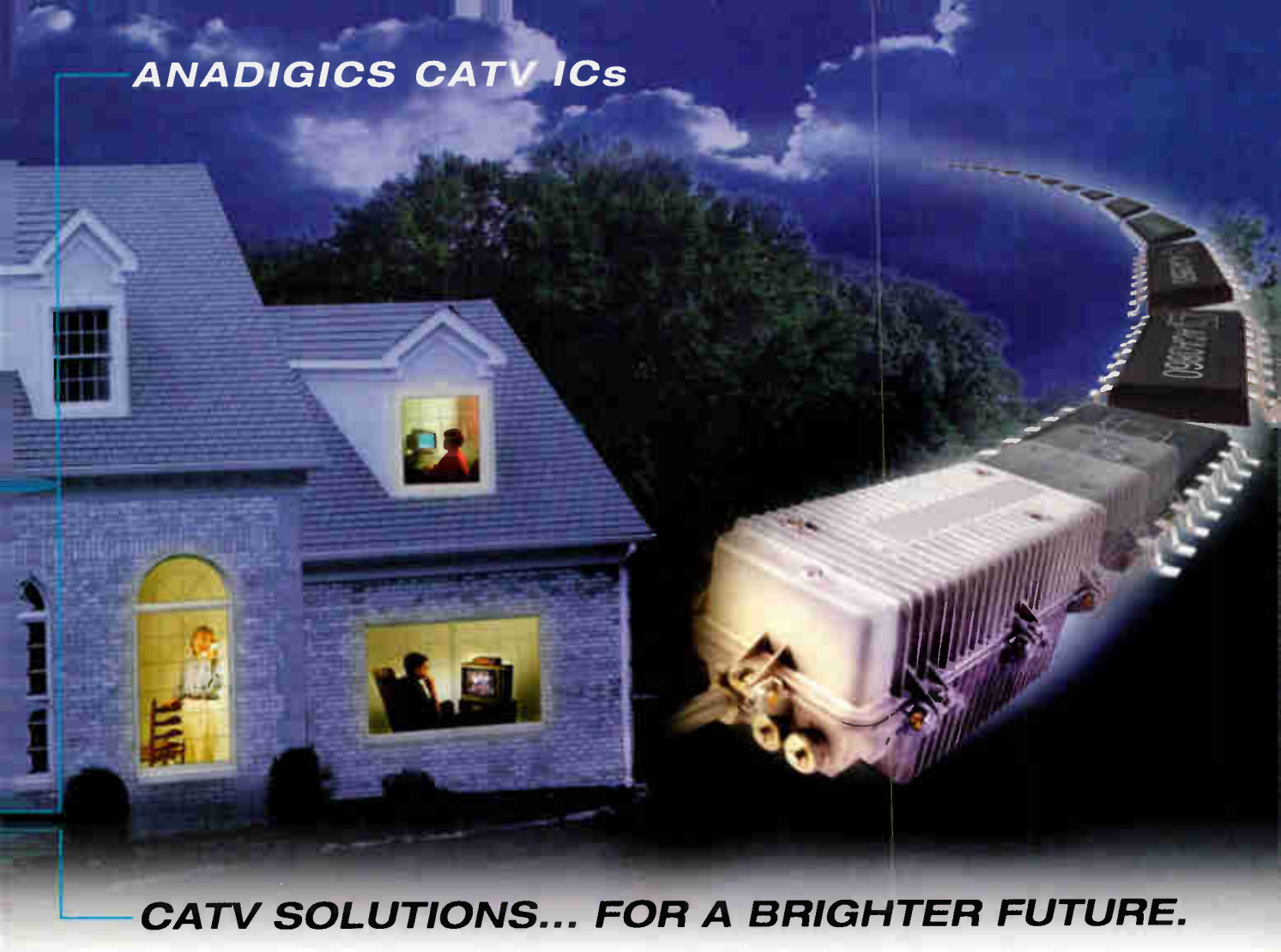
The Monarch pedestals are manufactured from ultra high-impact, UV stabilized thermoplastic to provide lasting durability in virtually any environment. The pedestals feature 360° access to internal components, a flanged base for additional vertical stabilization and stainless steel bracketry. Monarch pedestals come in 7-inch, 10-inch and 12-inch sizes, and most popular locking mechanisms, including self-locking options, are available.

Reader Service #308

Trouble Truck

Mobile Tool International's Telsta A-35 Trouble Truck affords workers a side reach up to 28 feet on a compact chassis. The unit's extended side reach is derived from a telescoping upper boom and articulating lower boom that allows a full 42-foot working height when fully extended. According to the company, the boom's design is well-suited for repair and maintenance work in areas that are typically difficult to reach using more traditional methods. The Telsta A-37 features 360° noncontinuous boom rotation. Optional related equipment is available from Mobile Tool.

Reader Service #306



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Reader Service Number 138

Signal Level Meter

The new CyberTek Vision signal level meter (SLM) from ComSonics is a hands-free, voice-activated device that allows users to perform a variety of cable tests including those for tilt, noise ratio, bit error rate (BER) and digital power.

One of CyberTek Vision's unique features is the black-and-white eyepiece display system and microphone, which mount on the user's head.

Reader Service #305

Turnkey Digital Compression

Israel-based Peach Networks has developed turnkey digital compression technology. The system, dubbed The Access Channel, combines patent-pending software at the headend with existing cable infrastructure to deliver compressed data and video streams to each subscriber. The cornerstone of the system, Peach's Interactive Media Server (IMS), serves a minimum of 150 subscribers, with the potential to expand to an unlimited number of users. Subscribers simply require the use of a Scientific-Atlanta Explorer 2000 or other similar set-top box with remote control and optional keyboard.

Reader Service #304

Demodulators

R.L. Drake has developed two video demodulators, the DM806 and the DMM806. The DM806 is packaged as a standard single rack space unit, and the DMM806 is a single compact card unit that integrates into Drake's Mini-Headend system. Both units will convert any UHF, VHF or cable TV signal into baseband for remodulation or distribution.

Reader Service #303

Coax Transitional Sleeve

Vector Utility has created the CoFlex-Sleeve to reduce kinks and bend radius in coax cable. According to the company, the unit eliminates reflection, reduces bit errors and other impedances that come from the forward flow and can cause service disruptions. By ensuring that the cable does not exceed a healthy bend radius, the CoFlex-Sleeve is intended to protect coax cable, safeguard its physical and electrical health, and minimize detriments to frequency signal at the installation point.

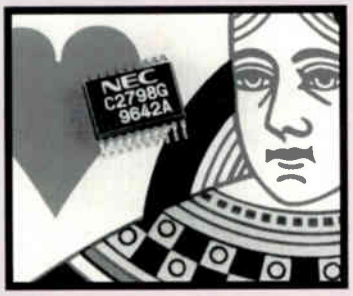
Reader Service #302

Digital Transformer Ratiometer

AEMC Instruments has developed the DTR Model 8500 portable digital transformer ratiometer for on-site testing of power, potential and current transformers. When connected to a non-energized transformer, the unit measures primary-to-secondary turns ratio while displaying polarity and excitation current. According to AEMC, the DTR 8500 is fully automatic and uses an American National Standards Institute/Institute of Electrical and Electronics Engineers-compliant test method; no user calibration, range selection, hand cranking or balancing is required. The unit automatically self calibrates and checks for open windings, connections, circuit breakers, short circuits, incorrect test lead placement and reverse polarity. Tests are performed at low voltage with step-down excitation. A dual-line alphanumeric liquid crystal diode (LCD) display enhances the tool's readability.

Reader Service #301

Downconverter



California Eastern Laboratories has designed the new silicon UPC2798GR RFIC Downconverter for set-top boxes and cable modems using quadrature amplitude modulation (QAM). According to CEL, the unit can help engineers reduce the size and complexity in the RF/analog aspects of their designs by combining an input automatic gain control (AGC) amplifier, mixer, oscillator and video amplifier into a miniature, 20-pin package. The UPC2798GR is manufactured using NEC's high fT NESAT III silicon bipolar process. The unit is available on tape and reel.

Reader Service #300

Fiber Links

Blonder Tongue has introduced the Trailblazer family of amplitude modulation-vestigial sideband (AM-VSB) fiber-optic links.

The family of equipment was designed with an eye on providing superior quality transportation of high bandwidth RF signals for applications requiring up to 860 MHz, giving Trailblazer the capacity to serve evolving needs.

Reader Service #299

Oscilloscope Control

LeCroy Corp. has released the ScopeExplorer 1.05, a personal computer (PC)-based connectivity tool that integrates the company's digital storage oscilloscopes and signal analyzers with a Windows 95/98/NT desktop. The shareware allows users to transfer screen images or raw data from a scope to a PC. This version, available at www.lecroy.com, is an update of last year's model from the company that enables the entire front panel setup of the scope to be captured and stored on a PC. A captured panel may be transferred from the PC back to the scope for setup reproduction.

Reader Service #298

Limiting Amplifier

Anadigics has designed a "monolithic" limiting amplifier for use in synchronous optical networks (SONET) optical carrier (OC)-192 and synchronous digital hierarchy (SDH) receiver applications. According to the company, the ALA90000 offers high-speed DC-10 Gb per second operation with low pulse width distortion, small signal gain and differential output. The unit is a three-stage, DC-coupled differential amplifier integrated circuit (IC), which the company says can replace a multistage discrete amplifier solution typically used after transimpedance amplifiers in OC-192/synchronous transfer mode (STM)-64 receiver applications. The ALA90000 has a 25 dB signal gain, 7 mV differential sensitivity and an output drive of 700 mV into 50 ohms.

Reader Service #297

Fiber Testing

GN Nettest has released the CMA8800 optical time domain reflectometer (OTDR). Geared to speed up the testing process, the unit offers remote testing, a 12-port optical switch to test multiple fibers and a built-in printer for use in the field. According to the company, the CMA8800 also features the attributes of a mainframe OTDR in a rugged, economical and field-portable package. In addition to offering a test range from 21 dB to 46 dB and deadzones as short as 2.5 meters, this model is compatible with existing and future CMA4000 optical modules.

Reader Service #296

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Reader Service Number 143

Tests for High-Speed

Tektronix has developed products for use with dense wavelength division multiplexing (DWDM) and synchronous optical network (SONET)/synchronous digital hierarchy (SDH) transmission systems.

According to the company, the D3186/D3286 bit error rate tester (BERT) produces high-quality waveforms for analyzing signals with extremely fast rise and fall times. The unit characterizes high-speed digital telecommunications network devices such as integrated circuits (ICs) and high-speed optical components in addition to targeting DWDM and SONET/SDH transmission systems.

The Q7606 chirp test instrument has been designed for measuring chirp in high-speed DWDM and SONET/SDH systems. Tektronix says that the unit calculates the alpha chirp value in approximately 45 seconds in optical communication signals transmitting 10 Gb or less.

Reader Service #295

Optoelectronic Devices

Kymata's new line of optoelectronic devices for wavelength division multiplexing (WDM) includes arrayed waveguides, optical attenuator switches and splitters. When the company begins commercial manufacturing by the end of this year, it has said it will use selected planar silica-on-silicon as its platform technology. Kymata's initial range of planar optoelectronic building blocks include a 16-channel multiplexer/demultiplexer with 100 GHz channel spacing, a variable optical attenuator, thermo-optic switches and Y-splitters. Product samples are available from the company's design team, which is led by Richard Laming former director of the Optoelectronics Research Center at England's Southhampton University. .

Reader Service #294

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Call for Entries

The 1999 Classic Equipment Competition

Sponsored By

The National Cable Television Center and Museum
in association with
Communications Technology Magazine
and
CED Magazine

The Cable Center seeks to enhance and enlarge the Technology Collection of The Barco Library by identifying and acquiring types of equipment not yet represented. Cash awards will be presented for the entries that most closely respond to the needs stated below. Winners will be announced at the 1999 SCTE Cable-Tec Expo in Orlando, Florida.

First Prize: $500
Second Prize: $200
Third Prize: $100

Guidelines for The 1999 Classic Equipment Competition:

- **Equipment should be delivered to The Cable Center booth** (#1612) at the SCTE Cable-Tec Expo on the opening day of exhibits.
- **Entries must include** a fact sheet with donor's name, address, and phone number, plus a description of the equipment (including name, manufacturer, model number, and function) and a letter transferring ownership to The Cable Center.
- **Priority in judging will be given to:**
  - Unique items, headend, distribution, tools, test, and safety equipment
  - **Especially seeking:** Jerrold SX1 and SLE line extenders, Scientific Atlanta line extenders, and Ameco Pacesetter gear.

Special Competition *(Open to Vendors Only)*
Unique, historical artifacts, whether or not they were sold to the industry. Winning vendors will receive a special plaque.

Judges
With a combined 100 years of service to the cable industry:

Chairman: David Willis, Curator and Industry Fellow, Technology Collection, The Barco Library

Committee Members:
Ron Cotton
Austen (Shorty) Coreyell
Roger Brown, *CED*
Paul Levine, *Communications Technology*

For additional information, call or write
David Willis, 11814 East Wesley Avenue, Aurora, Colorado 80014,
303/792-3671

Duplex Adapters

Featuring metal housing and a choice of zirconia or phosphor bronze alignment sleeves, the SC-ST and SC-SC Duplex Adapters from Molex Fiber Optics are designed for single and multimode applications. The adapters may be grounded to the equipment chassis to minimize electromagnetic interference (EMI). According to the company, both models meet International Electrotechnical Commission standards. Designed with a metal clip for mount installation or two threadless holes for flange installations, the adapters offer flexible installation options. Both models are compatible with Molex's plastic SC duplex shutters that are designed to minimize dust contamination and laser exposure.

Reader Service #293

Cable Strippers

Ripley's new line of stripping tools are created specifically to cut Times Fiber's Flexible Feeder cable. The TXFF is designed for use with Times Fiber's standard and tri-shield cable construction. The TXFF-Q is appropriately suited for the Flexible Feeder's quad-shield cable construction. With Ripley's two-step cable preparation, the first cut prepares cable to its proper center conductor length and the second cut removes the precise length of outer jacket to expose the braid. The flexible feeder stripping tools are color-coded and labeled for easy identification in green and blue.

Reader Service #292

Cabinet System

The MegaFrame cabinet system is geared to facilitate network center coordination by combining rack components, storage and security with full cable and cord management in a closed environment. Employee-owned Chatsworth Products offers the system in perforated metal or smoked plexiglass doors with a panel fringed by vents. Optional stabilizer feet that comply with many extension requirements are available for the cabinet. Chatsworth Products also offers structured termination systems and cable management products through an international distribution network.

Reader Service #291

Coax Cables

Belden Wire & Cable Co. has developed coax for central office digital signal (DS) interconnect and cross-connect applications that are compatible with standard connector offerings and reduce the need for 90° connectors. The cables have been designed to deliver low attenuation at all standard frequencies and be suitable for indoor and outdoor applications. They are available in single coax, single coax with tracer, multiple coax, Siamese design, Siamese design with tracer and single coax with double braid shield. According to the company, the cables have been tested to Bellcore GR-139-CORE specifications and

feature small-diameter solid bare or silver plated copper connectors that are UL listed according to National Electrical Code (NEC). The company says they have passed UL 1666 and Canadian Standards Association FT04 flame tests.

Reader Service #290

Cable Ties

Because Hook and Loop cable ties from Panduit are designed for use in air handling places, they are well suited for applications where over-tensioning and releasability are a concern, reported the company. TAK-TY ties are UL-listed in accordance with Sec. 300-22 (c) and (d) of the National Electrical Code (NEC). They also comply with UL94V-2 flame rating guidelines for safety assurance. According to the company, TAK-TY cable ties feature hook-and-loop closure and will not pinch or abrade. The cable ties are available in a variety of sizes to accommodate several bundle diameters.

Reader Service #289

RF Connectors

RF Industries has expanded its line of high-performance universal adapters by adding a connector kit to its Unidapt Series. The RFA-4023-01 is housed in a sturdy foam-lined, hinged plastic case with 43 universal adapters. Connectors in the company's Unidapt line are silver-plated machined brass with gold-plated contacts and insulation. Each adapter, when joined using the Universal Center Adapter, creates numerous combinations of coaxial interfaces. Any male-to-male, female-to-female or female-to-male adapter is readily available in the kit. Pieces may be mixed and matched to create the appropriate adapter. According to the company, the assorted adapters included in the kit provide users with maximum options for connectorization.

Reader Service #288

Are you plugged in?

VENDOR CONNECTION

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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ADC Telecommunications is a leading, global supplier of transmission and networking systems used to deliver voice, data and video services and physical connectivity products for wireless, fiber-optic, twisted-pair and coaxial networks.
Reader Service #34

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(864) 433-0333; Fax (864) 433-5560
Corie Fortune (864) 433-5409
www.alcoafujikura.com
AFLFiber@alcoa.com
Alcoa Fujikura Ltd. is the market leader manufacturing fiber optic cable for the telecommunications industry, providing products for fiber management systems. AFL also offers EF&I (engineer, furnish, install) services. Fujikura fusion splicers are also distributed.
Reader Service #77

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www.alpha.com
Baily Shewchuk
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Reader Service #N/A

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www.amlwireless.com
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sales@arcomlabs.com
Arcom has been manufacturing high quality filters used in cable television since 1980. Recent innovations in addition to some patented return products are Surface Acoustic Wave (SAW) negative traps and the new SAWDEC passive scrambling system. SAWDEC provides a way to secure low penetration pay services at an affordable cost. Due to the sharpness of the SAW filter, the system provides unmatched picture quality and a high level of signal security.
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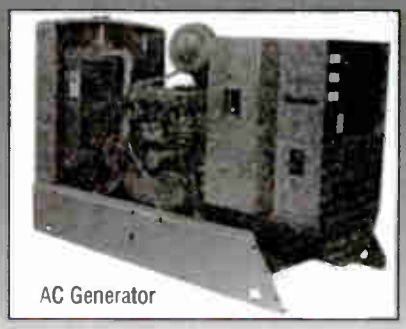
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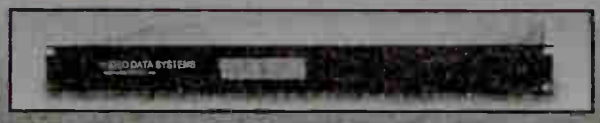

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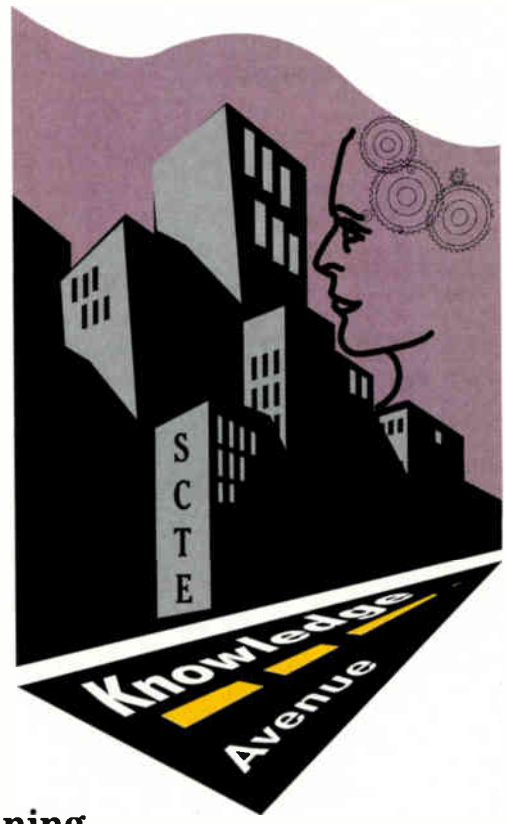

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TECHNICAL SUPERVISOR

(Installation and Service)

Jones Communications is a leader in telecommunications, telephone, Internet and distance learning. We have an excellent opportunity at our Prince George's County, Maryland, facility for a customer-oriented professional. You'll supervise our installers/technicians and handle all departmental activities that contribute to customer satisfaction. Duties include hiring, training, coaching and evaluating the staff; maintaining a positive work environment; handling quality control inspections; and complying with regulatory agencies/company requirements by ensuring that all paperwork, reports, permits, etc. are completed on time.

A high school diploma or equivalent and valid driver's license with a satisfactory driving record is required. Associate's degree in Electronics (or equivalent) and NCTI Installer Technician Certification preferred. Applicants also need 2-3 years of progressive CATV technical experience and 1 year of lead or senior tech experience with the ability to supervise a diverse work force. Other qualifications include knowledge of cable TV products/services as well as the National Electric Code/National Electric Safety Code, OSHA and related state/local codes. Effective PC, project management, math and written/verbal communication skills are a must. The ability to perform duties from high places is required. The proven leader we seek will act with integrity and professionalism to build rapport and trust with associates, customers, suppliers and a network of contacts.

For confidential consideration, please mail/fax resume to: **Jones Communications, Attn: HR Manager, 9315 Largo Dr. W., Largo, MD 20774; Fax: (301) 336-7490.** All successful candidates will be required to pass a drug test and background check. To learn more about current job opportunities, call our **Job Line: (301) 306-5800.** EOE

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Position Activities: Writing, editing and formatting standards documents. Updating hard and electronic copies of standards for all engineering committees. Distributing documents through postal, commercial or electronic mail. Maintain standards related information on ftp site, web site and e-mail reflector. Assist in completion of specific tasks and coordinate standards projects contributed by individual authors of the standards groups.

Duties also include standards meeting facilities coordination and domestic traveling to conference sites.

Requirements: Four-year college degree of technical discipline preferred. Comprehension of differential and integral calculus, logarithmic equation, elements of circuitry and signal distortions desired. College English proficiency required.

The Society of Cable Telecommunications Engineers is an international organization founded in 1969 to provide technical training, certification and standards to the cable telecommunications industries. Its offices are located in scenic Chester County, PA. SCTE offers a competitive salary, comfortable work environment and excellent benefits including 401K.

Send replies to: Director of Standards,
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A. Are you a member of the SCTE (Society of Cable Telecommunications Engineers)?
❑ 01. yes ❑ 02. no

B. Please check the category that best describes your firm's primary business (check only one):

Cable TV Systems Operations
- ❑ 03. Independent Cable TV Syst.
- ❑ 04. MSO (two or more Cable TV Systems)
- ❑ 05. Cable TV Contractor
- ❑ 06. Cable TV Program Network
- ❑ 07. SMATV or DBS Operator
- ❑ 08. MMDS, STV or LPTV Operator
- ❑ 09. Microwave
- ❑ 10. Telecommunications Carrier
- ❑ 11. Electric Utility
- ❑ 12. Satellite Manufacturer
- ❑ 13. Satellite Distributor/Dealer
- ❑ 14. Fiber Optic Manufacturer
- ❑ 15. Data Network
- ❑ 16. Commercial TV Broadcaster
- ❑ 17. Cable TV Component Manufacturer
- ❑ 18. Cable TV Investor
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- ❑ 20. Law Firm and Gov't. Agencies
- ❑ 21. Program Producers or Distributors and Syndicators
- ❑ 22. Advertising Agencies
- ❑ 23. Educational TV Stations, Schools and Libraries
- ❑ 24. Other (please specify)

C. Please check the category that best describes your job title:
- ❑ 25. Corporate Management (Chairman, Owner, President, Partner, Executive/Senior Vice President, Treasurer)
- ❑ 26. Management (Vice President, General Manager, System Manager and Director)
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- ❑ 28. Engineering Management (Vice President, Director, Manager)
- ❑ 29. Engineer
- ❑ 30. Technician (Technical Director, Manager, Supervisor, Technician)
- ❑ 31. Installer (Installation Director, Manager, Supervisor, Installer)
- ❑ 32. Sales (Vice President, Director, Manager, Sales Representative)
- ❑ 33. Marketing (Marketing Vice President, Director, Manager)
- ❑ 34. Other (please specify)

D. In the next 12 months, what cable equipment do you plan to buy?
- ❑ 35. Amplifiers
- ❑ 36. Antennas
- ❑ 37. CATV Passive Equipment including Coaxial Cable
- ❑ 38. Cable Tools
- ❑ 39. CAD Software, Mapping
- ❑ 40. Commercial Insertion/Character Generator
- ❑ 41. Compression/Digital Equip
- ❑ 42. Computer Equipment
- ❑ 43. Connectors/Splitters
- ❑ 44. Fleet Management
- ❑ 45. Headend Equipment
- ❑ 46. Transmission/Switching Equipment
- ❑ 47. Networking Equipment
- ❑ 48. Vaults/Pedestals
- ❑ 49. MMDS Transmission Equipment
- ❑ 50. Microwave Equipment
- ❑ 51. Receivers and Modulators
- ❑ 52. Cable Modems
- ❑ 53. Subscriber/Addressable Security Equipment/ Converters/Remotes
- ❑ 54. Telephone/PCS Equipment
- ❑ 55. Power Supply (Batteries, etc.)
- ❑ 56. Video Servers

E. What is your annual cable equipment expenditure?
- ❑ 57. up to $50,000
- ❑ 58. $50,001 to $100,000
- ❑ 59. $100,001 to $250,000
- ❑ 60. over $250,000

F. In the next 12 months, what fiber-optic equipment do you plan to buy?
- ❑ 61. Fiber-Optic Amplifiers
- ❑ 62. Fiber-Optic Connectors
- ❑ 63. Fiber-Optic Couplers/Splitters
- ❑ 64. Fiber-Optic Splicers
- ❑ 65. Fiber-Optic Transmitter/Receiver
- ❑ 66. Fiber-Optic Patchcords/Pigtails
- ❑ 67. Fiber-Optic Components
- ❑ 68. Fiber-Optic Cable
- ❑ 69. Fiber-Optic Closures & Cabinets

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- ❑ 72. $100,001 to $250,000
- ❑ 73. over $250,000

H. In the next 12 months, what cable test & measurement equipment do you plan to buy?
- ❑ 74. Audio Test Equipment
- ❑ 75. Cable Fault Locators
- ❑ 76. Fiber Optics Test Equipment
- ❑ 77. Leakage Detection
- ❑ 78. OTDRs
- ❑ 79. Power Meters
- ❑ 80. Signal Level Meters
- ❑ 81. Spectrum Analyzers
- ❑ 82. Status Monitoring
- ❑ 83. TDRs

I. What is your annual cable test and measurement equipment expenditure?
- ❑ 84. up to $50,000
- ❑ 85. $50,001 to $100,000
- ❑ 86. $100,001 to $250,000
- ❑ 87. over $250,000

J. In the next 12 months, what cable services do you plan to buy?
- ❑ 88. Contracting Services (Construction/Installation)
- ❑ 89. Repair Services
- ❑ 90. Technical Services/ Eng. Design

K. What is your annual cable services expenditure?
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SCTE INSTALLER PROGRAM INFORMATION REQUEST CARD

The SCTE Installer Certification Program was created to establish minimum skill requirements for CATV installers and installer/technicians. Participants in the program must successfully complete practical examinations in the areas of cable preparation and meter reading, as well as a written examination on general installation practice. The program is being administered by local SCTE chapters and meeting groups under the guidance of SCTE national headquarters. All candidates for certification in the program are recognized as SCTE members at the Installer level, and receive a copy of the *SCTE Installer Manual*.

☐ Please send me information and an application for the SCTE Installer Program

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CALENDAR

Planning Ahead

July 12-14: Wireless Communications Association '99, WCA, New Orleans. Call (202) 452-7823.
July 18-21: CTAM '99: Cable and Telecommunications, CTAM, San Francisco. Call (703) 549-4200.
July 18-22: Annual Multiplexed Telephony Conference '99, San Diego Marriott, San Diego. Call (925) 556-0810.
Aug. 16-18: Great Lakes Cable Expo, Indianapolis. Call (317) 845-8100.
Sept. 15-19: National Association of Telecommunications Officers and Advisors, NATOA, Atlanta. Call (703) 506-3275.
Oct 12-14: Atlantic Cable Show, Baltimore. Call (609) 848-1000.

May

3-6: Women in Cable and Telecommunications "Merging Cultures, Technology and the Consequences of Stagnation" conference, Hilton and Towers, San Francisco. Contact WICT at (312) 634-2330.
4: New York State Cable Show, Lake George, NY. BCT/E, Installer, Telephony and Service Technician certification examinations to be administered. Contact SCTE headquarters, (610) 363-6888.
10-14: NetWorld+Interop with EXPO COMM '99, Las Vegas. Call (650) 372-7068.
12: Bluegrass SCTE Chapter technical seminar, Intermedia office, Lexington, Ky. Contact Max Henry, (502) 435-4433.
12: North Country SCTE Chapter technical seminar, Wadena Technical College, Wadena, Minn. Contact Dan Shea, (612) 572-9290.
12: Old Dominion SCTE Chapter technical seminar, Richmond Hotel and Conference Center, Richmond, Va. Topic: "Services that Utilize Return Path" with speakers to be announced. Contact Maggie Fitzgerald, (540) 248-3400.
13: SCTE Satellite Tele-Seminar Program, Galaxy 1R, Transponder 14, 2:30-3:30 p.m. ET. Topic: "Transportation Systems." Contact Janene Martin, (610) 363-6888, ext. 226.
15: Penn-Ohio SCTE Chapter testing session, Butler, Pa. BCT/E certification examinations to be administered. Contact Michael Giobbi, (724) 283-0925.
16-17: Canadian Cable TV Association Conference and CableExpo, Vancouver, Canada. Call (613) 232-2361.
16: Desert SCTE Chapter technical seminar, Sizzler Restaurant, Banning, Calif. Topic: "FCC Proofs." Contact Jack Irwin, (909) 343-5157.
16: South Florida SCTE Chapter technical seminar. Topic: "Distribution Systems." Contact Jim Goins, (954) 423-7176.
18: Appalachian Mid-Atlantic Chapter testing session, TV Cable of Carlisle, Carlisle, Pa. Installer, BCT/E, Service

Technician and Telephony certification examinations to be administered. Contact Loarn Arthur, (717) 263-5541.
19: Chesapeake SCTE Chapter technical seminar, Comfort Inn, Bowie, Md. Topic: "HDTV." Contact Frank Cruse, (703) 358-2768.
19: Great Lakes SCTE Chapter technical seminar, Holiday Inn, Livonia, Mich. Topic: "Telephony over HFC." Contact Mary Gilliland, (810) 726-6886.
19: Piedmont SCTE Chapter technical session, Hickory, N.C. Topic: "Preparing the Drops, Plant and Headends for Cable Modems, OpenCable, Telephony and Other Two-Way Services." Contact Mark Eagle, (919) 573-7083.
19: Southern California Chapter technical session. Contact Charles Harper, (310) 647-6645.
19: Oklahoma Chapter technical session, Moore/Norman Vo-Tech, Norman, Okla. Topics: "Data Testing and Internet Ready for Drops." Contact Steve Johnson, (405) 422-2346.
20: Dakota Territory SCTE Chapter technical seminar, Sioux Falls, S.D. Topic: "Category VI Terminal Devices." Contact Tony Gauer, (605) 426-6140.
20: Piedmont SCTE Chapter technical seminar, Charlotte, N.C. Contact Mark Eagle, (919) 573-7083.
22: Southern California Chapter annual softball tournament. Contact Charles Harper, (310) 647-6645.
23-26: Cabling the Workplace '99, Association of Cabling Professionals, Hyatt Regency DFW, East Tower, inside Dallas/Fort Worth Airport. Call (214) 319-6077.
25-28: SCTE Cable-Tec Expo, Orange County Convention Center, Orlando, Fla. BCT/E, Service Technician, Telephony and Installer certification examinations to be administered. Contact SCTE Headquarters, (610) 363-6888.

June

2: Ark-La-Tex SCTE Chapter technical seminar, Holiday Inn, Longview, Texas. Topic: "Drop Installation and Basic Safety" with Steve Christopher. Contact Jim Bostic, at (318) 213-3322.
2-4: Washington State Cable Communications Association Summer Convention, WSCCA, the Inn at Semi-ah-moo, Blaine, Wash. Call (360) 629-0520.
6-10: Supercomm '99, Telecommunications Industry Association, Georgia World Congress Center, Atlanta. Call (703) 907-7700.
13-16: Cable '99, the National Cable Television Association Convention and International Exposition, McCormick Place Convention Center, Chicago. Contact the NCTA at (202) 775-3669.
21-25: 36th Annual Design Automation Conference, DAC, Ernest N. Morial Convention Center, New Orleans. Call (800) 321-3573.
22-24: International Conference on Consumer Electronics, Los Angeles. Contact Diane Williams, (716) 392-3862.
24: New Jersey SCTE Chapter vendor show. Contact Earl Bennett, (908) 665-0133. CT

By Scott Meek

Cable-Tec Expo '99: The Place For News and Education

We've all heard the saying, "No news is good news." In the broadband industry, we can not afford to ignore news—good or bad. The future of this industry depends on its ability to change with the times. Better yet, facing the future means setting trends for our time.

This ability relies on keeping up with the news. Understanding the news helps us answer questions such as: "What is it that consumers demand?" "What's going to be next in technology?" "What training will be necessary to use that technology to offer new services?" Technology and education is the key to our industry's survival.

That's why Cable-Tec Expo '99 is *the* place to be this month. This is not just a trade show to market hardware. This is a prime arena for education. With more than 400 exhibitors, attendees will be able to contact product manufacturers, learn what's new, understand how to use new tools, address troubleshooting issues and look at the big picture of our industry. It's a great opportunity to learn how you can benefit your company and ultimately how your company can benefit its customers.

Sold-out exhibition hall

The good news on Expo starts with the announcement that the exhibit hall will be sold out for the eleventh consecutive year. The 115,000-square-foot hall will feature product-specific premier hardware displays and 15 total hours of exclusive exhibit time. This means that attendees can browse the exhibits, talk one-on-one with vendors and receive hands-on instruction.

The Society of Cable Telecommunications Engineers also will again provide five technical training centers in the exhibit hall. The centers will be set up classroom style and provide a platform for vendors to showcase products, demonstrate equipment or offer technical presentations.

Other news on the floor will be the addition of an SCTE membership information booth. Attendees can stop by to check their membership status and receive information about the benefits of the Member-Get-A-Member program. We'll also be showcasing an SCTE training services booth so you can get the news on training programs and services offered by the Society. New resources such as books, technical videotape programs and computer-based training software will be available through an expanded SCTE bookstore. You will even be able to speak with training consultants and meet the industry's leading authors.

Networking is key

Let's not forget news from other companies. Expo is an ideal atmosphere for networking among peers. Find out what's happening in the design, construction, installation, repair, maintenance and operation of broadband telecommunications systems. Whether you're a first-time attendee or an old hand, Expo is an excellent forum for keeping ahead of developments in this changing industry.

With all the news swarming around the Expo exhibition hall, I'd like to take a moment to recognize the exhibitors themselves. First off, I'd like to extend a welcome to the more than 50 new exhibitors who will be showing at Expo for the first time. Second, I want to thank all the companies that exhibit at Expo, support local vendor shows, and contribute to the Society's ongoing mission of training, certification and standards.

These exhibitors also sponsor different events throughout the show. Wavetek is sponsoring the Arrival Night Reception; and Antec, CommScope, General Instrument, Philips Broadband Networks and Scientific-Atlanta, the sponsors for Expo Evening, are just a few of the exhibitors supporting hospitality events at Expo.

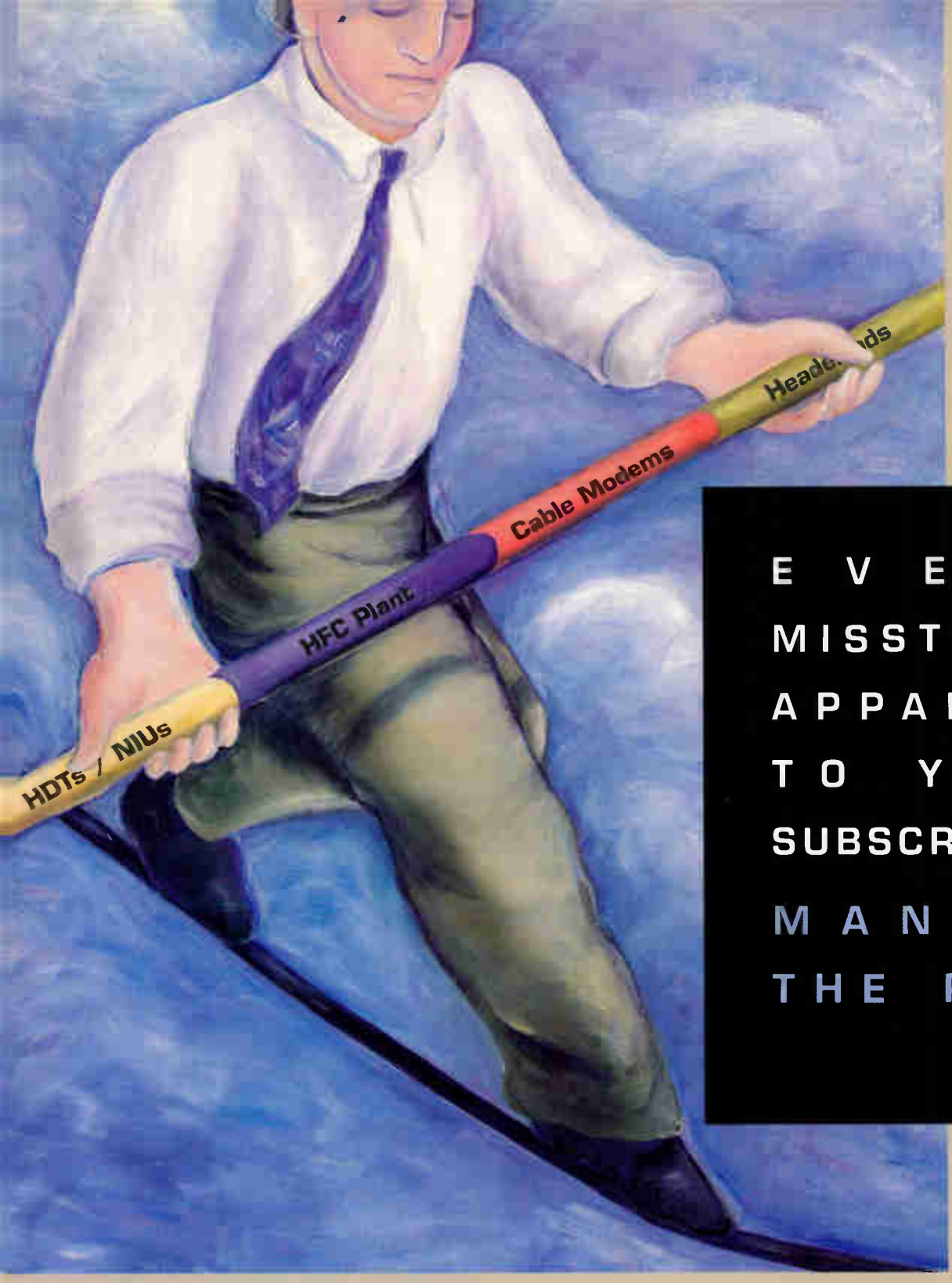
Throughout the Cable-Tec Games at Expo Evening, exhibitors also will support the individual games, including "Cable Jeopardy," sponsored by NCTI; "Cable Splicing," sponsored by Gilbert Engineering and Thomas & Betts; "TDRs," sponsored by JCA Technology Group and Riser-Bond; "OTDRs," sponsored by JCA Technology Group; and "Meter Reading," sponsored by Wavetek and Trilithic.

Check it out

And remember that there's more news off the exhibit floor, too. Valuable educational experiences can be gleaned from industry leaders at the engineering conference, and cutting-edge information will be presented at preconference tutorials and technical workshops.

The news about the exhibit floor at Expo is education, excellence and excitement. Officially opening with a 30th Anniversary ribbon-cutting ceremony, the Exhibit Hall hours will be Tuesday, May 25 from 2 to 6 p.m.; Wednesday, May 26 from 11 a.m. to 6 p.m.; and Thursday, May 27 from 9 a.m. to 1 p.m. On-site registration will be available at the event. More information can be obtained from the SCTE Web site at www.scte.org or by calling the Cable-Tec Expo '99 hotline at (610) 363-3822. CT

Scott Meek is manager of marketing services for Channell Commercial Corp. and is chairman of SCTE's Cable-Tec Expo '99 Exhibitors Subcommittee. He can be reached at (909) 694-9160.



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