Communications Technology

DECEMBER 1998

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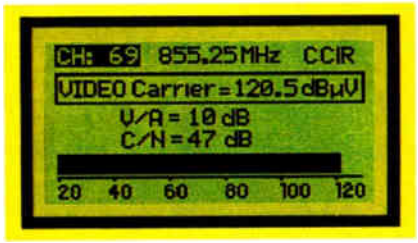

The equipment can also be configured for measurements on digital channels, giving us the value of the digital CHANNEL POWER as a figure and also on the graphic bar.

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Cover
Design by Maureen Gately
Photo courtesy of Cox Communications

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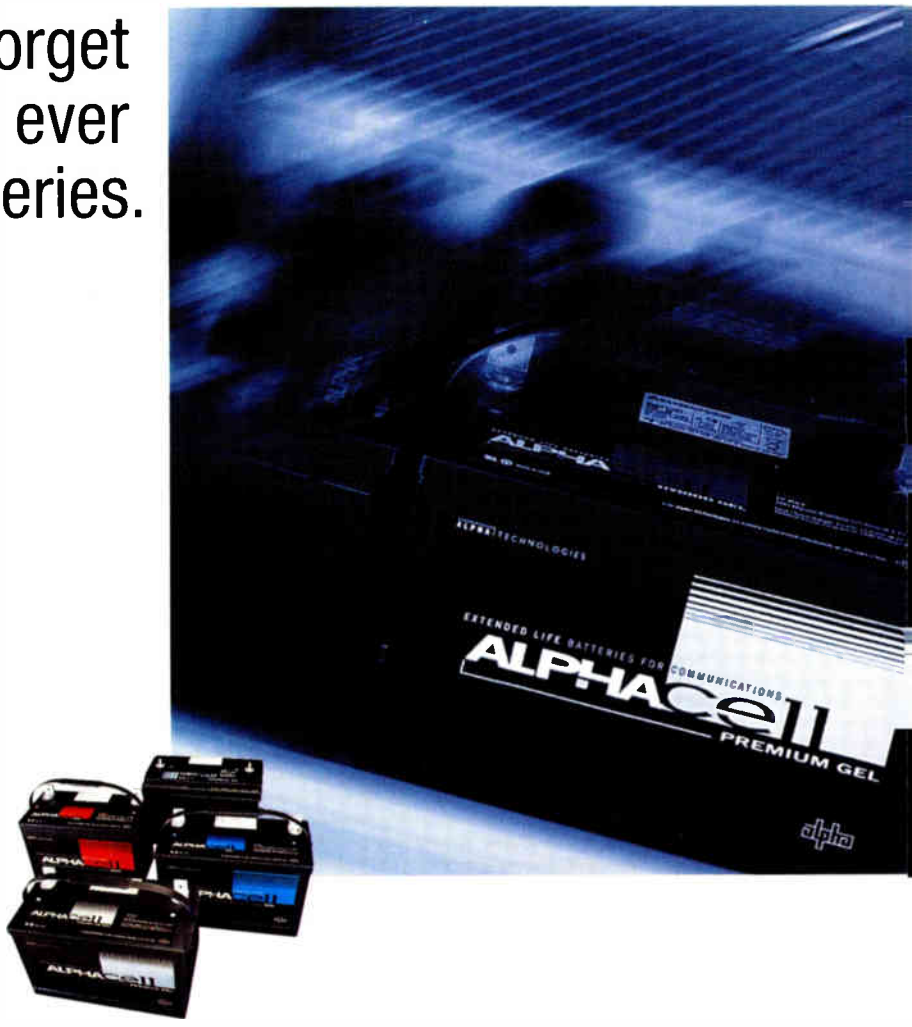
Four reasons to forget everything you've ever known about batteries.



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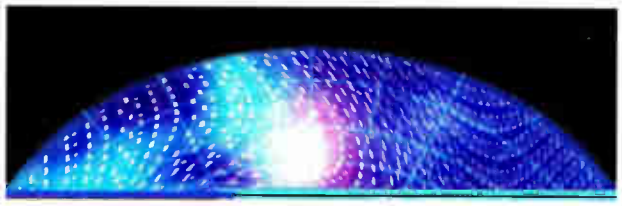

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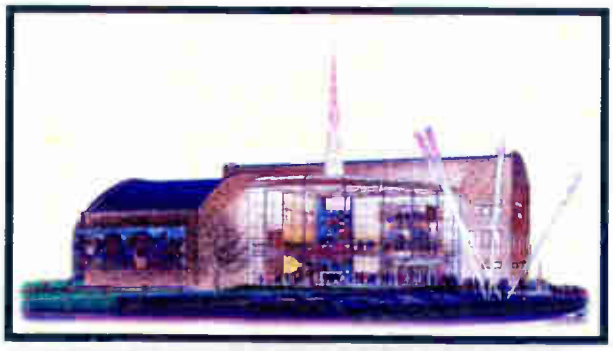

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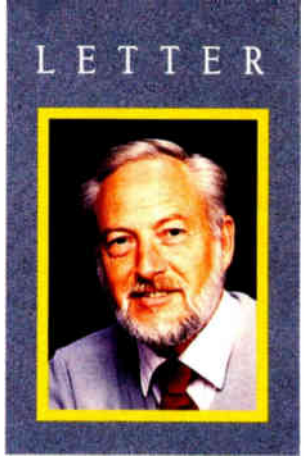
Reader Service Number 4

By Rex Porter



The Burden of Technology

This past month, many MSOs approved their annual operating budgets for 1999. As chairman of the Society of Cable Telecommunications Engineers' 1999 Nominations Subcommittee, I have noticed how many SCTE members want to serve on the board of directors and various industry committees.

But today, technicians and engineers hardly have time for their own personal lives or their families—much less for industry work outside their own local systems or MSO headquarters. New services are being demanded by system/MSO owners and general managers. Data systems, digital TV, high definition TV (HDTV) and Internet protocol (IP) telephony are valuable sources of revenue for cable operators.

I hope, during budget discussions and planning, the technical planning will factor in the need for additional personnel. The number of technicians and engineers needed to run a purely "entertainment TV" cable system is not the same number needed to staff a system that provides high-speed data, IP telephony and other services.

However, the need for additional personnel must be presented to the owners and management of the systems and MSOs. As an old system owner and MSO manager, I know we never wanted to hear that we would have to enlarge our staff to add new services. My position, and that of the board of directors, was that the system technicians would just have to work a little harder and a little longer, but the present staffing would be sufficient.

I guess the technical community always will have to put in extra hours and work a little harder than other departments within cable. But technology is not waiting for us to catch up, and there continue to be only 24 hours in a day.

We cannot afford to have exhaustion and "burnout" among our technical staffs and certainly not among our most qualified personnel. But then too, the chief technical officers have an obligation to provide a safe and healthy working environment for their staffs.

The most important time to act is during budget planning. Stand firm and demand enough people so that technicians and engineers can work hard but still have time to enjoy the fruits of their labor.

Rex Porter
Editor

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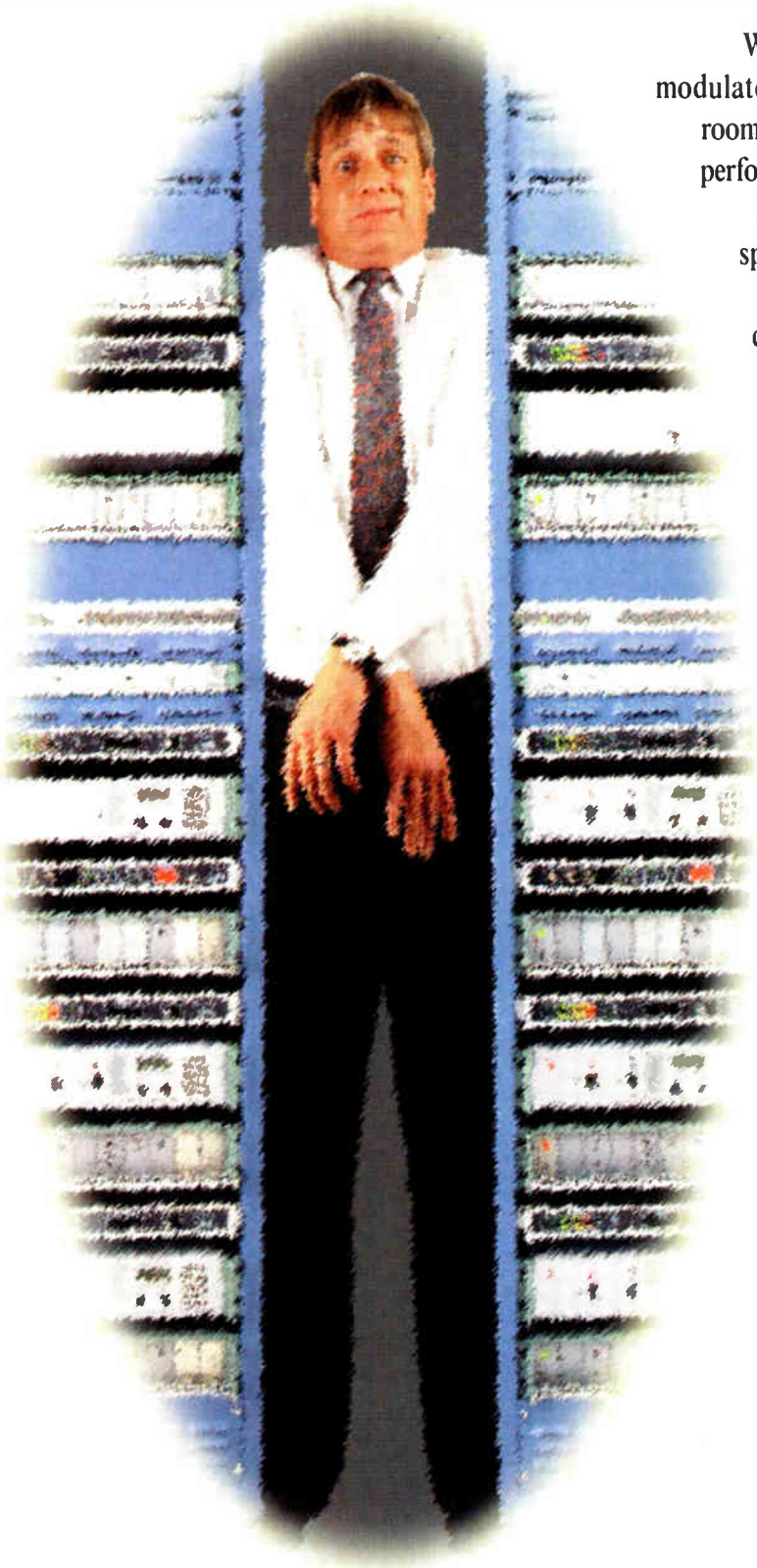

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Reader Service Number 8

By Greta Durr

GI Benefits From HDTV

Years of research are rewarding broadband vendor General Instrument as it revels in laurels and contracts for its brand of high definition TV (HDTV).

Since *R&D Magazine* honored GI and the six other Grand Alliance members for significant technology development in 1998, the vendor saw a flurry of contracts based on its contributions to the Advanced Television Systems Committee digital TV (DTV) standard.

In one week, GI announced several deals with broadcasters eager to meet the Federal Communications Commission's November deadline for digital transmission or simply to join the digital age.

GI will gear up HBO's new HDTV feeds to be launched in early 1999. The technology, developed by the vendor's San Diego-based Satellite Data Network Systems unit, will compress and multiplex both standard definition TV (SDTV) and HDTV signals within a single integrated transmission system.

The HDTV system is ATSC-compliant and was designed to be compatible with the DigiCipher II systems deployed worldwide, which feature standard definition Moving Pictures Expert Group-2 (MPEG-2) compression. HBO said the system provides a natural growth path for existing users as well as a proven platform for new customers who wish to launch HDTV, SDTV or a mix of both TV services.

San Francisco's KRON-TV went with GI's high definition and standard definition encoders for the launch of its digital TV services. In addition, the vendor was asked to install one HDTV channel, configured for 1080i transmission, and one SDTV channel as part of an integrated system to offer viewers both types of content.

CBS also chose GI's DigiCipher II system for the conversion of its network distribution system from analog to digital. The project includes the digitization of all current network programming as well as future advanced HDTV programming. The vendor will provide 12 digital 4:2:2 SDTV channels and two HDTV channels at CBS' Broadcast Center in New York City.

A backup site is planned for CBS facilities at Television City in Los Angeles. For CBS affiliates, GI will provide newly designed integrated receiver/decoders (IRDs) as integral parts of CBS' new digital receive system. The IRDs will decode both standard definition 4:2:2 and HDTV services. GI's Network Control System provides scheduling, encoder provisioning and monitoring, and authorization management for the end-to-end system.

Adopted by the FCC two years ago, the ATSC standard is based on the system originated by the Grand Alliance. The group formed in 1993, and includes Lucent Technologies, Massachusetts Institute of Technology, Philips Electronics, Sarnoff Corp., Thomson Consumer Electronics and Zenith.

With this technology, a broadcaster can multicast up to four digital programs on a standard TV channel. These programs offer resolution similar to that of analog systems, says GI, but without the snow and ghosts.

Core elements of the Grand Alliance system include multiple video transmission formats, multi-digital audio MPEG-2 video compression, the MPEG-2 packetized data transport structure, and the vestigial sideband (VSB) digital modulation and transmission system.

ATSC enables digital TV sets to work with or incorporate computers. The standard provides for cable and satellite transmission as well as terrestrial broadcasts.

In FCC plans, by 2002 all commercial

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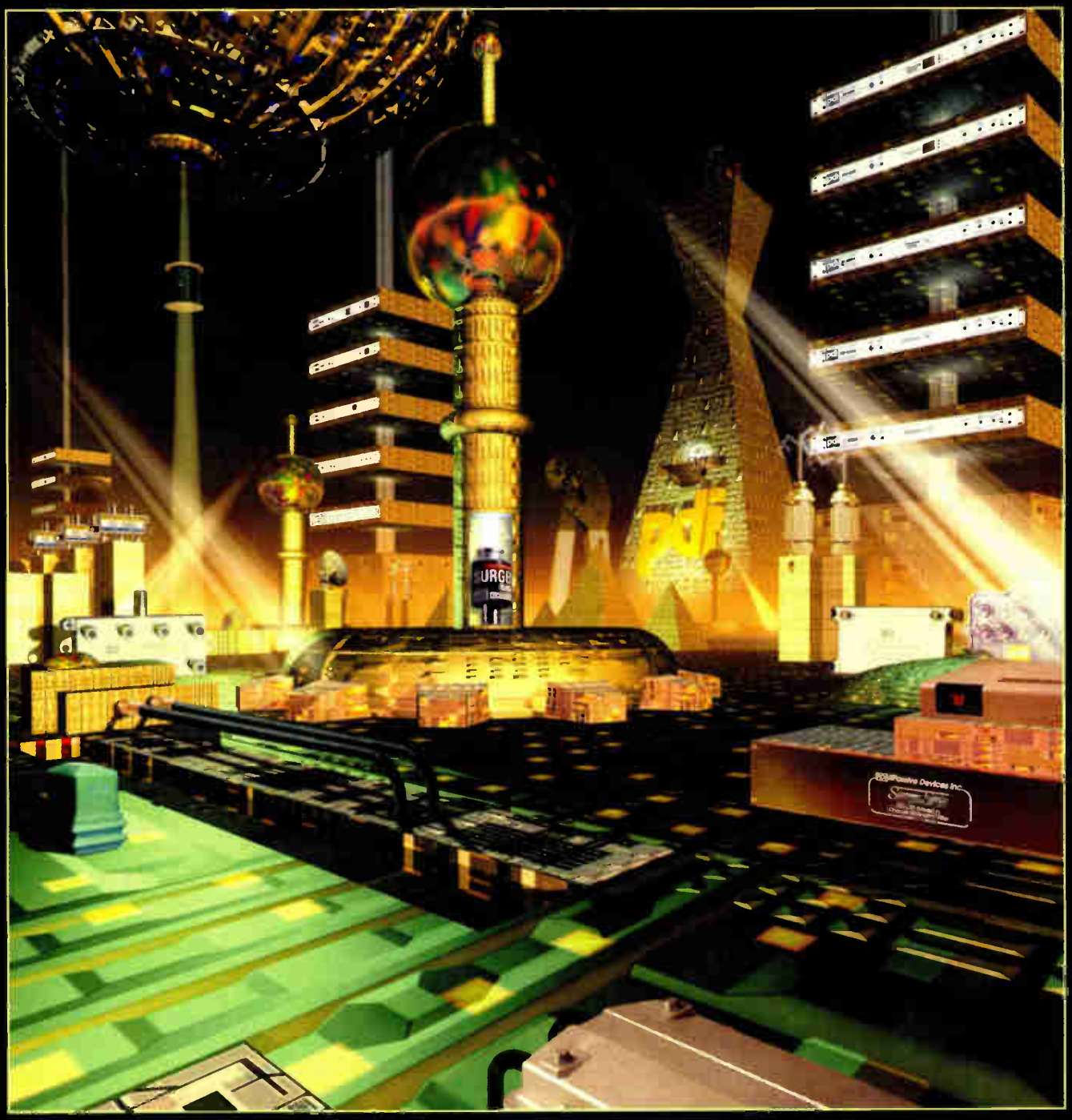

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Reader Service Number 10

stations will provide a digital signal, and by 2003 all public stations also will be broadcasting in digital. The current analog TV broadcast system is expected to phase out beginning in 2006.

MSOs Hot for WebTeacher

As industry leaders rally to empower teachers and students with education and high-speed Internet access, public libraries are the latest addition to cable's menu of community service offerings.

Since 1989, more than 8,400 cable operators and 38 cable networks have invested more than $500 million to wire and connect schools to cable. Together, they've delivered more than 540 hours of cost-free, commercial-free educational programming every month to classrooms across the country, reports the National Cable Television Association.

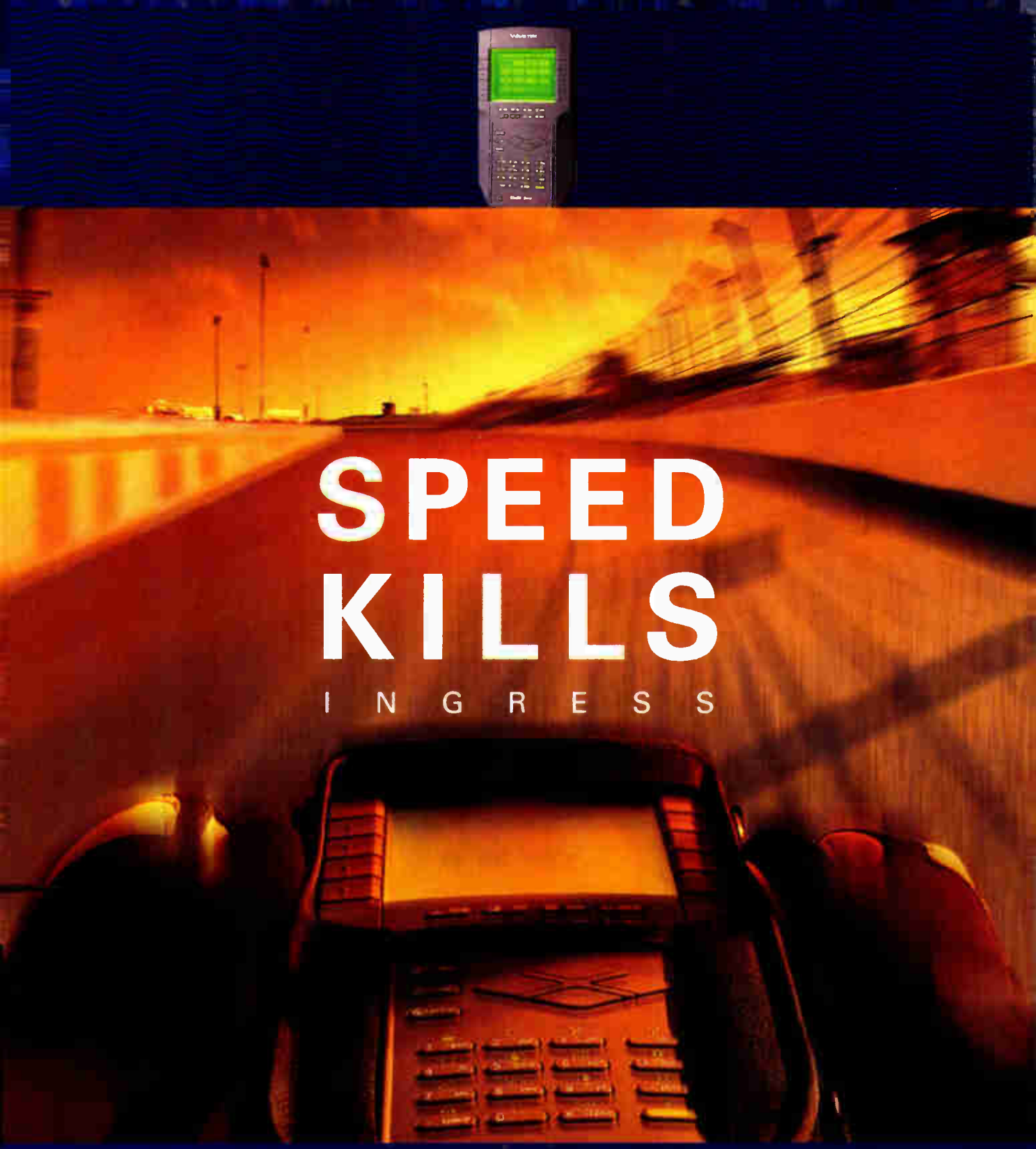
Time Warner Cable, Jones Intercable, TCI, Adelphia, MediaOne, TCA, Intermedia Partners, Comcast, Charter, Bresnan, CableVision Corp. and others recently expanded a commitment to provide schools with high-speed Internet connections using the latest cable modem technology.

"Cable's High-Speed Internet Connection," an NCTA-sponsored program, was expanded in 1997 to include resources to help teachers connect to the Internet. The resulting WebTeacher program hosts a Web site (www.webteacher.org) that has an end-to-end tutorial that explains how to use the Internet. It includes lessons in basic cable modem technology, Internet safety and e-mail. How to use Telnet, file transfer protocol (FTP) and hypertext markup language (HTML) are among the topics tackled on the site.

To facilitate the WebTeacher training component of "Cable's High-Speed Education Connection," the cable industry has teamed up with Tech Corps, a nonprofit organization composed of technology volunteers dedicated to bringing technology into classrooms. The collaboration is resulting in increased availability and training for teachers nationwide.

In October, industry leaders announced they have identified nearly 700 communities to be wired by the year 2000. Since the effort began two years ago, the industry has wired more than 2,500 schools with free cable modems.

Thirteen regional training sessions for



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RETURN PATH OUT

WAVETEK

Reader Service Number 12

teachers were scheduled across the nation in 1998. The NCTA says that even more is in store for 1999, as the industry advances its pledge to wire public libraries with Internet connections that will take the Information Age into the next century.

Feasting on New Services

CableLabs' OpenCable may be warm on the table, but industry leaders are hungry for two-way interactive networks' monetary desserts and are making moves to provide new services over the set-tops that will change the industry.

Time Warner Cable chose SeaChange International as the first video server vendor for its Pegasus video-on-demand (VOD) test. In the deal, Time Warner will test the SeaChange MediaCluster video server and interactive TV software in its first site to deliver VOD to cable viewers at an undisclosed system over Scientific-Atlanta's Explorer 2000 digital set-tops.

In other Explorer 2000 news, S-A plans to enable Wink's Enhanced Broadcasting and electronic commerce applications.

The program allows interactivity and electronic commerce functionality to traditional programming and advertising. Viewers may respond by requesting additional information over a remote control.

Wink also has joined S-A's CreativEdge Developers program designed to allow technical support certification and services so that participants can facilitate rapid deployment and maximize two-way interactive digital networks.

Wink also has agreements with a number of MSOs, broadcast and cable networks to provide its services. Century Communications, Charter and Intermedia are a few of the American operators on the bandwagon since Wink's initial deployment three years ago in Japan.

Fiber Diet Alternative

Reports of falling prices and dwindling market acceptance may present some cable operators with fiber for thought.

Analysts at the Newport, RI-based KMI Corp. project fiber prices to fall by as much as 10% per year over the next two years according to a report. Its study, "Worldwide Markets For Optical Fiber and Fiber-Optic Cable," says prices are dropping at a rate less than the increases in the installed volume. Consequently, the cable market's value could increase from $6.4 billion in 1998 to $10 billion in 2003. The report notes that the 1998 figure is down 4% from 1997.

The report tracks six global regions, finding that decreases in uncabled fiber are passed through to the cable customer, causing cable prices to drop at similar rates. Price erosion is the greatest current threat to fiber and cable manufacturers.

The Boston-based Fiber Optic Association last summer surveyed its members on the slow acceptance of fiber for premises cabling. Members blamed the cost of electronics for fiber, a lack of qualified installers and infighting among fiber vendors for retarding market growth.

Greta Durr is assistant features editor at "Communications Technology" in Denver. She can be reached via e-mail at gdurr@phillips.com.

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LETTERS TO THE EDITOR

Column Kudos

I just wanted to let you know I really enjoyed reading Laura Hamilton's column "One Way To Skin A Data Cat" in September's *Communications Technology*.

I have been working for the last 20 years with the Texas Department of Transportation Main Computer Center in Austin.

Here at TxDOT, we have a large IBM shop with local area networks/wide area networks (LANs/WANs), microcomputer and telecommunication lines all over the state for four regional TxDOT computer centers in Dallas, Houston, San Antonio and Lubbock. We have more than 14,000 employees statewide to maintain an active system.

I know from experience when I read a column that directly relates with the people in the front line.

I look forward reading more interesting columns by you and wish you good luck.

Jimmy Castro
Computer Systems Specialist
Texas Department of Transportation

Locking Terminators with Resistors

While reading my July issue of *Communications Technology*, I was pleased to find your troubleshooting ingress pull-out wall chart. It is enlightening, in this day of high-tech anachronisms, to find basic common sense presented clearly.

There was one item, however, that I did find fault with: The caution not to use locking terminators with resistors built into them. While some products lack proper mechanical interfaces or resistors soldered to ground, it is unfair to blame all products for the shortcomings of a few.

It is, as your chart pointed out, sound engineering to terminate unused "F" ports. A directional tap's flatness response will improve as will security of services by the use of locking terminators. There is also the new potential of a cable thief stealing RF signal by attaching to an unprotected tap port that also passes AC power. This potential liability also will be reduced by the use of these devices.

There are products that protect services and do terminate properly. While some are better than others, the axiom "you get what you pay for" may apply here. CT

Neil Phillips
President, Signal Vision Inc.

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/or space.

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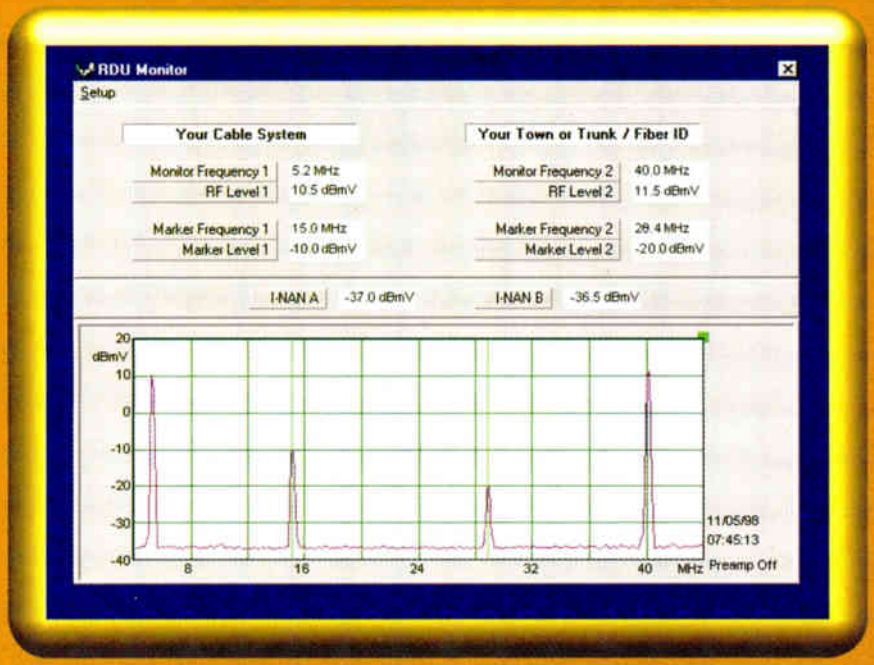

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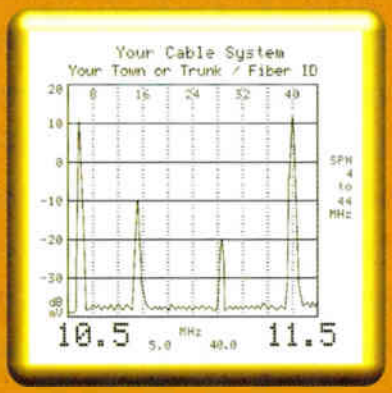

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Reader Service Number 16

DEPLOYMENTWATCH

By Greta Durr

It seems as though there are no lumps of coal going into the cable industry's stocking this holiday season.

Vendors are working overtime, like so many elves in Santa's workshop, preparing for the deployment of the latest in enhanced services for good subscribers everywhere.

Metro Cable Basks in Revenue

Metro Cable Systems deployed HomeStream service in the Philadelphia metropolitan area in cooperation with Cable Web Services, an area start-up.

The deployment follows a year's testing by CWS, in conjunction with a cable affiliate consortium and its Internet service provider (ISP). Four thousand individual sessions were logged during 6,800 hours online. During this time, more than 62 gigabytes of data were transferred downstream over cable, said CWS.

During the trial, testers used Ch. 74 in the poor signal roll-off area. Testers found this to be an excellent spot for their service offerings. During the tests last month, CWS said that not a single technical support call was logged.

With the addition of the HomeStream tiered service to its channel lineup, Metro Cable became the only cable operator in Center City Philadelphia offering high-speed Internet access to its subscribers. The operator serves more than 25 apartment and condominium complexes in town.

HomeStream focuses on the downstream path from the Internet to the home. With the service, upstream traffic from the subscriber's personal computer (PC) continues to travel through their current ISPs over a telephone line, while downstream traffic from the Internet to the subscriber's PC travels through Metro's cable plant via CWS' hardware and software.

According to CWS, the entire data routing process is invisible to subscribers. The only difference they notice is a marked increase in speed—up to 1.5 Mbps. Subscribers don't need to change their e-mail addresses, access settings or user preferences.

In addition to its deployments with Metro, CWS is working on offering telco-return and additional cable ISP services through other operators east of the Mississippi River.

Fordham Goes Two-Way

MagnaVision leveraged existing coax distribution for the rapid deployment of Hybrid's cable modems throughout New York's Fordham University campus.

The installer of private cable TV and data distribution systems also works in wireless installation, systems integration and support services. One of the reasons officials said they selected Hybrid is that the company's systems work in their wireless as well as in their wired environments.

The company says the massive installation of two-way high-speed Internet access services to 33,000 students on two campuses in Manhattan and the Bronx took only four months to complete. The system now provides dedicated access to the University's intranet, which links libraries, computer laboratories, faculty, students and administration to enhanced e-mail while providing World Wide Web access.

One Provider Fits All

The ISP Channel announced its third recent agreement with an MSO to provide high-speed Internet access via cable in various franchise service areas.

A contract with Arizona's *News Press Gazette* will enable services to 120,000 homes in the system's multiple franchise service areas. Parent company SoftNet said this is the third contract it has signed in the past four months. The agreement extends an earlier contract to service 25,000 homes in *News Press'* Lake Havasu cable system to now include the company's seven other Arizona systems. Commercial rollout to the remaining seven systems is slated to take place into 1999.

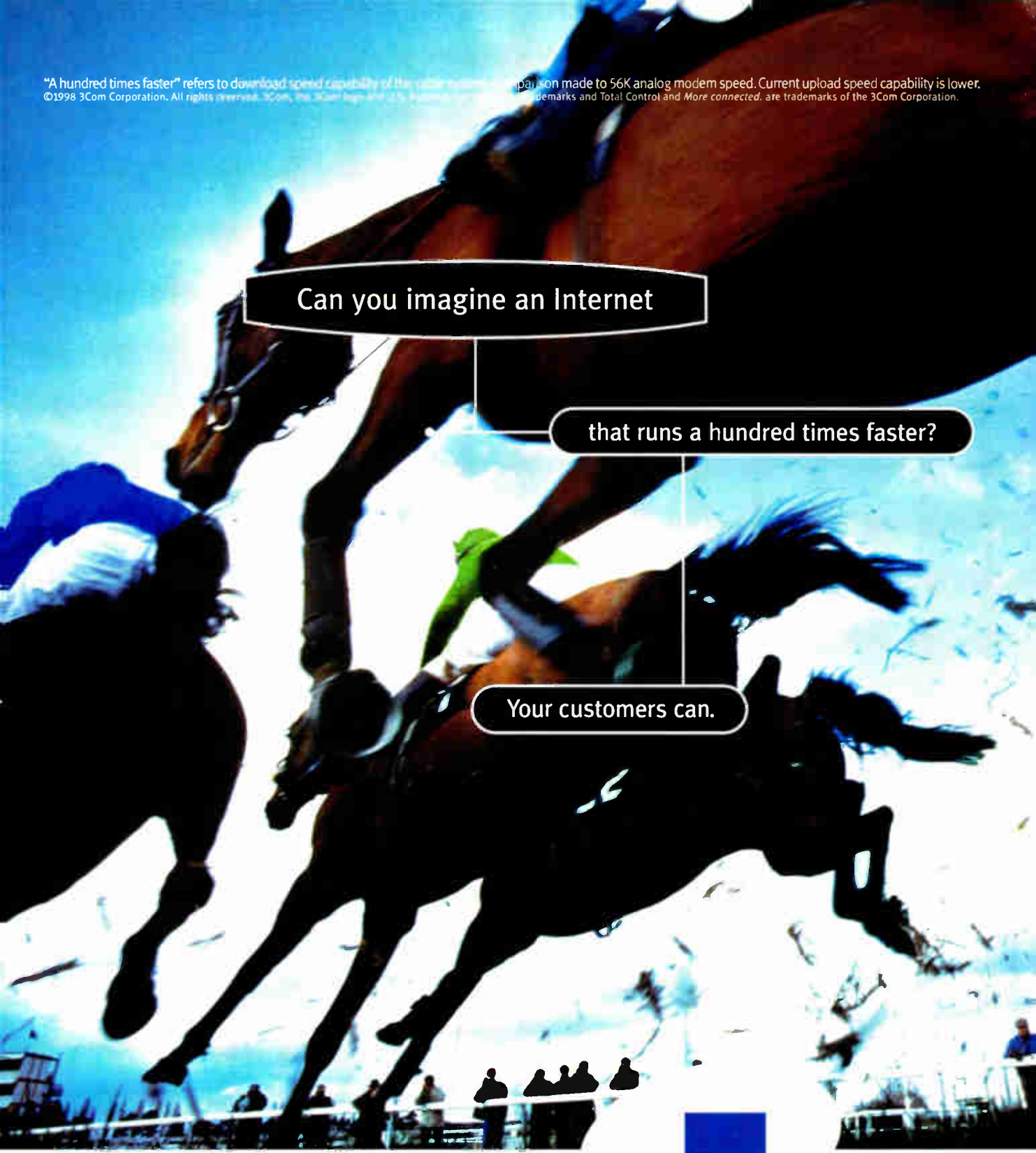
ISP Channel will continue to deploy a network clustering strategy for these remaining NPG systems. The company says that clustering will make advanced communication services from a centralized location possible.

In addition to NPG, ISP Channel has agreements and is in the process of high-speed Internet services deployments with Galaxy Cablevision, Northland Communications, Alexcom Limited Partnership and OnePoint Communications. CT

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

Recent Deployments

- **@Home** announced intentions to pursue smaller cable systems for the deployment of its high-speed Internet services.
- **Genesis Cable** and **High Speed Access Corp.** deployed their high-speed Internet access alternative throughout the operator's Georgia systems, passing more than 41,000 homes.
- **Stanford Telecom** has shipped more than 35,000 units in its series of demodulators for cable headend equipment in the United States and abroad.
- **Bell Atlantic** deployed a new TV service to 2.5 million residents of multiple dwelling units (MDUs) on the East Coast. The service combines **DirecTV** channels and positions the telco to offer voice, video and data services to those subscribers.



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Reader Service Number 17

Women in Technology Award Winner

The Society of Cable Telecommunications Engineers, Women in Cable & Telecommunications and *Communications Technology* are pleased to announce that Sheri Stinchcomb is the recipient of the 1998 Women in Technology Award. (See page 44 for the full story.)

Stinchcomb, who is the vice president of new product operations for Cox Communications in San Diego, was selected for this year's award for her "high level of technical expertise and professionalism...and her commitment to furthering the role of women in the technological field," according to a WICT statement.

A registered professional engineer, Stinchcomb has worked in the telecommunications industry for 12 years. During her four-year tenure with Cox, she has managed the technical requirements of the Cox@Home Internet access product, in addition to leading the company's residential digital telephony efforts.

Her responsibilities include launching high-speed data and telephony services in the San Diego area, as well as developing and implementing technical procedures for field and headend technicians, frequency allocation and management, operational processes, methods, and procedures for data and wireline.

As a self-proclaimed risk-taker, Stinchcomb says she loves the cable industry and the fact that Cox allows her to "pave the path" and try new things. She is proudest to have stuck to her values, both personal and professional, throughout her life and career. She always has faced tough issues and done her best.

Stinchcomb received her bachelor's degree in electrical engineering from the University of Oklahoma and her MBA from Oklahoma City University. In addition to her participation in SCTE and WICT, she is a member of the Institute of Electrical and Electronics Engineers and the Society of Professional Engineers.

The Women In Technology award, cosponsored by SCTE, WICT and *CT* magazine, will be presented to Stinchcomb during the 1998 Western Show in Anaheim, CA, early this month. The award was established in 1995 to recognize and honor women leaders within the broadband and telecommunications communities and to increase awareness of the accomplishments of women pursuing technical careers within the industry. Past winners include SCTE members Yvette Gordon of SeaChange International, Pam Arment of TCI International and Pam Nobles of Jones Intercable.

SCTE Revamps Distance Learning

The SCTE recently unveiled its revised Satellite Teleseminar series format to support candidates enrolled in the Society's professional certification program.

SCTE's 1999 Satellite Teleseminar program, as part of the Society's ongoing campaign to offer technical training in the latest technologies available to the broadband community, will kick off in January.

The new program will complement the Society's Broadband Communications Technician/Engineer (BCT/E) certification program with information as well as study and resource materials to guide participants in their preparation for exams.

BCT/E Subcommittee Chairman and 1999 Member of the Year Keith Hayes comments: "For some time, SCTE has heard from its members that finding the time and resources to prepare for BCT/E certification is often difficult, particularly if one lives in a rural section of the country. To address this problem, the Society has created a two-prong program that will make the road to certification easier to find. This is just one more example of how SCTE listens and responds to the needs of its members."

Upcoming seminars in 1999 include:
Jan. 14: Signal Processing Centers
Feb. 11: Video and Audio Signals and Systems
March 11: Digital System Deployment
April 8: Transportation Systems
May 13: Distribution Systems
June 10: 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 Teleseminars in 2000

Another key program change includes a registration process for individuals who wish to receive complimentary study guides and resource listings for each Teleseminar program. Registered members also will receive e-mail reminders the week of the broadcast so they do not miss the opportunity to tape the program. (Each tape also will be available for purchase from SCTE headquarters.)

SCTE also plans to support its chapters and meeting groups to develop face-to-face learning sessions that provide additional training in each area covered by the Teleseminar series.

Satellite Teleseminar programs are one-hour instructional presentations that are broadcast via Galaxy 1R, Transponder 14, on the second Thursday of each month from 2:30 p.m. to 3:30 p.m. EST. Anyone with downlinking capability can participate in the program at no cost. Videotaping of Satellite Teleseminars is encouraged for personal reference or for use as company training tools.

To register for the program, send your name, membership number (if known), full mailing address, telephone and fax numbers to Janene Martin, SCTE marketing implementation coordinator. Fax (610) 363-5898; phone (800) 542-5040, ext. 220; or e-mail jmartin@scte.org.

The Society of Cable Telecommunications Engineers is a nonprofit professional organization serving the broadband industry's technical community. SCTE currently has more than 14,000 national members and offers a variety of programs and services for the industry's educational benefit. SCTE has 72 chapters and meeting groups and has technically certified more than 3,000 employees of the cable telecommunications industry. T

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Reader Service Number 18

By Ron Hranac

Mismatched

Small Imperfections Add Up

A few months ago, there was an interesting discussion on the SCTE-List concerning regularly spaced impedance mismatches in a length of cable and how those mismatches can create a frequency response notch effect.

I posted a couple of messages explaining my understanding of how the phenomenon works. After some thought, I decided it would make a good subject for this month's column. So, if you've ever wondered about structural return loss (SRL) and periodic impedance discontinuities in coaxial cable, read on.

To grasp this concept, it's necessary to go over some basic transmission line theory. I'll keep the mathematics down to a dull roar and leave Ph.D.-speak out of the discussion. I'll also point you to some useful references should you decide you'd like to dig into the subject in more detail.

Theory vs. reality

If a signal source of impedance Z, a lossless transmission line with a characteristic impedance Z_c, and a resistive load with a terminating impedance Z_t have the exact same nonreactive impedance ($Z = Z_c = Z_t$), all of the energy transmitted from the signal source through the transmission line will be absorbed by the load.

In reality, of course, cable does have attenuation, and even the best quality signal sources, cables and loads do not have exactly the same impedance at every frequency. You'll be hard-pressed to find cable and other components that exhibit a purely resistive impedance; some amount of reactance almost always is present.

Every piece of coaxial cable ever made has minor imperfections throughout its length, resulting in very small, periodically spaced impedance mismatches. This periodicity is a normal byproduct of the coaxial cable manufacturing process.

Things such as wheels, pulleys, motors and other parts of a cable manufacturing line create small vibrations and oscillations that can affect the cable's physical dimensions and the ratio between the shield and center conductor diameters at a microscopic level.

These imperfections are nearly impossible to detect individually, but as you'll see later, their effect can be additive. SRL testing provides an indication of the magnitude of these periodicities.

Reality's consequences

If there is an impedance mismatch anywhere along the transmission path, it will cause at least some of the forward, or incident, signal to be reflected back toward the source. Worst-case impedance mismatch conditions would be a short circuit or open circuit. (A pure reactance is another problem, but let's save that for a rainy day.)

In either case, all of the incident signal power will be reflected back toward the source. If the load is a short circuit, its impedance will be zero ($Z_t = 0$). The reflected signal voltage will have the same amplitude but be 180° out of phase with the incident signal voltage, and the reflected signal current will be in phase with the forward current.

If the load is an open circuit, the load impedance will be infinite ($Z_t = \infty$), and the reflected signal voltage will have the same amplitude and be in phase with the incident signal voltage, but the current's phase will be reversed. Because the reflected signal has the same amplitude as the incident signal, we say this particular impedance mismatch—the short or the open—has 0 dB return loss. More on this in a moment.

In practice, a true short or open is difficult to produce, so when an impedance mismatch exists, some of the forward signal will be absorbed by the load, and some of the signal will be reflected back toward the source.

In this case, the reflected signal's amplitude will be less than the incident signal. Furthermore, if the load's impedance is less than the characteristic impedance of the transmission line ($Z_t < Z_c$), the reflected signal will be similar to a reflection from a short circuit. If the load's impedance is greater than the transmission line's characteristic impedance ($Z_t > Z_c$), then the reflected signal will be similar to a reflection from an open circuit.

Gnarly, gnasty math

The ratio of the reflected voltage to the incident voltage is called the reflection coefficient. It is represented by the formula:

$$G = E_r/E_f$$

where
G is reflection coefficient
E_r is the reflected voltage
E_f is the forward, or incident, voltage

The term return loss is more commonly used in the cable TV industry. Return loss is the reciprocal of the reflection coefficient, in dB, and is defined by the formula:

$$R = 20\log (1/|G|)$$

where

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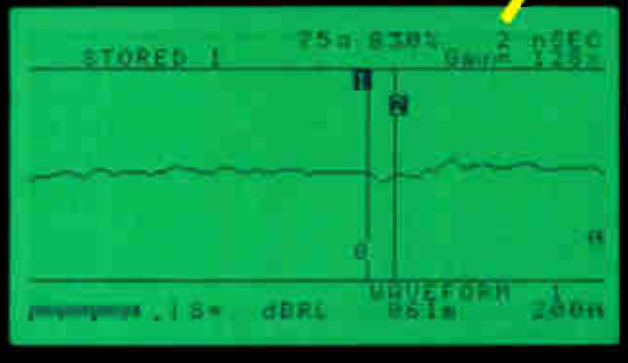

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R is return loss
|G| is the reflection coefficient's absolute magnitude

By the way, "return loss" usually is used in reference to reflections from a point impedance discontinuity—that is, a mismatch that exists at a single point such as the input of an amplifier, a splitter port and so on. "Structural return loss" is used in reference to periodic impedance discontinuities, or those spaced at regular intervals, as found in a length of coaxial cable.

When an impedance mismatch exists, the resulting reflected signal interacts with the incident signal to produce what are called standing waves. If you could take a voltmeter and measure the voltage at various points along the transmission line, you would find a succession of voltage peaks and valleys where the incident and reflected voltages interact constructively and destructively.

The ratio of the maximum voltage along the transmission line to the minimum voltage is called the voltage standing wave ratio (VSWR). So, VSWR = E_{max}/E_{min} and is related to reflection coefficient by the formula:

$r = (1 + |G|)/(1 - |G|)$

OK, enough of that stuff. I promised I wouldn't get too deep here, but I wanted to make sure you understand what happens to signals that are reflected by an impedance mismatch, as well as the various relationships that exist among fundamental terms used in transmission line theory. Now to some more practical ideas.

Cause and effect

Imagine a single continuous wave (CW) carrier traveling through a piece of cable. Now imagine regularly spaced but very small impedance mismatches throughout the length of the cable, a result of the normal manufacturing process. A more extreme example might be drop cable held to the side of a house by evenly spaced staples, each of which puts a small dent in the cable. These regularly spaced impedance mismatches, or periodic impedance discontinuities, will be separated by one-half wavelength at some frequency. Let's assume the spacing is a half wavelength at the frequency of our imaginary CW carrier.

If the impedance of each mismatch is less than the cable's characteristic impedance, then any reflections will resemble what happens when a short circuit exists. That is, the reflected voltage will be 180° out of phase with the incident voltage, but at a lower amplitude.

However, because the impedance mismatches are spaced one-half wavelength apart, the reflection from any one mismatch will be in phase with reflections from all the other mismatches. Thus, the reflected voltage from each mismatch will be additive with the reflected voltage from the other mismatches. Because the overall reflected voltage is 180° out of phase with the incident voltage, some cancellation will occur, producing a frequency response notch effect, or suckout, at the frequency of

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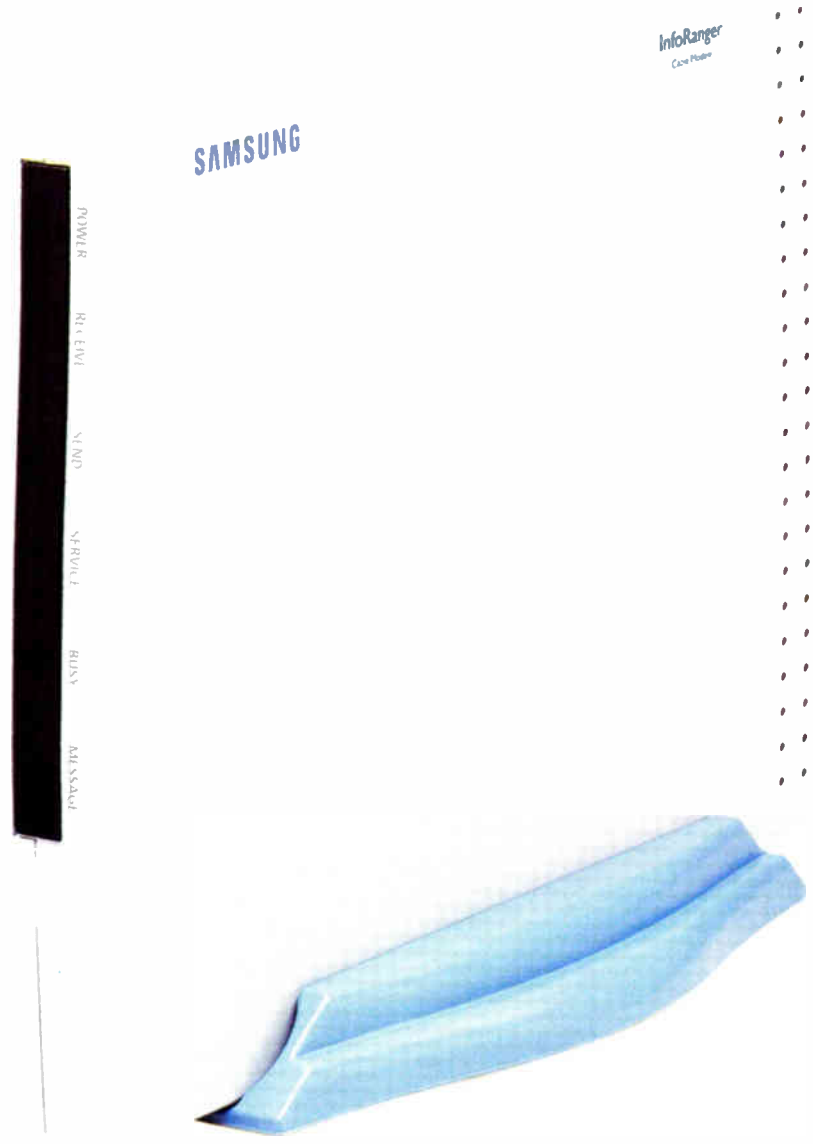

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our CW signal.

If each mismatch has an impedance that is higher than the cable's characteristic impedance, then any reflections will resemble what happens when an open circuit exists. That is, the reflected voltage will be in phase with the incident voltage, again at a lower amplitude.

As before, because the impedance mismatches are spaced one-half wavelength apart, the reflection from any one mismatch will be in phase with reflections from all the other mismatches and will be additive. But now the overall reflected voltage is in phase with the incident voltage, so some addition will occur, producing a frequency response spike at the frequency of our CW signal.

Another way to look at it

To visualize all of this, draw a sine wave on a piece of paper to represent the incident CW signal. Next draw dots every half wavelength across the horizontal axis to represent the periodic impedance discontinuities. If you draw a lower amplitude sine wave (originating at any of the dots) of the same frequency to represent either an in-phase or out-of-phase reflected signal, you'll quickly see that each reflection is in phase with regard to every other reflected signal.

Therefore, even though any single impedance mismatch may result in a very low amplitude reflection, the additive nature of numerous half wavelength-spaced reflections can produce an overall reflected signal that is substantial enough to cause problems with the incident signal, which will degrade the cable's SRL.

Any questions? Good. Now close your books, and get ready for a pop quiz!

Further references

If you want to read more about transmission line theory, I suggest the following references:

Handbook of Coaxial Microwave Measurements, David A. Gray, GenRad Inc., 1968. Currently available from Gilbert Engineering, Glendale, AZ.

Reflections (Transmission Lines and Antennas), M. Walter Maxwell, American Radio Relay League, Newington, CT, 1990.

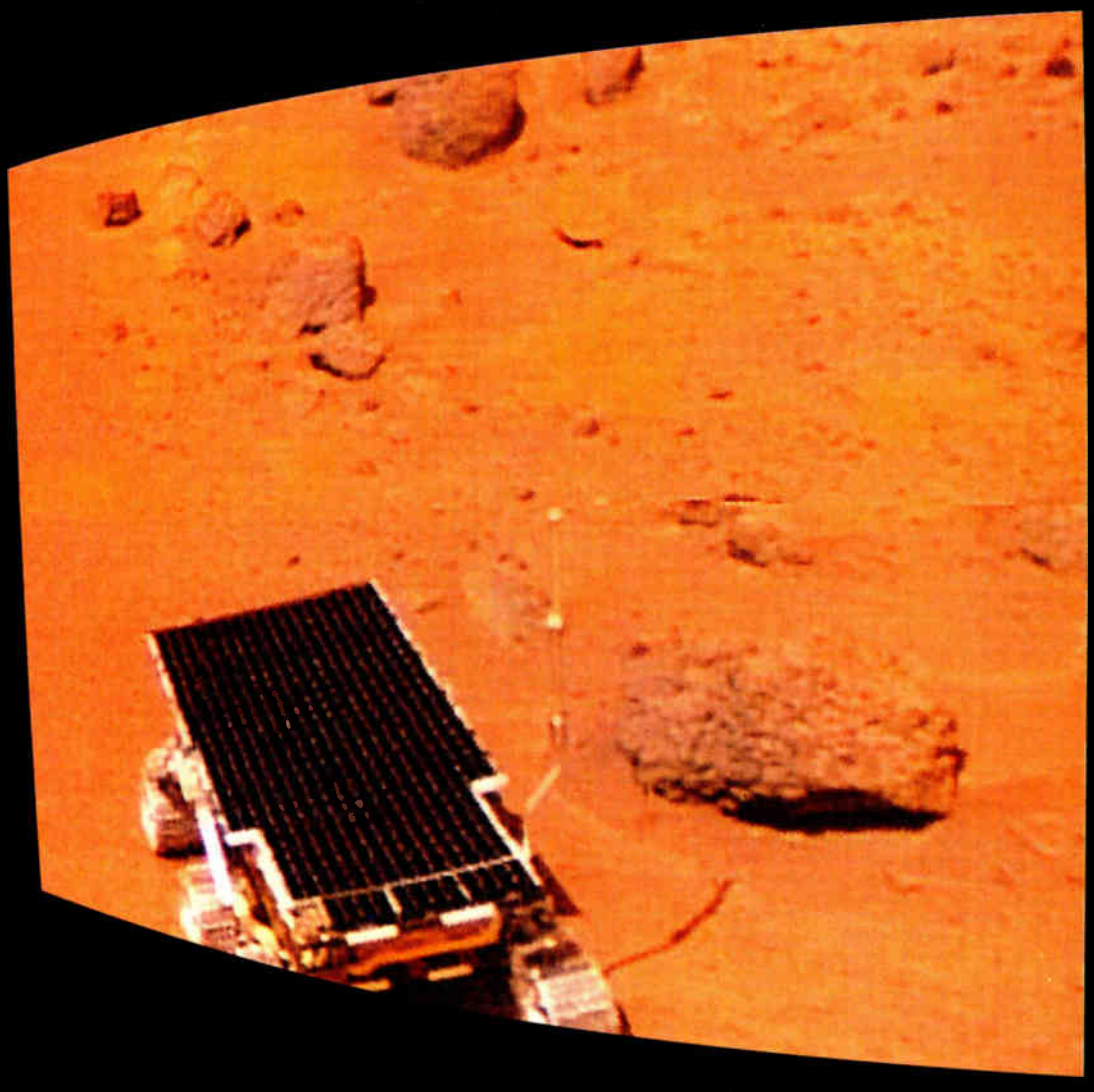
Technical Handbook for CATV Systems, Ken Simons, Jerrold Electronics Corp., 1968. Note: This one's out of print; check with General Instrument for current availability.

"Testing CATV Cable To 1 GHz," Technical Note #1069, Times Fiber Communications, Wallingford, CT.

The ARRL Antenna Book, American Radio Relay League, Newington, CT.

The ARRL Handbook for Radio Amateurs, American Radio Relay League, Newington, CT.

Ron Hranac is senior vice president of engineering for the Denver-based consulting firm Coaxial International. 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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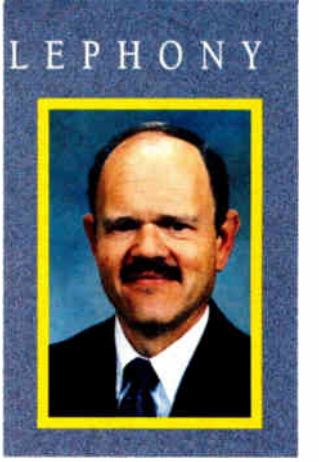
Reader Service Number 23

By Justin J. Junkus

Whatever Happened To Portable Phone Numbers?

Various Obstacles Impede Progress



Once again, it's near the end of the year, and for some reason, in this column that seems to be the proper time to think about local number portability. This year, the subject is particularly pertinent because December 1998 marks the original deadline set by the regulators for carriers in the top 10 metropolitan areas to offer number portability to their local service customers.

It may, however, take a little longer for portability to reach your neighborhood.

The reason is that making a telephone number portable is not as simple as people thought it would be. The deadline was created as part of the Communications Reform Act of 1996, to foster local service competition. The concept itself is simple—your phone number belongs to you, not to the phone company.

Since the driving force of communications reform was to increase the number of service provider choices available to the consumer, the regulators wanted to remove any obstacles to your choice, such as the inconvenience of changing your phone number every time you change service providers. (After all, you don't have to change phone numbers when you change long distance carriers, do you?) Hence, the mandate to the incumbent carriers: Find the technology to make it happen, and do it within two years.

Implementation is not easy

Unfortunately, your phone number is tied to a lot of other stuff—such as your phone bill and the routing of your phone call. Making number portability a reality requires a massive database to track which number belongs to whom, in addition to each number's carrier association.

Furthermore, to make sure the system would handle all carriers equitably, regulators insisted that the database be maintained by an independent administrator. They thereby ruled out its ownership or development by the businesses that had the most experience with how number administration works—the incumbent phone companies.

"Making number portability a reality requires a massive database to track which number belongs to whom, in addition to each number's carrier association."

The country was divided into eight regions. A working group consisting of carrier representatives and the federal government was created to choose vendors to solve the number administration problem for each region. Only two other companies were able to bid for this business successfully—Lockheed Martin and Perot Systems, both of which have extensive database administration experience.

Lockheed Martin's experience with the delivery of the databases for 800 number administration obviously helped, since today it is the only survivor of the development process and is the administrator for the entire country.

The key to the system's success is the creation of the Number Planning Administration Center (NPAC), which is tied to both the service order change processes of the carriers and the common channel signaling (CCS) network that sets up call connections prior to establishing a voice path.

The NPAC is responsible for service provider data and network data administration, audits, resource accounting, billing and cost apportionment, and mass changes, such as area code splits. There are two NPACs in the United States: one in Illinois and the other in New York.

The NPAC contains a database that links each switch's 10-digit identifier, called the location routing number (LRN), to the actual telephone number. Before portability, this was unnecessary because the phone number itself was the link to the switch. With portability, each switch that hosts ported numbers has a 10-digit LRN assigned to it.

In actuality, the NPAC database is a master copy, which is continually updated

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and downloaded to a copy in each participating carrier's CCS network. The downloading is controlled by the NPAC's local service management system (LSMS). Updates and changes to the NPAC database are via the service provider's service order administration system.

Many switches and carriers

Calls are routed through the public switched telephone network (PSTN) via several switches in the networks of multiple service providers. The responsibility for retrieving the number information from the database belongs to the switch that is one network removed from the network serving the called number.

This switch is known as the N-1 switch and may belong to an interexchange carrier (IEC), a new service provider or an incumbent local exchange carrier (ILEC). All the ILECs must change their CCS networks to work with the new system, and thus will provide a backup method of retrieving the translation between called number and switch should the switch belonging to the N-1 carrier not be able to do so.

The linkage between the carriers' switches and CCS, as well as the switches themselves, requires modifications to allow the carrier's CCS system to receive data from the NPAC. This, of course, involves the commitment of the carriers to spend the required dollars on the modifications.

As number portability is implemented, carriers have three choices: do nothing, use service bureaus to perform the database lookup or modify their own CCS systems to work with portability.

The "do nothing" approach shifts the responsibility for the database lookup to the ILEC that would have terminated the call had the number not been ported. It also shifts the distribution of the revenue from the call to the carrier that actually performed the lookup. As numbers increasingly become ported, the financial incentive to join the system becomes greater. Even if revenue weren't a factor, the need for the porting information to support various operations systems, such as billing and customer service, still would drive carriers to participate.

Using a service bureau to access the database temporarily avoids the capital investment needed to modify CCS, but it requires the carrier to share call revenue with the service bureau. Also, it doesn't give the carrier the information for its operations systems.

Once a carrier decides to participate, either through modifying its own system, or by using a service bureau, it must contact the Lockheed Martin NPAC to become a "customer." Lockheed Martin provides support, coordination and certification of the various interfaces to the service order system.

Not all phone numbers will be portable immediately. Carriers are beginning to work together to place unused numbers in a pool, which will be drawn upon for new number assignments. In the meantime, other efforts are underway to assign numbers to new carriers and their services in smaller blocks, to avoid exhausting available number assignments.

Special challenges

As we mentioned last month, Internet protocol (IP) telephony calls require a translation between an Internet address and the local phone number. This is done at the IP telephony gateway.

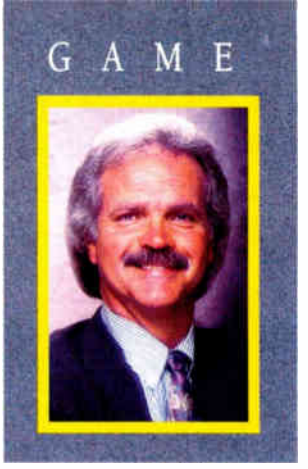
With number portability, the lookup now requires not only matching an IP address with a local phone number, but also checking the ported status and finding the LRN. This means not one, but multiple database dips to route an IP call. Many design issues remain to be worked out to make this a reality.

Wireless number portability also is mandated by the Communications Reform Act, and it also requires network and equipment changes. The deadlines are later, but the mandate to port still applies.

The bottom line is that it will be a while before all consumers can really own their phone numbers.

Justin J. Junkus is president of KnowledgeLink Inc., 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.

By Terry Wright



That Old Cart and Horse Story

Keep Service Delivery Ahead of Marketing

In the October issue's "Data Game," I expounded on the need for momentum in high-speed broadband data services. I believe momentum will be necessary in order for the industry to compete successfully in the advanced telecommunications space.

Shortly after writing the October column, I read dangerously misleading comments quoted from panel members of a recent (September) industry seminar. While not the exact language quoted, the gist of the comments sounded a lot like, "Marketing and sales are the key ingredients to succeeding in cable-based high-speed data services."

The misleading aspect of this comment is the relative importance placed on the role of marketing and sales in the overall deployment of broadband data services, as compared to technical and operations capabilities.

In fact, in the current high-speed data services environment, a focus on marketing and sales as the top deployment agenda item would be a serious mistake. Believing a comment like this could in fact be the quickest way to guarantee your data services hit the proverbial ditch. Why? Well, I've seen it happen already, and without a solid, reliable, well-behaved and manageable technical service delivery horse in front of the marketing/sales cart, your deployment can't miss the ditch.

I am not saying that there isn't a place, even an important place, for marketing and sales in your data services deployment effort. I'm simply saying that it isn't priority No. 1, and in the high-speed data services market, it probably never will be—nor should it.

Marketing programs for high-speed cable data services get the word out and are excellent packaging mechanisms to perhaps gain a few more traditional cable subscribers through the data service offering. But marketing and sales programs have to take a back seat to the technical side of things.

I could stop here and simply leave you with my humble opinion. However, I think you'll value this opinion a little more if you understand the rationale behind it.

> "In the current high-speed data services environment, a focus on marketing and sales as the top deployment agenda item would be a serious mistake."

Evolving market climates

Today, the majority of your subscribers will be folks commonly referred to as "early adopters." Early adopters are experienced Internet/data users looking primarily for a faster version of the dialup or other telephony-oriented service they already have.

In fact, one of the first things many of them will do is to run their own analysis of the performance they are getting with their cable modem service. They assume (and expect) that all other aspects of their Internet/data service, such as reliability, integrity and security will be at parity with their old service.

As with almost any group of people sharing a common interest, early adopters tend to talk among themselves, coworkers, friends and neighbors about their high-speed service.

About the last kind of "word of mouth" you want them spreading among their associates would be something like "Well, it's very fast...when it works," or "I guess it would be terrific if it didn't average 60% to 80% packet loss." Perhaps the worst would be: "Gee...I wish I could tell you how it works; it's been two weeks since they installed the thing, and I can't reach anyone who knows anything about the service to find out when it actually will be up and running in my neighborhood."

System first, sales second

At all costs, you should avoid premature focus of resources and efforts on marketing and sales prior to getting your network reliable, robust and service-ready, and before you have all your processes, policies and procedures defined.

Such a mistake can lead to just the kind of scenario described earlier—a poor reputation that will plague your Internet/data services deployment ever after. Don't think your competitors wouldn't use such awkwardness against you. You've probably already seen and/or heard ad spots touting the reliability and security of their networks and all the wonderful things they do for the community through their services. ➤

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If you work in the technical side of your cable operations, do yourself a huge favor: Don't let anyone put the cart before the horse, and closely review for accuracy any marketing collateral that will be used.

Assume the majority of your initial subscribers will be Internet-savvy early adopters who will closely scrutinize your service offering and will most appreciate the performance, but in general will be the hardest to satisfy.

The future will change little regarding the importance of prioritizing technical and operational aspects of service delivery over those of marketing and sales.

What will change as your Internet/data services evolve is that your supply of local early adopters will be exhausted, and you'll start to see an increasingly less-sophisticated (but no less demanding) subscriber base. Many of these subs won't know exactly how the 'Net works, but they'll spout buzzwords as though they do.

You'll also see your subscribers initiating a plethora of new applications designed to exploit the performance of broadband. While novice users send video mail everywhere and listen to net radio, some early adopters will probably try to get you to let them do something strange on your network.

And don't forget about the younger generation. Mom and Dad might be paying the bill, but you can bet the youngsters will be stressing the limits of the service, either deliberately or unknowingly. Do you have any idea how much bandwidth a game server can chew up?

Summary

The bottom line is that in the data game, having your technical and operational act totally together before marketing and sales efforts are introduced is an absolute must if you expect to be in the game very long. Marketing and sales should package value into service offerings that are appealing to your market base after quality technical and operational capabilities enable and ensure the delivery of that value.

Terry Wright is chief technology officer at Atlanta-based Convergence.com Corp. He can be reached at (770) 416-9993 or via e-mail at twright@convergence.com.

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Fiber Optic Customer Premise Cabinets

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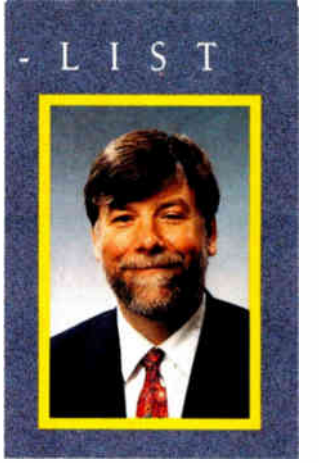

By David Devereaux-Weber

The Correct Way to Clear Poles

A Lesson From the School of Hard Knocks

From the "Don't try this at home" file comes this hard-earned life lesson from Steve Allen. This message thread started out simply enough, as a query about which kinds of antennas are best. As usual, this has been edited to fit.

From: Steve Allen
Date: Friday, Oct. 16, 1998
Subject: Parabolic isotropic screen reflectors??

Since we are talking about antennas, I will share an adventure I had about 25 years ago, when I could literally run up a pole on hooks.

The cable system in Chico, CA, is located in the north end of the Sacramento Valley. It was in this system that I was introduced to the ingenuity and brilliance of some of the post-WWII engineering that made the cable industry what it is.

On my first trip up to what they called the headend, I was greeted by a huge line of telephone poles, assembled in an arc and pointed in the general direction of Sacramento and the Bay Area. The poles were fitted with aluminum struts, on which stainless steel lashing wire was run back and forth across all of the poles to form a metallic parabolic reflector about three acres across.

I swear, this reflector, or "metal mesh dish" (if you want to call it that), was 80 feet high and 600 feet long. Out in front of the reflector grid were two wooden buildings elevated on poles to place them in the focal point, center of the arc.

In a manner similar to a simulsat, the two buildings coincided with the reflected angle of the signals from Sacramento and San Francisco. The receiving antennas were ordinary Yagi antennas, and rather than pointing them toward the transmitters, as in normal reception, they were rather pointed toward the reflective grid. I am not sure what the effective gain of the reflector was, but it was able to pick up usable signals from almost 200 miles away.

On one occasion, as I was watching television in my basement hole while I was attending college, the picture and sound on Ch. 2 were wiped out, and they were replaced with a lot of "Hey, good buddy, got your ears on?" It happened that a couple of people from the CB (citizens band radio) crowd figured out that parking their cars at the focal point of the reflector was a wonderful way to work CB skip. It also overloaded the antennas. We had to chase the CBers out of there.

I had the unique opportunity a couple of years later to help dismantle the screen reflector when we installed a microwave system to import the bay area channels. My job was to cut and strip all of the wire and hardware from the poles, in preparation for removing the poles.

These were 90-foot poles, and there were probably 10 of them. I was young and eager, and I efficiently worked my way up the pole, cutting and slashing until I got to the top and removed the last supporting guy wire.

I now had a 90-foot pole with absolutely nothing supporting it in the air. Every time I shifted my body or took a step, it set the pole to swaying. By the time I got to the bottom of the pole, it was loosey-goosey and swaying pretty well in the hole, and I was shaking pretty badly. On the rest of the poles, I proceeded to climb the pole and strip it from the top down, rather than from the bottom up.

That primitive screen reflector was a fascinating dinosaur and was patterned after early radar antenna principles. I understand that there are still a few of these in operation around the country. I don't know where the first one appeared, but it is a moment in cable history and a tribute to the engineering pioneers who helped advance the cable industry in the rural areas where cable TV originated and grew. Yes, Jim, I am familiar with this antenna—up close and personal.

Steve Allen

Requiescat in pace

As I was writing this, I received word of the death of Internet pioneer Jon Postel. Jon ran the Internet Assigned Numbers Authority (IANA) and edited the Requests for Comment (RFC), the primary documents containing the Internet specifications. He was integral to starting and operating the Internet. We all owe a great deal to his work and dedication. T

David Devereaux-Weber, P.E., is a network engineer at the University of Wisconsin-Madison. He is a senior member of the SCTE, and he can be contacted via e-mail at djdevere@facstaff.wisc.edu.

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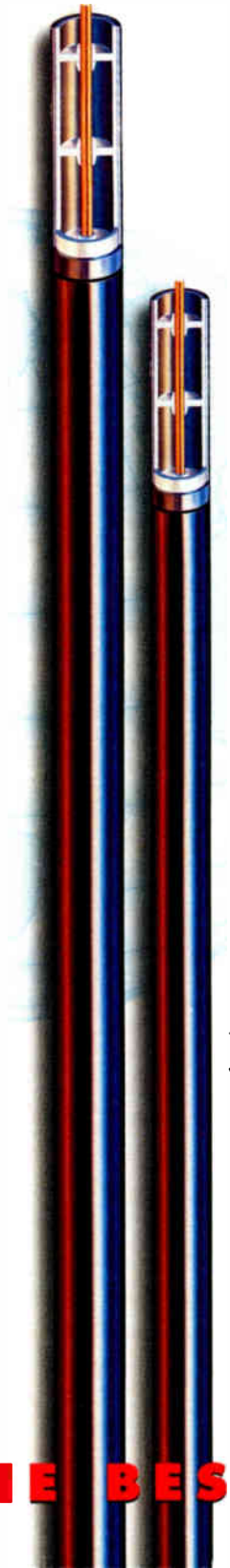

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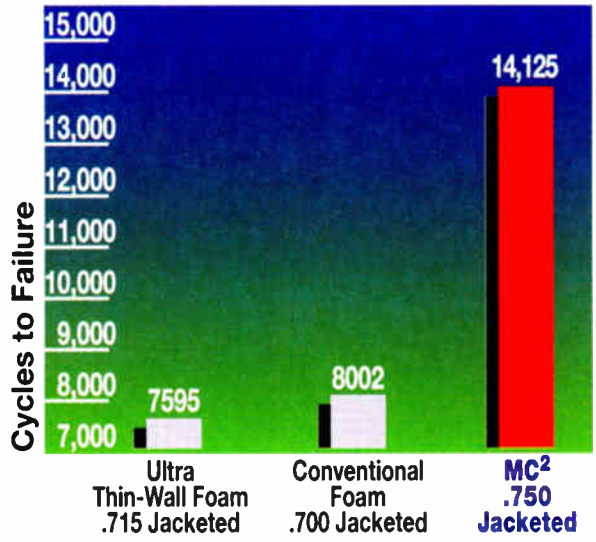

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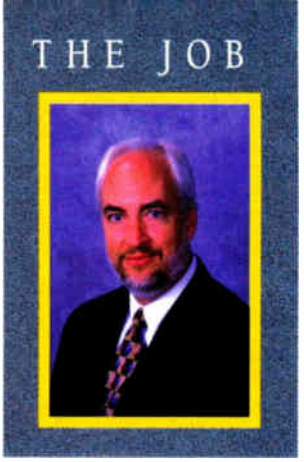
By Alan Babcock



How to Pick the Right Seminar

It's *Caveat Emptor* From the Start

Many companies offer various seminars, conferences, classes and symposiums in an effort to provide training in areas related to broadband technology. Hardly a day goes by that I don't get at least one flyer or brochure tempting me to enroll in a program "coming soon to my area." I suspect most of you are inundated with the same type of mail.

Some of these training events undoubtedly are very good. A few probably are even worth the cost of enrollment. Some, though, aren't even worth the time it takes to toss the advertisement in the round file.

How do you know which ones are valuable and which ones should be avoided? Unfortunately, the decision sometimes is a crapshoot, but you can do a few things to make an informed decision about where to spend your limited training dollars.

Training vs. information

Many programs tout the content of their offerings by providing an extensive outline detailing all the topics to be covered. Take a look at the way in which the information will be provided. Will the presenter do a "brain dump," or are opportunities provided during the course for attendees to ask questions, perform hands-on activities or otherwise apply the information?

Many seminars just present scads of information and don't offer real training opportunities. If you learn well in a lecture format, you will get some good information from this type of program. If you learn best by doing, however, look for programs that include application activities. Programs that offer hands-on learning usually will say so in their promotional materials.

Most programs present information in a one-way format only. A few use a test or other mechanism to confirm that attendees understand the information presented. If I am paying to send an employee to a seminar or class, I want some verification that the employee learned something. An attendance certificate does little to convince me that the attendee actually learned. A written exam isn't the best feedback tool, but it's better than nothing.

> "You can do a few things to make an informed decision about where to spend your limited training dollars."

Another item to look for is the amount of information included in the scheduled time frame. It's hard to fit 10 pounds of stuff into a five-pound bag.

For example, I once got an eight-page flyer about a program on telephone technologies that included six pages of outline. I tossed it in the round file because I found it difficult to believe that any presenter could do justice to the content in the two-day duration of the seminar.

My experience tells me that it would be difficult to read the outline to the class in that time, let alone provide detail beyond what was already indicated. Use some common sense.

The company

Who is offering the program? Many of the programs offered today are created and delivered by individuals or companies out to make significant dollars in the training business.

While there isn't anything wrong with this on the surface, you should be wary of fly-by-night organizations that may not have the expertise or support structure to pull off a good program. It really is "buyer beware."

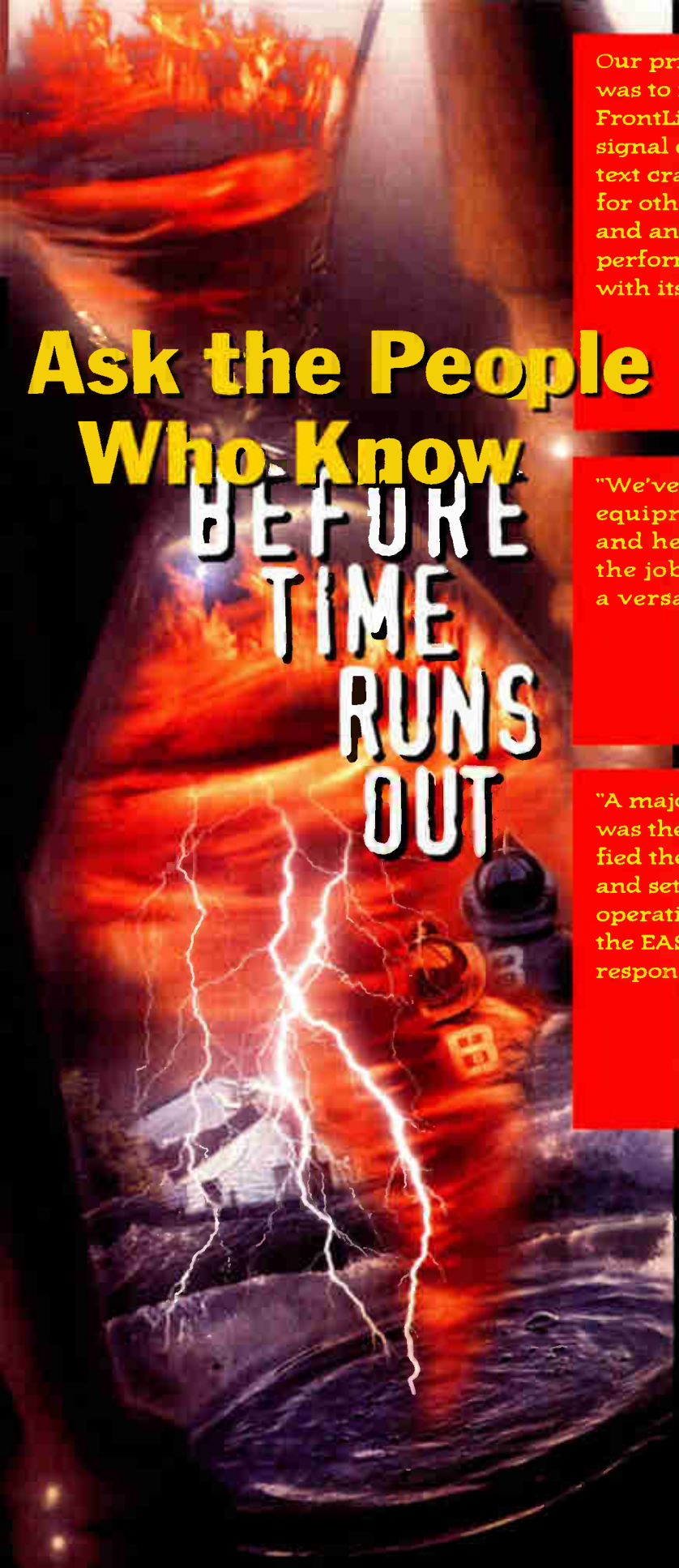
Do some research if you have never heard of the organization. Check out its Web site (assuming it has one), call the Better Business Bureau and talk to others who have attended programs presented by the organization in question.

Some companies may even offer an opportunity to audit a program if you are looking to enroll several people in the future.

Large training companies may offer multiple seminars on a variety of subjects. That one seminar was good doesn't mean all of them will be.

Likewise, don't assume all will be bad if the one you attended was poor. Any presenter can have a bad day.

Let the parent company know you were unhappy, and perhaps they will give you



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Dick Snyder
Area Engineer
Comcast Cable Communications
Philadelphia, PA

"A major reason for our choice of FrontLine was the ease of installation. They've simplified the wiring issues, making installation and setup easy and helping to assure reliable operation down the road. FrontLine knows the EAS business and they've been very responsive to our needs."

Neil Fladeland
Assistant VP of Engineering
Insight
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As these industry veterans know, FrontLine EAS systems are proven in leading cable operations around the country. With more experience, the widest range of products, and proven quality and reliability, FrontLine is the leader in EAS.

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another opportunity to attend the program with a different presenter.

The presenter

Some of the brochures I have received read like a "Who's Who" of one company or another. I am convinced that the entire engineering staff at one technology company quit and contracted their services to a training organization to provide a recent seminar on telecommunications technologies.

These individuals undoubtedly hold a significant body of knowledge in the subject matter.

But ask yourself, do you really want to go to a seminar that provides only one point of view? I believe that some variety in the background of the presenters is best.

I also tend to steer clear of programs where the biography of the presenter is more than two paragraphs in length. From my perspective, it is important to know your presenter has the background pertinent to the subject covered.

Therefore, when the marketing angle focuses on the speaker rather than the program content, I tend to question the potential quality of the program.

Again, do some research yourself to find out if the presenter knows his or her stuff. Ask colleagues, or others who have attended before you.

There are all manner of reputable firms and individuals providing training opportunities for the telecommunications industry.

With the rapid pace of technological change it is difficult for any one person to remain current in all facets of the industry.

All of us must pursue a path of professional growth and use multiple methodologies to gain the required knowledge.

Seminars, conferences, training classes and symposiums offer a variety of opportunities to learn. If you choose your programs wisely, then you can expect to get a decent return for the training dollars that you spend. CT

Alan Babcock is director of training development for the Society of Cable Telecommunications Engineers. He can be reached via e-mail at ababcock@scte.org.

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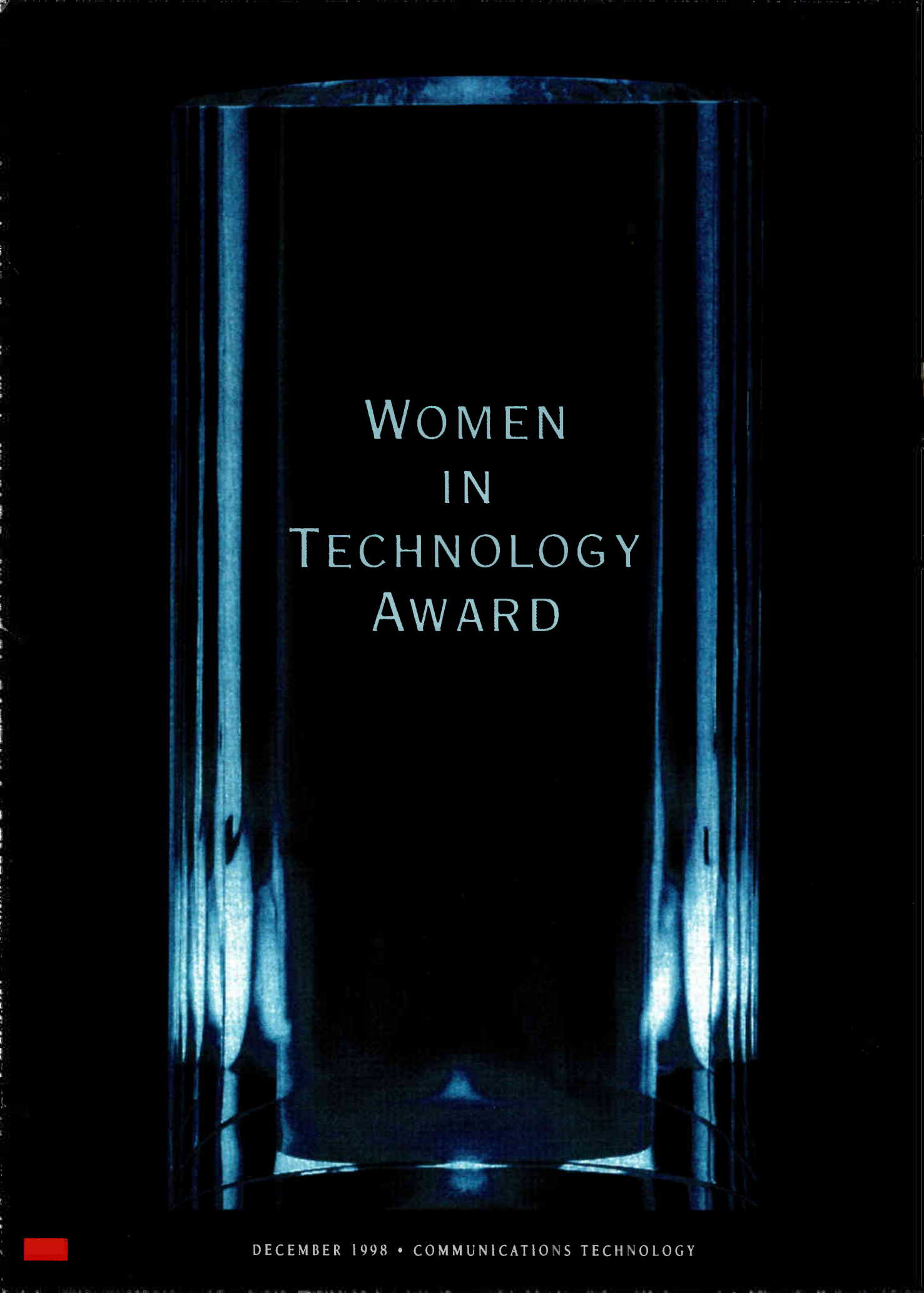
WOMEN
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Congratulations

Sheri Stinchcomb, Cox Communications

By Yvette Gordon

Sheri Stinchcomb, the 1998 Women in Technology Award recipient, is an inspiration to the industry. Her achievements show through her professional accomplishments as well as her involvement in the community.

"Cox Communications has always given me the opportunity to take risks and try new things," says Stinchcomb about what she enjoys most in her job. Considering the fact that Stinchcomb managed the technical requirements of the successful Cox@Home launch in San Diego in addition to leading the New Product Team responsible for the launch of Cox Digital Telephone, it seems that she has proven herself quite successful at trying new things. ➤

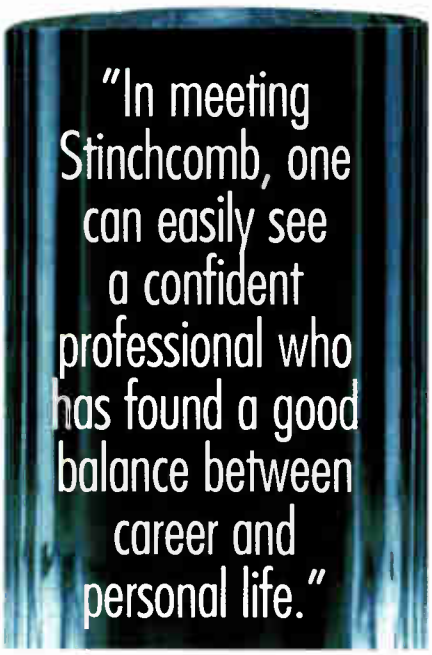
Technology contributions

Sheri Stinchcomb is the vice president of New Product Operations for Cox Communications. Her responsibilities entail overseeing all aspects of the Cox@Home and Cox Digital Telephone product launches and operations, including establishing technical procedures for field and headend technicians, frequency allocation and management, as well as developing operational processes and procedures for data and wireline.

Stinchcomb also is responsible for the planning, implementation and testing of the San Diego data network backbone, switching and synchronous optical network (SONET) transport network covering more than 700,000 homes passed.

"She has treated her role as a complete residential broadband vice president as though she owns the business, and her diligence and dedication are demonstrated by her outstanding results," says Alex Best, senior vice president of engineering for Cox Communications.

The Cox@Home service now boasts more than 22,000 Internet customers in San Diego, for which the company gives much of the credit to Stinchcomb. Bill Geppert, vice president and general manager of Cox San Diego, states: "We are delighted that Sheri has been selected for this prestigious award. It is reflective of the dedication and extremely hard work she has placed on the rollout of our products."



In February, she was rewarded for her efforts with a promotion to vice president from her previous title of director of residential broadband services. Within Cox, she is considered an expert in the introduction of broadband services to new markets, which shows in her responsibilities, including all aspects of a successful product launch—from planning product installation to customer satisfaction.

In addition to giving Stinchcomb credit for surpassing every expectation of product delivery and sales of high speed data products, Maggie Bellville, vice president of operations for Cox Communications adds, "Her integrity, work ethic and humility make her not only a highly respected member of Cox San Diego's executive team, but an inspiration and model for the entire organization."

Stinchcomb's respect for others shows through in her attitude towards her coworkers; she considers them to be a

part of her success, referring to them as unable to be matched in the industry.

Leadership skills always have stood out in Stinchcomb's background. From the onset, she wanted to balance hands-on engineering with understanding of the business side of the industry. She received her bachelor's degree in electrical engineering from the University of Oklahoma and her master's in business administration from Oklahoma City University.

Stinchcomb started her career at SBC Communications, at the time Southwestern Bell. At SBC, she was involved in network modeling and switch transmission engineering as well as mergers and acquisitions. She worked in the telephony business for eight years before joining Cox. Asked why she joined the cable business, Stinchcomb quickly answers: "I love the changes and opportunities to do new things. Cable is great for that."

A good balance

Stinchcomb is most proud of her ability to "stick to her values" throughout having to move on several occasions and facing change in her personal and professional life. During her spare time, she enjoys a mixture of sports and crafts.

In meeting Stinchcomb, one can easily see a confident professional who has found a good balance between career and personal life; she can move from being a technical professional to playing softball to sewing with ease. As to family, Stinchcomb laughs and says, "I'm single and have no children—that's still on my 'to do' list."

In addition to her career and hobbies, Stinchcomb is a member of the board of directors for the Juvenile Diabetes Foundation and teaches Sunday school for four-year-olds. She also has been active in cleaning up local schools and in contributing to the Cox San Diego employee newsletter.

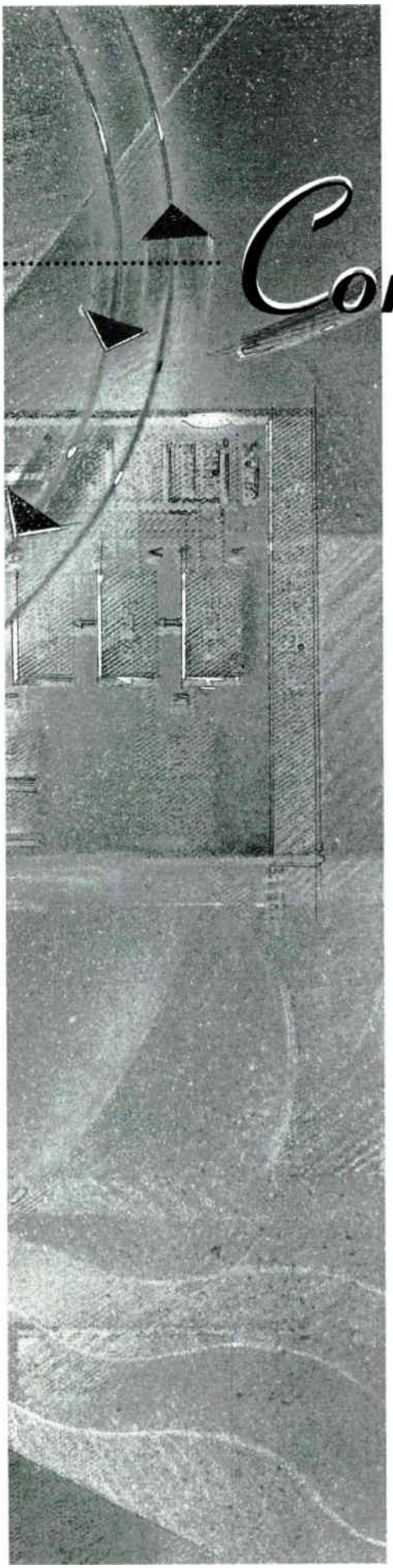
She is a registered professional engineer and involved in organizations including the Institute of Electrical and Electronics Engineers, the Society of Cable Telecommunications Engineers, Women in Cable & Telecommunications and the National Society of Professional Engineers.

Award history

The annual Women in Technology award was created in 1995 by *Communications Technology* magazine, the SCTE and WICT. It is designed to recognize and honor leading women in technology positions within the cable and telecommunications community and to create visibility for all women in technical careers.

Each year it identifies and acknowledges the achievements of one woman who has demonstrated outstanding personal and professional growth and who has contributed significantly to the industry. Please join me in congratulating a great role model and truly deserving candidate for this year's award, Sheri Stinchcomb. CT

Yvette Gordon is director of interactive technologies for SeaChange International and was last year's Women in Technology winner. She can be e-mailed at Ygordon@schange.com.



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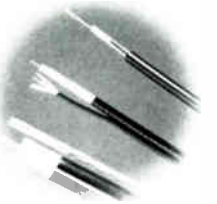

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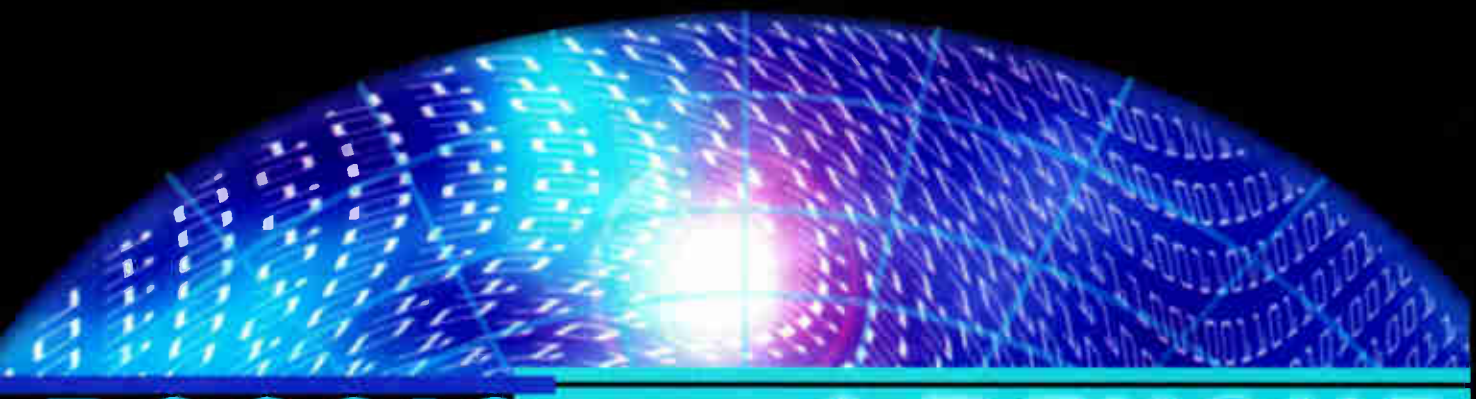

DOCSIS and BEYOND

What's Next in Standardization Efforts?

By David Lin

The Data Over Cable Service Interface Specification (DOCSIS) is offering the cable TV industry one of its best chances in decades to profit from incremental and unregulated revenues. And based on the momentum of the success of DOCSIS, CableLabs has initiated two other standardization projects: OpenCable and PacketCable.

Once completed, they will enable new classes of services such as telephony and videoconferencing, digital audio and video, and interactive applications over two-way cable networks.

After three years of intensive efforts since the introduction of DOCSIS (in the fourth quarter of 1995), vendors currently are delivering DOCSIS 1.0 cable modem systems to the market. DOCSIS 1.0 was first developed to meet requirements for time-to-market, interoperability and support for the evolution of the architecture.

DOCSIS 1.1 is being developed with an eye toward several enhancements, including quality of service (QoS), fragmentation and flow scheduling. The QoS feature is essential to support Internet protocol (IP) telephony and videoconferencing applications.

After DOCSIS 1.1, CableLabs plans to be developing DOCSIS 2.0, which will include the advanced physical layer (PHY), super MAC (media access control) and an integrated solution for OpenCable and PacketCable.

OpenCable

OpenCable was initiated by CableLabs to develop key interface specifications to foster interoperability among advanced digital set-top boxes produced by multiple vendors.

Several interface specifications are being reviewed by the industry and

BOTTOM LINE

DOCSIS, OpenCable and PacketCable

The Data over Cable Service Interface Specification (DOCSIS) is revolutionizing the cable TV industry by enabling the next generation of full-service digital cable networks to deliver high-bandwidth data, video and audio. OpenCable and PacketCable standardization initiatives are designed to help bring Internet telephony, videoconferencing and interactive applications to living rooms across America.

The OpenCable standard provides for interoperability among digital set-top boxes from multiple vendors and specifies the interface to high-speed interconnections between the boxes and appliances. PacketCable supports voice and video over cable systems using standard Internet protocol (IP) addressing.

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should be finalized by end of this year.

Key elements covered in OpenCable include modulation, a consumer privacy system, Moving Pictures Experts Group (MPEG-2) formats, a core decryptor and an architecture that allows an operator to use DigiCipher and PowerKEY in the same system. The OpenCable initiative does not specify a single microprocessor or operating system. Most interactive services will be implemented at the middleware layer using open Internet specifications, including hypertext markup language (HTML), common gateway interface (CGI), JavaScript and popular plug-ins.

OpenCable also will support an existing high-speed interconnect, IEEE 1394, as the link between OpenCable advanced digital set-top boxes and devices such as TV sets and digital video disk (DVD) players. This 1394 interface allows for passthrough of a vast amount of data at rates up to 400 Mbps, which is important when delivering digital video and data services.

PacketCable

PacketCable was initiated by CableLabs to support Internet-based voice and video products over cable systems. The

> "DOCSIS is offering the cable TV industry one of its best chances in decades to profit from incremental and unregulated revenues."

services would be delivered using basic IP technology that is used to send data via the Internet.

At present, a number of focus teams consisting of vendors and MSOs are finalizing specifications in different areas, such as codes, embedded client QoS, security, public switched telephone network (PSTN) interconnectivity, stand-alone/personal computer (PC) client signaling, stand-alone/PC client QoS, embedded client signaling, addressing and provisioning.

PacketCable will be completed in three phases. Phase 1 is expected to be concluded at the end of 1998. This phase will create key component specifications, focusing on mechanisms to implement features, such as call waiting, three-way calling, call forwarding, call hold, caller ID, multiple line support, voice mail and message waiting indicator.

Phase 2 will specify network management, ancillary back-office functions and zone-to-zone communication. It will focus on features such as speed dialing, return call, repeat call, call block and supervised call transfer. CableLabs plans to start this phase in January 1999 and complete it by March 1999.

Phase 3 will address additional features and advanced product roll-out services, such as virtual private branch exchange (PBX) integration and enhanced facsimile capabilities. This phase is expected to begin in April 1999 and should be completed by October 1999.

MSOs currently are considering many new business initiatives, including telephony, video-on-demand (VOD), interactive TV and broadband Internet access. It is generally believed that cable is well-positioned to be the dominant provider of these types of services to residential customers in the future.

Adding these services has a price, of course. MSOs will have to make sizable investments to upgrade cable plant to make it capable of carrying bidirectional services. They will have to develop or buy content optimized for broadband access that will allow them to differentiate their services from those provided by narrowband giants such as America Online. Standards are helping to smooth the way. CT

David Lin is director of marketing and business development at the networks division of Samsung Telecommunications America. For more information, call (408) 544-5400.

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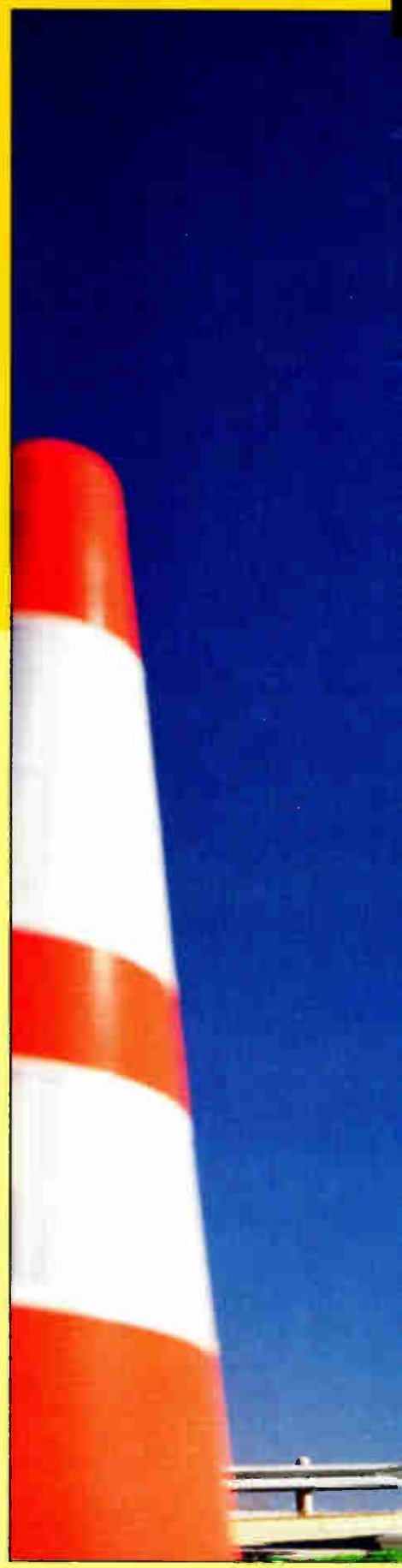

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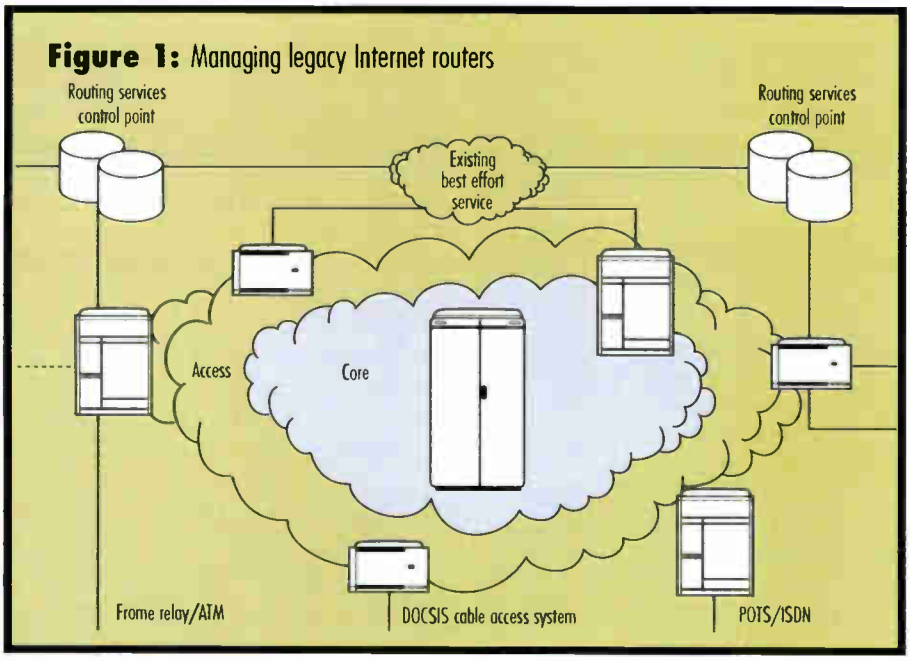


Figure 1: Managing legacy Internet routers

systems operate in a broadcast mode, with specific addressing to a particular modem. The data is packaged in fixed, 188-byte MPEG-2 (Moving Pictures Experts Group) payloads, allowing the cable to easily support data/IP traffic or native MPEG video. The packet payload is encrypted to ensure privacy. This effectively allows the headend to establish any data rate to any target modem and adjust that bandwidth in real time as required.

In the upstream direction, shared bandwidth is organized around mini-slots, which are synchronized and managed on 6.25 µsec intervals from the headend. Data is transmitted using variable frames that are binary multiples (1, 2, 4...128) of mini-slots.

With quadrature phase shift keying (QPSK) modulation, a mini-slot consists of 16 bytes, and data frames can therefore vary from 16 to 2,048 bytes. Mini-slots can either be reserved per cable modem, or a number can be allocated as a contention pool between all cable modems.

Given these downstream and upstream transmission capabilities, DOCSIS can support the following four classes of service:

- Guaranteed service, by pre-assigning fixed amounts of bandwidth in the downstream or upstream direction as required
- Real-time variable bit rate (VBR—that is, with delay guarantees), by reserving enough bandwidth and resources in the downstream and upstream directions so that the QoS objectives such as loss and delay can be statistically met

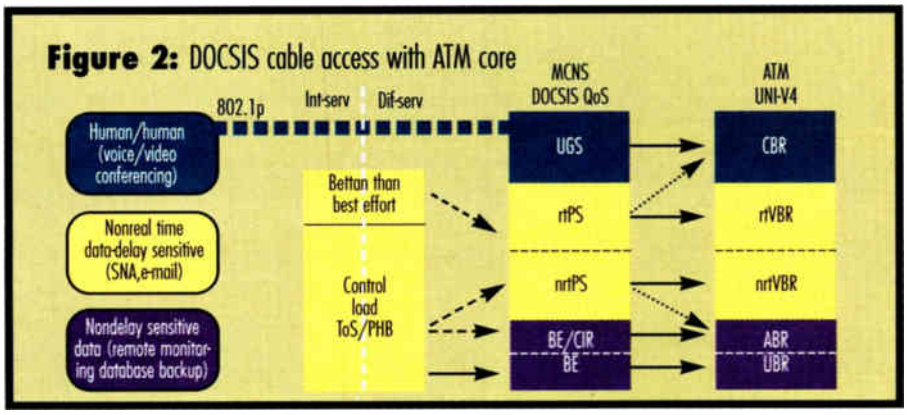


Figure 2: DOCSIS cable access with ATM core

- Nonreal-time VBR (without delay guarantees), by reserving enough bandwidth and resources in the downstream and upstream directions so that the QoS objectives such as loss can be statistically met
- Best-effort delivery, where the headend allocates bandwidth in the downstream and upstream directions as required by the cable modems

Sharing bandwidth Across the backbone network

ATM was developed to take into account the "bursty" nature of packet traffic, while enabling a mixing of both synchronous and packet traffic types. All incoming traffic is segmented if necessary, then quickly switched to its destination through intermediary switching and routing control nodes.

Therefore, backbone nodes can easily accommodate any combination of traffic types. For example, a cable operator might mix constant-rate MPEG video with packet e-mail traffic, which is relatively immune to small delays in transmission.

ATM pays very careful attention to the QoS delivered. This is made possible by careful statistical modeling of all loading characteristics and network capacity limitations to ensure that these resources cannot be over-subscribed.

ATM functions that ensure that QoS objectives are delivered include admission control, conformance monitoring or policing, scheduling, and congestion control.

CSI enables DOCSIS QoS at defined cable service access points and provides the functions necessary for mapping to any QoS infrastructure topology, including ATM.

DOCSIS cable access with ATM core

Mapping DOCSIS QoS over ATM is one example of CSI capabilities. All the classes of QoS specified by the DOCSIS QoS technical report can be easily mapped between the DOCSIS cable network and the ATM wide area network (WAN). (See Figure 2.)

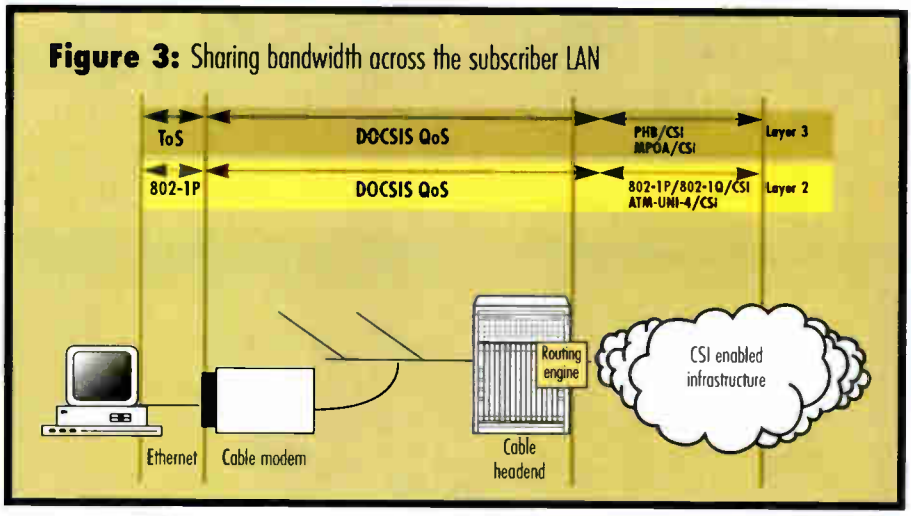
There are intentional similarities between the classification definitions and nomenclature of DOCSIS and standardized

elements defined for QoS over ATM. The result is a seamless boundary between the DOCSIS network and the ATM WAN with respect to QoS-differentiated services.

CSI can enable the core infrastructure behind a DOCSIS-compliant cable access network to deliver ATM levels of QoS, including service profitability, service differentiation and service interworking. In addition to these significant commercial advantages, CSI-enabled cores also allow the cable companies to bundle in other telecommunication requirements, such as enterprise IP services or full-quality video over the WAN.

As the number of customers grows, customer change management and service management become critical factors in business growth. CSI is closely aligned to industry sponsored standardization efforts for managed services and tackling these issues that deal with the "soft" limits to building a true carrier-scale service. CSI makes it possible to provide telecommunications services to tens of thousands, even millions, of customers.

Figure 3: Sharing bandwidth across the subscriber LAN



Sharing bandwidth Across the subscriber LAN

You can't charge for QoS if you can't deliver it or have no control over who gets it. The DOCSIS cable modem-to-customer interface (SP-CMCI-102) specifies 10BaseT Ethernet to a subscriber local area network (LAN) as the standard interface to multiple client devices. One method for delivering IP-based class of service (CoS) to an IP application is to use the "type of service" (ToS) bits in the IP header.

The Internet Engineering Task Force Differentiated Services working group is now defining standard interpretations of these bits, termed packet hop behavior (PHB) bits. However, many systems will overwrite (not pass) or misinterpret these preference bits. Because of these implementation ambiguities, there is no assured

or guaranteed service with ToS/PHB.

There also are problems using ToS/PHB to police the class of service within the subscriber LAN. ToS/PHB lacks the capability to police traffic on the local LAN that does not originate or terminate across the cable plant. In addition, most commercial applications do not have the mechanisms in their IP stacks for writing the precedence and ToS bits into a packet.

The 1998 revision of IEEE 802.1d includes 802.1p traffic prioritization. Unlike ToS/PHB, 802.1p delivers a uniformly interpreted, standard mechanism for CoS over Ethernet. This prioritization of IP traffic at the end points is complementary with the per-hop prioritization within the network. Subscriber LANs can now police their CoS using an Ethernet standard.

In addition, other Layer 2 devices (DOCSIS cable systems, Ethernet switches, Layer 3 switches and ATM fabrics) can work directly with or map 802.1p (and soon 802.1Q VLANs) more reliably and faster than any Layer 3 mechanism.

Cable engineers should make sure that equipment in their networks is designed to take full advantage of faster, forward-looking, end-to-end Layer 2 standards. (See Figure 3 on page 65.)

Conclusion

The CSI multivendor open architecture was designed to extend subscriber and access network QoS end-to-end throughout the network while improving legacy best-effort routing and offering the additional benefits of scalability, reliability and reduced operational costs. QoS issues across the cable data plant and through the network infrastructure should be a central consideration for cable engineers as they expand their networks.

Enhancing the DOCSIS QoS capabilities on both the network side and the subscriber side of the cable network is the best way to add value to cable data plants without the unnecessary costs of legacy Internet routing equipment.

Levent Gun is vice president and general manager of the Cable Access Business Unit at 3Com Corp. He may be reached at levent_gun@3com.com. Conrad Lewis is executive vice president of the Access Product Group at Newbridge Networks. He may be reached at clewis@newbridge.com.

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Frequency Conflicts in The Broadband Spectrum

Where They Are and What to Do About Them

By Joseph P. Yakel

In recent years, cable TV systems have launched many new services over the broadband spectrum. Unfortunately, some of these new services are occupying bandwidths that conflict with the traditional TV signals normally carried on the cable system.

This article addresses some of the frequency conflicts that can occur in the broadband spectrum and points to consider before adding new services. It also suggests ways to minimize or avoid these conflicts.

The situation

Some of the new "players" vying for a piece of the broadband spectrum include audio programming such as Digital Cable Radio (DCR) and Digital Music Express (DMX), in addition to the more traditional FM audio service.

Other services, such as the Sega Channel and data services, also have made their way into the network's customer [illegible] All of the aforementioned example services [illegible] for the cable [illegible] operator and the subscriber.

Some system operators have been accommodating the new services by placing them at various locations throughout the spectrum—many times "squeezing" them in. For example, a common insertion location for some services is the roll-off area below Ch. 2. Another location is above the system's highest operating video channel. These signals also have found their way into the FM band and the guardband between Chs. 4 and 5.

The problem

The problem is not with content, but rather it is an incompatibility between the operating frequencies of some new services and channels in the broadband spectrum. In the past, a technician would not consider placing two video channels with the same operating frequency [illegible] any other signal. In fact, they should not [illegible] have been [illegible] have introduced picture quality impairments to their TV programming, not to mention technical violations, by launching new services that occupy the same portion of the spectrum as their TV programming. Some system technicians aren't even aware of the frequency conflicts they have created.

As an example, a spectrum conflict has been frequently observed between a converter control carrier and Ch. A-2 (98 [illegible] With a center carrier frequency of 10[illegible] MHz, the control signal has a lower [illegible] er boundary around 107.9 MHz and upper carrier boundary near 108 [illegible] Ch. A-2 generally operates at an offset video carrier frequency of 109 [illegible] This is required to [illegible] the Federal [illegible] may now be operating [illegible] the lower channel boundary [illegible] This configuration is not [illegible] and results in picture quality im[illegible] to the TV channel. In general, [illegible] of interference to the TV channel [illegible] pendent upon the location and [illegible] competing signal. Other [illegible] frequency conflicts, as [illegible] have been ob[illegible]

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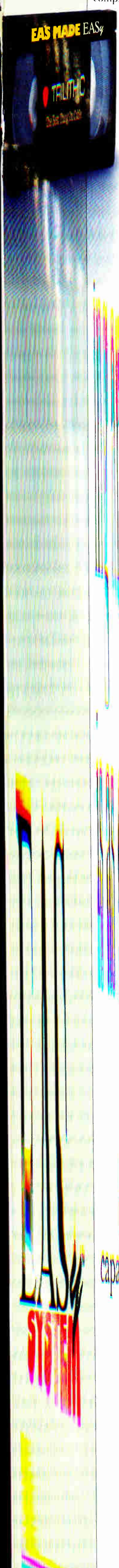

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Considerations

You must consider the following points:

1) What are the center frequencies and bandwidths of any new services being considered for insertion in the cable spectrum?
2) What are the frequencies and bandwidths of services already on the system? Do not overlook the lower channel boundary of the TV signal (1.25 MHz from the visual carrier frequency).
3) Is there an obvious conflict between either of the aforementioned points?

Frequency conflicts are undesirable with any services offered on the cable system. They are double trouble when they occur with premium services. In some cable systems, Chs. A-1, A-2 and A-3 often are selected as a preferred location for premium services.

When a frequency conflict occurs with a premium service, the technical problem is compounded because customers receive a degraded quality picture on a channel that they are paying an additional fee to watch. This situation is no good for the customers and does nothing for the reputation of the system operator when the complaints start coming in.

The solution

So, how do we avoid this bad situation? Technicians must use good engineering practices. Spectrum management is a key factor.

The chief technician must look at every signal being considered for introduction to the cable TV system for compatibility with the existing services. Do not "squeeze" any new signals into the passband of an existing service. ➤

BOTTOM LINE

Nobody Likes Conflict

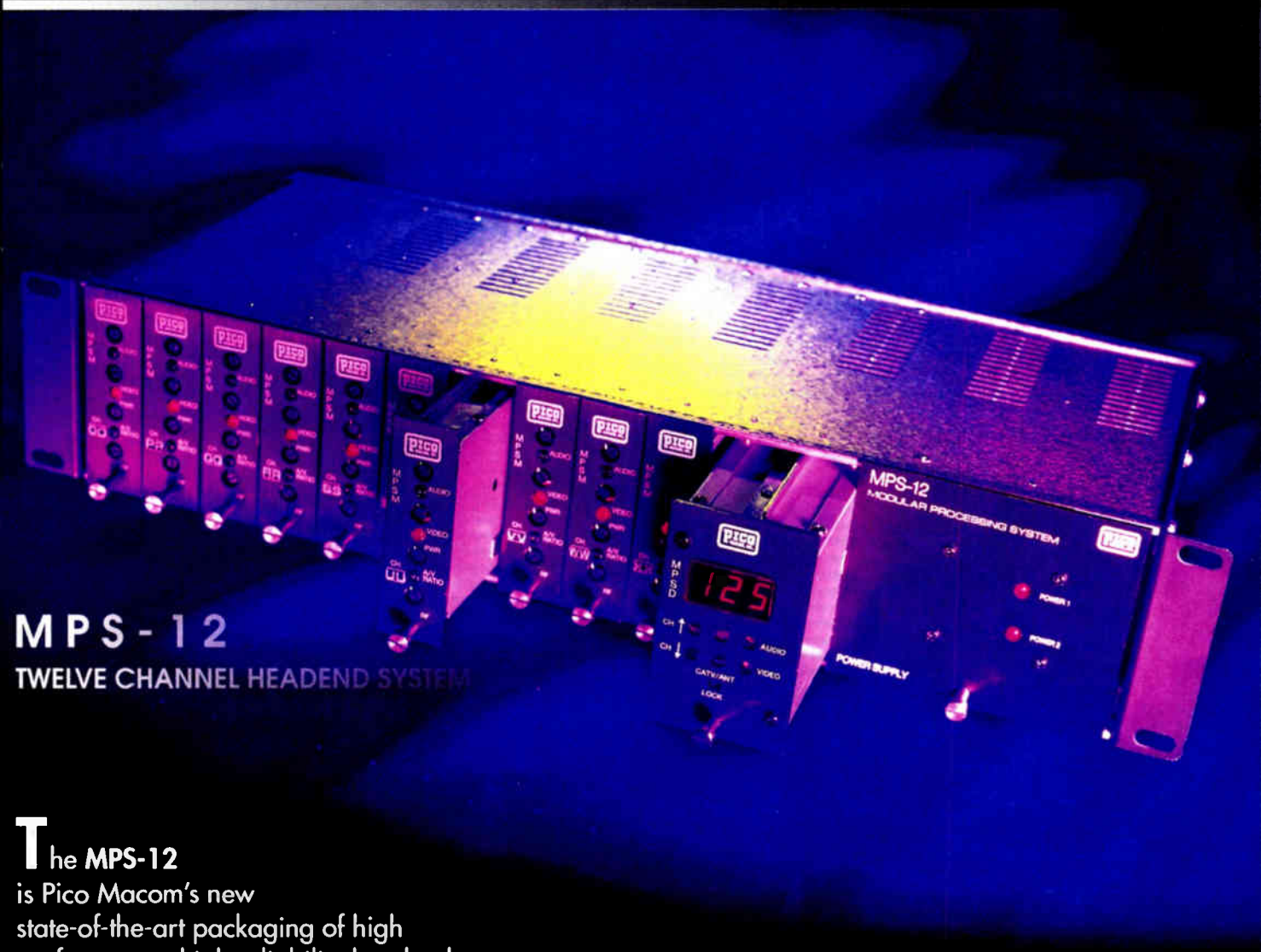
In recent years, cable TV systems have launched many new services over the broadband spectrum. Unfortunately, some of these new services are occupying bandwidths that conflict with the traditional TV signals normally carried on the cable system.

Engineers and technicians must address frequency conflicts that can occur in the broadband spectrum before adding new services. They also must consider new ways to minimize or avoid these conflicts.

Our challenge is to correctly arrange signals in the broadband network and provide good quality service to the subscriber. Good spectrum management is essential here. You can avoid future headaches, costly mistakes and (justifiable) customer complaints by managing your broadband spectrum properly the first time.

FLEXIBILITY

BY DESIGN



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If the system already has one or more of these frequency conflicts, move the carrier of the interfering signal to a non-interfering location in the spectrum. The logistics of this solution may be difficult because retuning converter control carrier equipment (headend and subscriber terminals), for example, may be cost-prohibitive and impractical.

Another alternative may be to relocate the affected video channel to an unused portion of the spectrum (if bandwidth permits).

The stop-gap

If there are two services conflicting with each other, as in the previous example, reducing the amplitude of the control data carrier at the headend may reduce the interference to the TV channel. A signal level adjustment of this kind, if performed, must be monitored carefully since it may lead to other technical difficulties, such as subscriber terminals' not responding to the headend control signals.

Keep in mind that this still does not correct the frequency conflict, and this solution is simply a bandage until a proper fix is made.

Regardless of how we consider a frequency conflict of this nature, a video channel reacts to these other carriers as one thing: interfering signals. And with peak carrier amplitudes only 10 dB to 25 dB below the affected visual carrier, portions of these signals are certainly well above the -51 dBc FCC limit for such interference.

Conclusion

It is apparent that with new services constantly emerging, competition among signals for carriage within the broadband spectrum will continue to rise. With common equipment and services available to all operators, I would venture to say that these problems are becoming commonplace throughout our industry.

Cable companies count on the increased revenues that new service offerings provide, and they rely on their engineering departments to make the system work properly. Our challenge is to correctly arrange these signals in the broadband network and provide good quality service to the subscriber. Again, good spectrum management is essential.

I am reminded of the saying, "Why is there never enough time to do it right, but always enough time to do it over?" Avoid future headaches, costly mistakes and (justifiable) customer complaints by managing your broadband spectrum correctly the first time. Nobody likes a conflict.

This article is solely the author's. It has not been reviewed by the Public Service Commission of New York State and is not endorsed by the Commission. CT

Joseph Yakel is a cable TV specialist at the New York State Department of Public Service. He may be reached via e-mail at joeyakel@wizvax.net.

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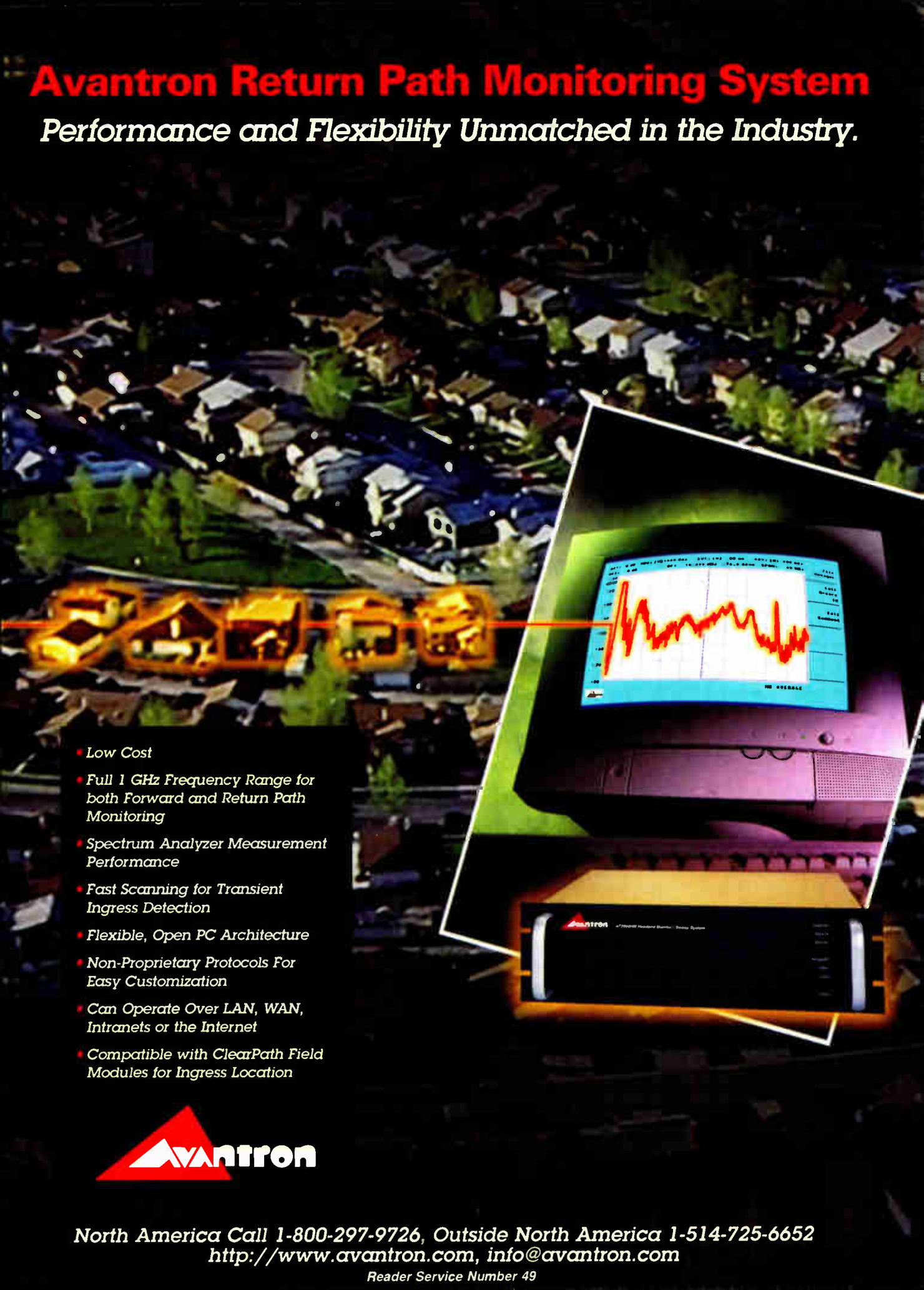

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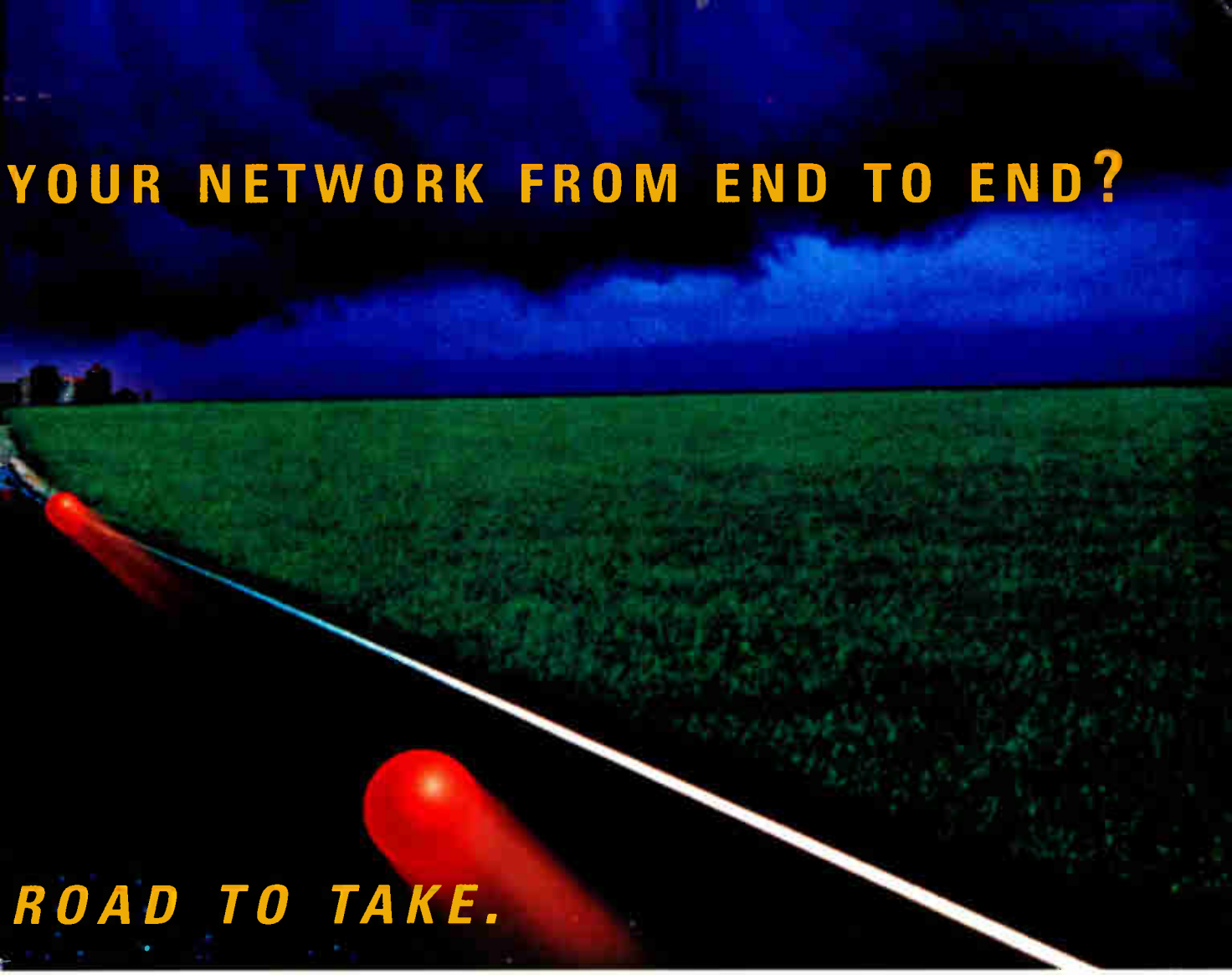

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Reader Service Number 50

Fly Solo or Form a Partnership?

Tips for Deciding How to Offer High-Speed Internet Access

By Ron Pitcock

Some cable operators have chosen to venture into the great wide world of the Internet on their own. An increasing number, however, are opting to partner with turnkey Internet service providers (ISPs), one-stop-shop companies that provide all the investment capital.

These providers also handle technical services, customer support and marketing (including covering the associated costs) in exchange for a share of the revenue.

In order to decide what route to take, cable operators need to evaluate three things: capital outlay, engineering experience and personnel.

Capital outlay

Before a cable operator can even consider the capital outlay currently needed for cable modem service, the plant itself must be upgraded to handle data transmission. Once the plant is ready, cable operators will first need to consider the cost of the modems. Proprietary modems cost about $350-$450, though operators buying in bulk may be able to purchase them for less. The high end of modem prices probably will fall down to the $250-$300 range once modems are available on a retail basis.

In addition to the modems, a system with about 100,000 subscribers would likely pay at least $200,000 for servers, headend controllers for the cable modem systems, networking gear, switches and routers. For smaller systems, the economics scale down somewhat. Systems with 15,000 subscribers or fewer would likely incur costs of about $100,000. These capital outlays can be considerable and often

When we arrived on the scene, accusations weren't flying. Just farm equipment, telephone poles and

cost-prohibitive for smaller systems.

To decide what modems to buy, cable operators will need to bear in mind various factors, including the size of the system, personal computer (PC) penetration, online penetration to computers, location of the system, competition and regulation.

The Internet service provider (ISP) equipment, which includes operational servers and commercial Web servers, can run from $3,500 to more than $500,000. A system will need at least one rack space in the headend to store the equipment.

Engineering costs and issues

Cable companies will need to train their engineers to handle data traffic on the RF plant, or hire additional engineers specially trained in data. In addition, the cable plant has to be tightened to accommodate the data traffic. Engineers no longer will be able to quickly disconnect the RF plant for a momentary tweaking since the data service needs to be uninterrupted.

Routine maintenance of the cable plant will need to be carefully planned since data traffic is much more sensitive than video traffic. If an engineer needs to splice in a network management device, for example, he or she can make that repair and the TV picture will register only a slight flickering. But with a data stream running on the plant, all the modems would be disconnected in such a situation. As a result, network maintenance needs to be carefully scheduled.

Engineers will need to tweak the plant when few are using their cable modems. The system will need to notify customers in advance with an e-mail informing them about the routine maintenance and expected service disruption.

Ingress also becomes a more significant issue when offering data service because it affects the return path. Operators will need to spend more time chasing down ingress and also will need to consider a number of solutions such as traps and a general tightening of the plant.

Improper tightening of connectors and improper connector installation can aggravate ingress. Cable operators need to make sure their technicians are thoroughly schooled in proper installation. Technicians should ensure the cable has maximum shielding on it and that the braid is folded back evenly. They also should use correct installation and cable prepping tools.

Personnel costs

Provision of high-speed data services will require several new hires across many disciplines. Cable operators will be able to rely on some of their current staffers in RF engineering, marketing, sales, billing, project management, implementation, operations

and general management.

But they also will need new personnel entirely unique to the high-speed business, such as workers skilled in Internet protocol (IP) engineering, online customer care, network operations centers (NOCs) and Web development. If system employees take on additional data responsibilities, they may not be able to focus well on either the data business or the core video business.

The economics of offering high-speed service without a partner can be daunting. Any size system can expect several new dedicated employees from the start including project managers, Internet professionals, networking experts, technicians, installers and at least six to seven customer service representatives.

Employees with Internet skills cost more than cable TV employees because of market demand. Operators can pay $40,000 and up for most positions. (IP engineers can demand $100,000.) Personnel costs far outweigh capital expenses.

Marketing will make the difference

In addition to the costs associated with hiring and equipment, cable operators will incur marketing costs. Most residential customers pay between $39.95 and $49.95

BOTTOM LINE

The Pros of Partnering With a High-Speed Internet Provider

As the Internet increasingly defines our future as a society, high-speed access has the potential to become a vast source of new revenue, and a necessary one in a day and age when cable operators face increasing costs and pressure from programmers and regulators and an increasingly competitive environment.

Some cable operators have chosen to venture into the great wide world of the Internet on their own to offer the service. An increasing number, however, are opting to partner with turnkey Internet service providers (ISPs), one-stop shop companies that provide all the investment capital. They also can handle technical services, customer support and marketing (including covering the associated costs) in exchange for a share of the revenue.

A cable company can choose to invest several hundred thousands of their dollars in cable modem equipment, necessary personnel and marketing support. A partnership with a high-speed provider, however, means the cable operator doesn't need to grapple with personnel and capital requirements while benefiting from the Internet service provider's (ISP's) experience.

In order to decide what route to take, cable operators need to evaluate three things: capital outlay, engineering experience and personnel.

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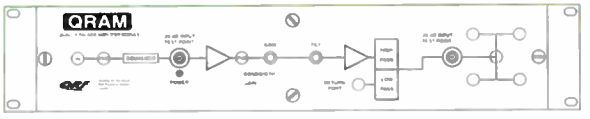

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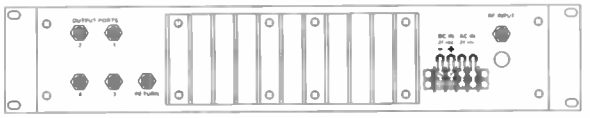

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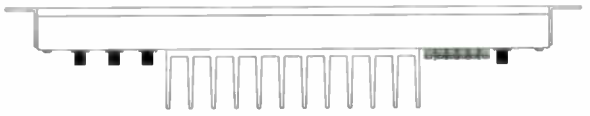

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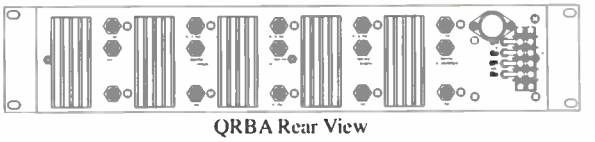

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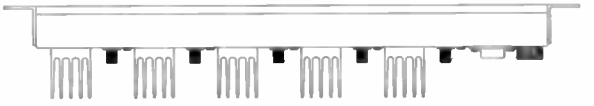

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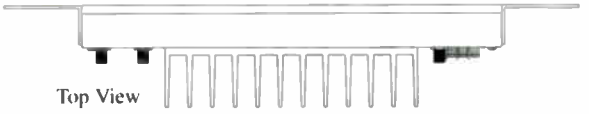

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for cable modem service and lease the home package for $10 to $15. They also incur install fees of $150 to $200. To make the most of their capital and operating investment, cable operators will need to aggressively market their data services.

Monthly revenue generated will depend on the penetration levels the cable operator can achieve. When partnering with a turnkey ISP, most system managers can expect about 1% to 5% of their homes passed to sign up for service in the first year, while 5% to 8% will become customers after two years.

Those goals will be harder to reach in the tougher to market one-way systems. In a one-way system, either penetration levels or the selling price may be lower, impacting the level of the system's profitability.

Nearly one million North Americans will call themselves cable modem customers within a year. To make this vision a reality, cable operators need to infuse marketing muscle into the broadband pipe. Cable modem markets that have been properly cultivated can achieve extraordinary results.

Statistics indicate that third-party providers can shepherd cable modem markets to penetration levels exceeding 8% within 18 months. Some markets have even surpassed 8% penetration after 15 months. To reach these levels, providers have implemented aggressive national and local marketing campaigns consisting of TV and radio ads, kiosks, direct mail and online and cross-channel promotions.

An enterprising marketing campaign is necessary to reach beyond the early adopters. In fact, without the resources of a third-party provider dedicated and skilled in marketing high-speed access, a cable operator can find itself with very few subscribers.

In fact, one cable system counted only 30 data customers after offering the service on its own for two years. But once that system formed a partnership with a turnkey ISP, its data business grew to 300 customers in a mere eight months. The system attributes the change to the marketing resources invested by the turnkey provider.

Cable operators historically have more heavily focused on the residential market than the commercial customer base. Thus, few cable operators have the databases or experience necessary to effectively market to commercial accounts. Third-party providers are, however, skilled in this area. ➤

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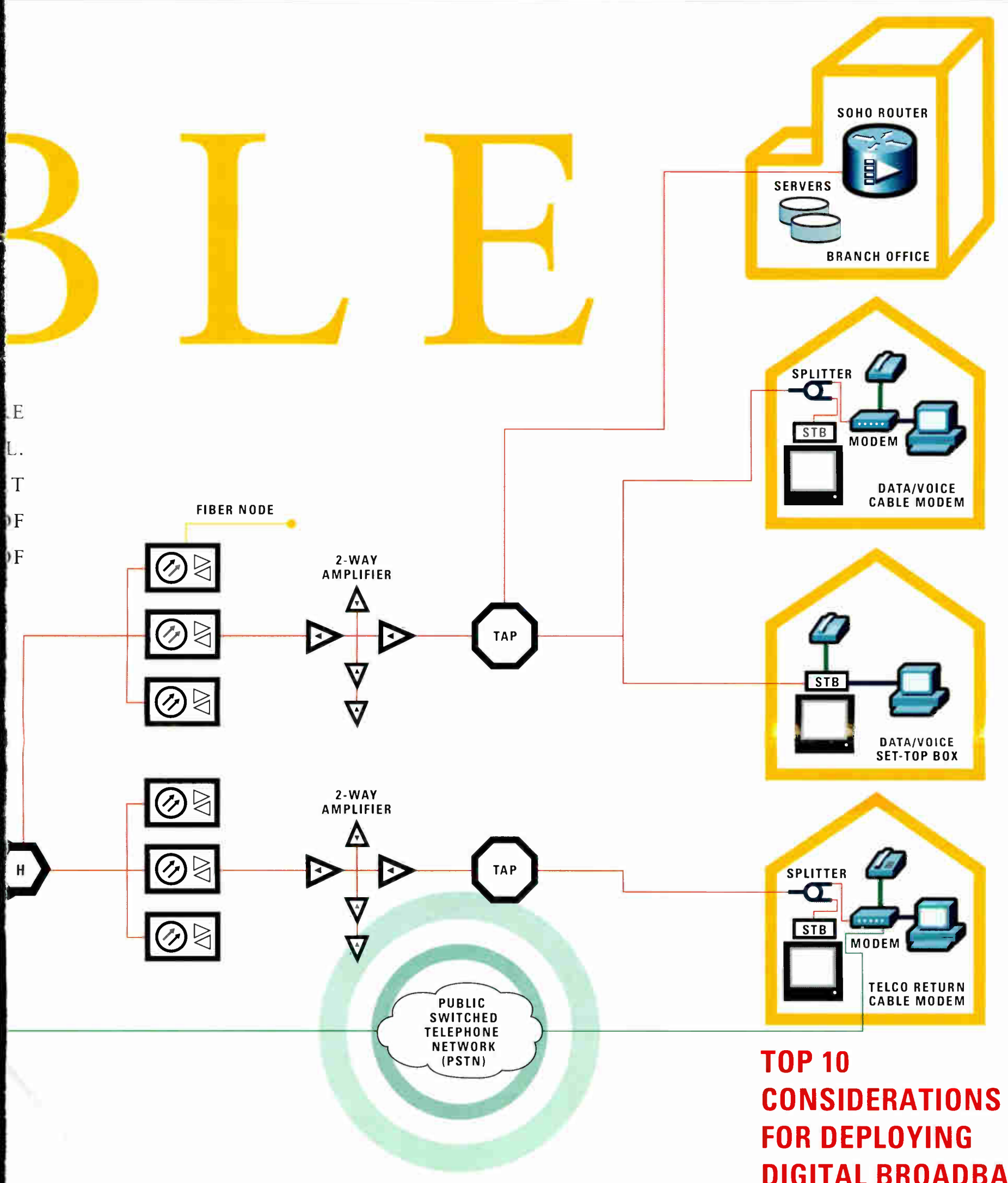

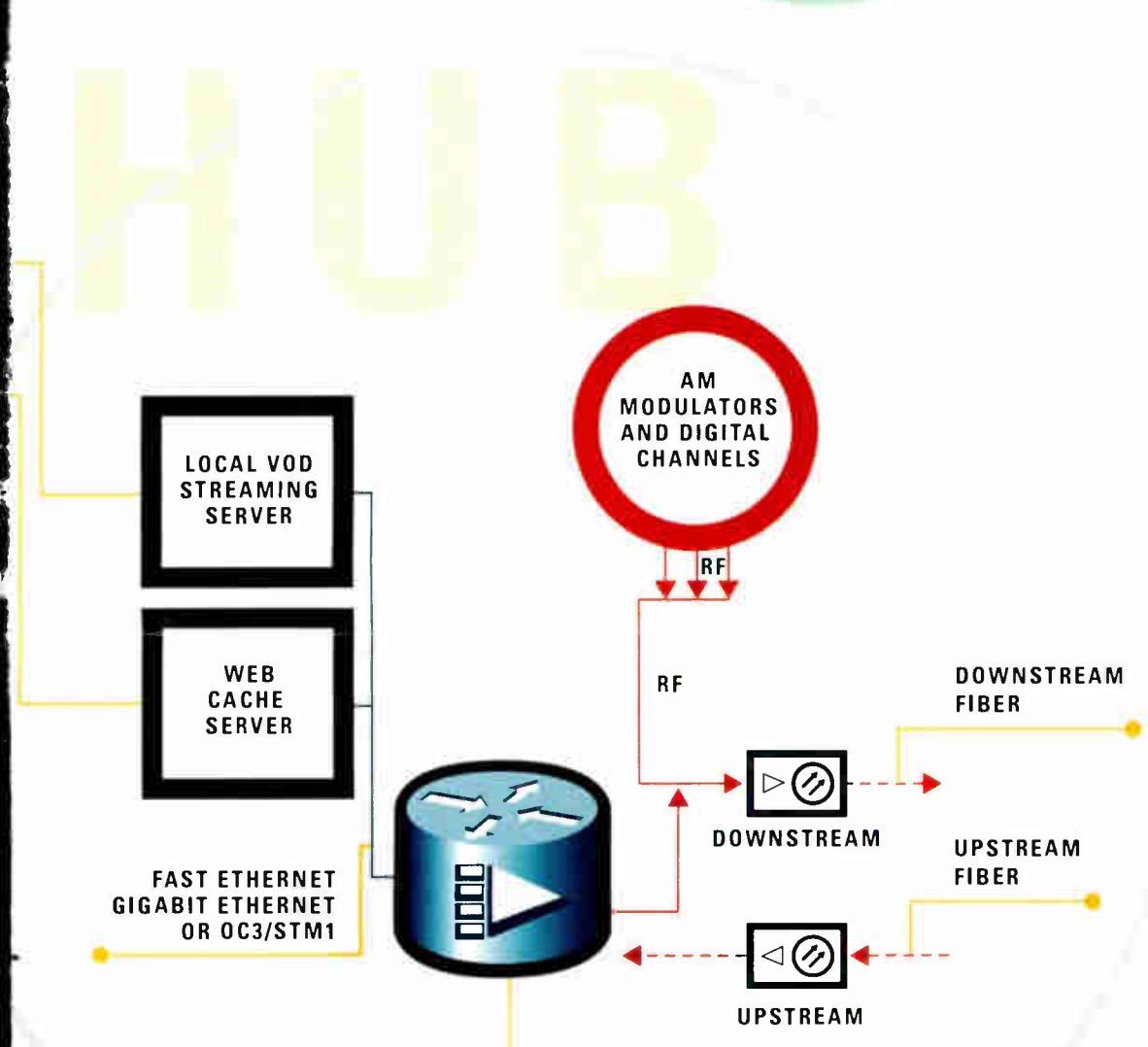

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All of this is possible because of the convergence of data, voice, and video onto IP networks.

TOP 10 CONSIDERATIONS FOR DEPLOYING DIGITAL BROADBAND

1 BUSINESS READINESS

- Understand the needs of your customers and the services you can deliver to increase revenues and opportunities for your business.
- Develop your technical and marketing plans for residential and commercial services.

2 OPERATIONAL READINESS

- Simplify operations by choosing equipment with remote access capability, unified user interfaces, and optimized provisioning and billing systems.
- Minimize the time required to install and activate new cable modems.
- Select network devices that support a wide variety of interfaces, such as OC3, ATM, Serial, and Fast Ethernet.

3 PLANT READINESS

- Upgrade cable plants to provide two-way capabilities in a Hybrid Fiber-Coaxial (HFC) architecture.
- Define channels for digital services and select 0, 6, or 10 dB down from analog video.
- Isolate and correct ingress problems in the upstream plant and identify upstream channels for digital services.

4 PLANT DIAGNOSTICS AND TROUBLESHOOTING

- Establish dynamic monitoring of your network by learning how your cable modem termination shelf (CMTS) can help diagnose radio frequency (RF) plant, and backbone network problems.
- Minimize downtime by selecting network equipment that supports advanced remote monitoring and control.

5 PROVISIONING BANDWIDTH

- Define bandwidth required for each service per residential and commercial subscriber and choose a CMTS that can enforce these policies.
- Provision for voice by ensuring CMTS can efficiently prioritize for minimum latency in a mixed Data-over-Cable System Interface (DOCSIS) 1.0 and 1.1 environment on the same upstream channel.

6 PROVISIONING MODEMS

- Choose a proven provisioning system that can readily scale to support a successful service offering with high penetration rates.
- Determine if Dynamic Host Configuration Protocol (DHCP) server, time-of-day server, and Trivial File Transfer Protocol (TFTP) server can efficiently support large quantities of modems coming online, such as after a power outage.

7 BILLINGS

- Decide how services are integrated into legacy billing systems.
- Determine how the CMTS will enable differentiated billing based on QoS per packet or by application statistics, including peer-to-peer traffic.

8 INTEGRATED LAYER 3 INTELLIGENCE AND SECURITY

- Ensure your equipment provides carrier-class routing.
- Protect your system against hacker attack and other security issues by ensuring your CMTS can provide true Layer 3 functionality.
- Enable your system to support encrypted multicast with entrance authentication.

9 HEADEND PREPARATION FOR HIGH AVAILABILITY

- Ensure sure the CMTS can support redundant power in the digital headend and consider AC or -48 VDC powering options.
- Select equipment with hot-swappable modules.

10 SERVICE AND SUPPORT

- Check to make sure your CMTS and modems can be upgraded via software to support new features and compliance standards.
- Choose an equipment vendor that offers superior after-sales service and support.

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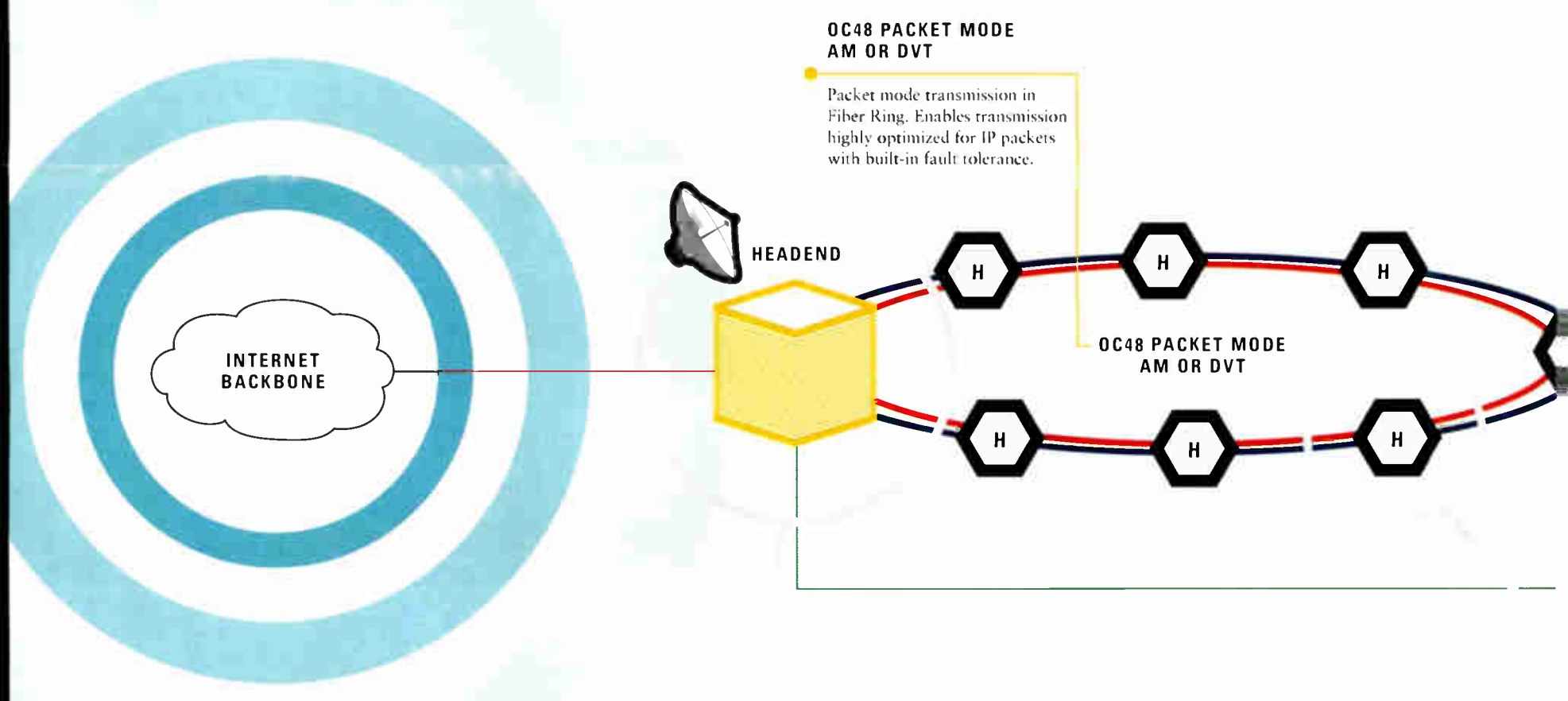

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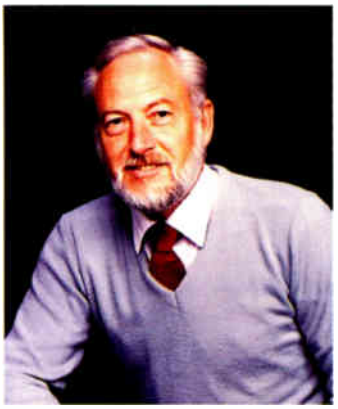

By Rex Porter
Editor
Communications Technology magazine

Managing today's modern hybrid fiber/coax (HFC) networks is no longer simply the monitoring of cable TV plants. With the addition of Internet access, business data and Internet protocol (IP) telephony services, modern two-way, full-service networks must operate in such a manner that short response times can be attained when locating outages.

Cable's HFC networks now are being used to compete with telephone companies, utilities and direct broadcast satellite (DBS) operators for full-service provision. Telephone companies pride themselves in being able to offer phone service when power might be unavailable to sections of their service areas. The power companies have relatively short response times in repairing power outages unless the cause is a major storm. DBS service can have a distinct advantage in that any home with power does not depend on service over fiber or cables. So, network management of cable's HFC network equipment becomes ever more important in satisfying cable customers' appetite for reliable, enhanced services.

Lately, there has been a lot of controversy about how to properly provide network management without exceeding the cost limits. The chief technical officer of one of our largest MSOs recently wrote me regarding this controversy. Among the many items in his letter, he pointed out that we could achieve "reliability through simplicity." He called for vendors and operators to develop and deploy cable TV transmission system network management based on the integration of information from various terminal element managers and a geographical database of all critical active and passive system components.

To accomplish this task, companies that provide network management equipment must understand cable industry system engineering. They must provide a system that is friendly to amplifiers on the lines and equipment in the headends.

Additionally, this system must monitor the entire plant, from the headend to the last terminator. It must be compatible with modern laser transmitters and receivers and identify with the operation of the various nodes. Of course, the No. 1 cause of system failure is commercial power outages. But the proper network management system reaches far beyond monitoring power outages.

Network management should provide new services to the operator and engineer; power monitoring is only one part of network management. It should continuously monitor the health of both the forward and return paths. A good network management system provides a "physical" for the health of your system. However, unlike our annual "physical," it provides data on a 24-hour basis.

I continue to believe proper network management in a cable system will begin to ease the burden of continuous cumulative leakage index (CLI) monitoring as a separate daily effort. For example, the information provided by quality network management will provide data that can be tracked to locations with poor isolation, and preventive maintenance to solve those problems may create a solution with poor isolation being discovered as the true culprit.

As I ended last year's "Importance of Status Monitoring," I repeat: "Today's cable TV systems will be tomorrow's full-service networks. The speed of modern HFC networks can be the future of a new information superhighway. But the cable industry will not replace the present telco architectures in delivering telecommunications services unless we are prepared to properly and continually monitor the operational status of our systems." ■

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Network Management From the Firing Line

By Brett Price
President
Cheetah Technologies

Network management can provide remarkable benefits, including improvements in network reliability, customer service and subscriber satisfaction. Many cable operators are quickly gaining experience and have proven the value of network management.

There are specific issues to be concerned with when planning to manage an HFC network:

• Integration: Integration of network elements and operational support systems can be a monstrous challenge. Operators of HFC networks are faced with truly hybrid systems: part telecom, part datacom and part cable. This broad array of network elements brings with it a broad array of interface standards.

• Data vs. Information: As the number of elements under management grows, the challenges associated with managing the data coming out of the network will grow as well. Simplistic network management systems eventually will present your network operation center operators with an overwhelming amount of information, rendering the system nearly valueless. More effective network management systems can turn thousands of alarms into a few, clear, actionable problems. Only then will the investment in network management achieve the goal of reducing the cost of operations.

At Cheetah Technologies, we build systems that address these requirements. Our CheetahNet suite of network management tools includes ObjectArchitect , a toolset that allows you to quickly integrate network elements with both standard and proprietary interfaces. ExpertArchitect is an extremely powerful tool that allows you to tailor the processing logic of the system to your needs, reducing thousands of messages to the few actionable alerts you want to manage.

These tools are part of NetMentor , a framework designed to handle your physical layer management, network test, datacom systems and telecom systems. You have one system that can correlate information across these environments.

Getting going

A common sequence for network providers is to start simple, implementing status monitoring so you can watch the performance of your physical network.

CHEETAH TECHNOLOGIES

Moving beyond status monitoring includes the management of telcommunications and datacommunications devices. This is where the systems start to get interesting.

Many network operators are looking to harness the information coming out of the cable modem systems and host digital terminals (HDTs) for enhanced physical layer monitoring. Once enhanced services penetration grows, one can correlate network outages quite precisely given the information coming out of these systems.

There are two interesting challenges, however. First, this presumes you have either one system or a set of tightly integrated systems managing those environments.

Second, this also presumes you've solved the customer premise problem. The network management system must understand the state of the network in order to make fault and network performance determinations. At a minimum, the network management system must know where customer devices are located in the plant.

Most operators are finding it a challenge to simply document their networks, let alone provide physical network asset information to a real-time network management system on the fly. Additionally, providing add/change/delete information to network management systems from the customer care systems has not begun.

While significant problems, they are definitely worth solving. Turning customer premise devices into managed elements can help pinpoint network problems. Correlating physical layer alerts with test system and cable modem alerts can stop the wasted time and money associated with unnecessary truck rolls.

At Cheetah Technologies, we are providing solutions that go well beyond status monitoring systems. We are providing a single management system capable of reaching across multiple systems and services to provide you with a single management environment. As we go forward, we'll be solving the problems of interfacing to design systems and customer care systems so we can efficiently turn your customer premise devices into managed elements.

As you read the following case studies, it is our hope that the challenges, goals, decisions and results presented therein will help you define and address your network management questions. I urge you to call us with any questions you have on network management technology—we'll be more than pleased to help you find answers. ■

MediaOne Meets the Reliability Challenge with Cheetah

By Doug Larson, Senior Editor, *Communications Technology* magazine

Like so many other cable TV operators, MediaOne is branching out from its core video programming business to harness the seemingly unlimited potential of its broadband pipe.

MediaOne's Western Region, for example, provides video programming, digital telephone service and Express-Net high-speed data services, all of which are delivered across its HFC network.

And, like so many others, MediaOne has faced its share of growing pains. With the added service offerings have come added network management responsibilities.

No one knows this better than John Roy, MediaOne's network management manager for its Western Regional networks. "When you are on the cutting edge, there are bound to be unexpected issues and problems: No pain, no gain," says Roy. These days, MediaOne is seeing a lot more gain and a lot less pain, due in large measure to its Net*Mentor* monitoring system.

According to Roy, a network management system was necessary in order to ensure the integrity of its HFC network. "The reliability is necessary to provide dependable broadband data and digital telephone service, as well as providing reliable video to our present customer base," says Roy.

MediaOne's Western Region started deploying Net*Mentor* in February 1998 and now actively monitors more than 500 fiber-optic nodes and an estimated 700 power supplies. "By the end of the year," says Roy, "there will be approximately 700 nodes and 1,300 power supplies actively monitored."

MediaOne's Western Regional NOC

The decision to run with Cheetah was easy. "Net*Mentor* has allowed an in-depth look into the network that was never available before," explains Roy. "Monitoring the fiber-optic nodes has allowed the constant measurement of optical power, internal temperature, local power supplies and the control of digital inputs.

MediaOne® Group

"One of the most useful devices monitored is the power supply," says Roy. "Net*Mentor* has identified equipment failures before the loss of power. Batteries, total amp draw, output VAC and digital inputs are constantly being measured and are alarmed if the readings go out of specification."

> "Net*Mentor* has allowed an in-depth look into the network that was never available before."

By the end of this year, the Western Region will be well into the Net*Mentor* deployment. "The project is now full speed ahead: 95% of all the technical and operational issues have been resolved," says Roy.

"The main focus is to get the devices deployed and start monitoring the network," he continues. "Eventually, the Western Region may start to utilize the automated Federal Communications Commission proofing and ingress analysis systems."

Roy is not the least bit worried about Net*Mentor*'s ability to keep pace with MediaOne's growth, either. According to Roy, Net*Mentor* has been very scalable. "Initially, the Western Region had one Sun UltraServer 170 and one Windows NT client running the Net*Mentor* software," says Roy. "Now after eight months, there are two ES450 UNIX servers and six Windows NT clients at the regional network operations center (RNOC) and four NT clients located at the headends and maintenance departments.

"With our current configuration," Roy continues, "the Western Region will be able to support our population of 20,000 devices being monitored by 30 Windows NT clients.

"MediaOne's ultimate goal is to provide a reliable network to our customers who subscribe to our broadband data services," says Roy.

"I treat MediaOne's relationship with Cheetah Technologies as a partnership," Roy continues. "Neither will be successful without the other. I have spent many hours at Cheetah Technologies qualifying and testing product before it is shipped to our region.

"When both sides sign off," concludes Roy, "we know there is a winner." ■

Knology Launches Video, Voice and Data with Cheetah

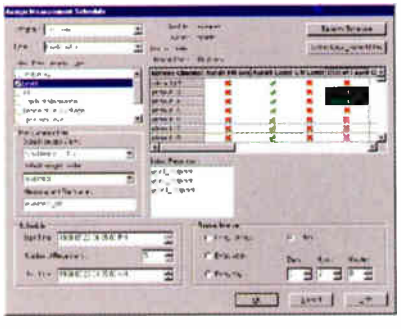
By Doug Larson

West Point, GA-based Knology is one of a new breed of broadband communications companies. Founded in 1995, Knology operates interactive broadband networks in three cities: Montgomery, AL; Columbus, GA; and Panama City Beach, FL. Knology offers its residential and business customers digital video, local and long distance telephony and Internet services under its Olovision, Olotel and Olobahn brand names.

Knology now is in the process of building a $50 million 750 MHz HFC network in Augusta, GA. Knology expects to reach a 100% home pass rate within three to five years but faces formidable competition from the likes of cable giants Jones Intercable and Charter Communications.

Knology believes the quality of its customer service operations will set it apart from the competition. Much of this is accomplished at Knology's network operations center in West Point, GA. Here, Knology monitors network activity, receiving real-time information regarding network performance, power supply status and telephony customer premise equipment (CPE) activation. It accomplishes these tasks with the help of Cheetah.

For Marcus "Rickey" Luke, Knology's chief technical officer, the decision to purchase the NetMentor system was based on a number of factors. First, Luke was searching for a standards-based element manager that would offer a complete set of HFC monitoring building blocks. "Knology needed a system that would integrate with its existing operations support systems (OSS) to provide a clearer status of the HFC portion of the system," says Luke. "Cheetah is able to interface with our existing OSS via simple network management protocol (SNMP) and American Standard Code for Information Interchange (ASCII), enabling us to filter and view high-level alarms at our discretion.



Cheetah Assignment Manager

CABLE TV ~ TELEPHONE ~ INTERNET
KNOLOGY
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"We also wanted to know when equipment was switched over to protected electronics and when power supplies were in standby," adds Luke. "It is important to know when equipment has switched to standby in order to correct the fault that caused the switch, thereby allowing protection and reduced downtime."

Moreover, Knology wanted a multi-user access system with predictive analysis that would allow it to conduct critical fault and performance monitoring tests. "We needed the capability to see our system from our customers' perspective and be proactive from a maintenance perspective," continues Luke.

Luke also was searching for a modular system that would provide for incremental system growth without any initial investment loss or interruption of service. "We needed to work with a vendor that had the flexibility to integrate with other OSS deployments we already had in operation," explains Luke.

Knology started purchasing the Cheetah system in 1996 and currently is conducting extended interface testing with Cheetah power supply transponders and the Unity Wave power supply. Thus far, the tests have been successful. "Cheetah transponders have been beneficial in locating power supplies which have switched to redundant mode," says Luke.

The Cheetah system is expected to be fully operational by the end of the year and will operate in Knology systems in Montgomery, Columbus, Charleston, Augusta and Panama City.

Luke's goals for the Cheetah system are threefold. "We expect Cheetah to play a big role in controlling ingress in the return spectrum, reducing downtime and increasing mean time between failures, and identifying problem areas before they interrupt service," says Luke. Success in each of these areas will help Knology attain high levels of customer satisfaction and keep it one step ahead of the competition. ■

> "We needed the capability to see our system from our customers' perspective and be proactive from a maintenance perspective."

Cheetah Improves Customer Service in South America

By Doug Larson

Santiago, Chile-based VTR Hipercable provides cable TV services to more than 380,000 subscribers. Its HFC network passes 1.5 million homes in all of the major urban population centers throughout the country.

In June 1997, VTR began offering telephone services over its HFC plant in Santiago and currently counts about 15,000 telephony subscribers. In addition to the telephony project, VTR launched premium cable TV services in Santiago in early 1998. Using cable modem technology, VTR has plans to roll out Internet access services in the near future.

VTR started searching for a network management system to improve the quality of service (QoS) to its customers. Hernan Benavides, VTR's engineering manager, points out: "This especially applies to the telephony services because we must provide the same QoS as the traditional twisted-pair phone provider. This is not an easy task with more electronic devices between the central site and the customer."

To make this QoS goal a reality, VTR turned to Cheetah. "A very important issue was the company behind the product, including its technology, technical support, experience and quality," says Benavides. "We determined that Cheetah was the company that best complied with the main requirements that we established through a request for proposal (RFP) process."

VTR's RFP specified a number of capabilities. According to Benavides, these include "the capability to integrate all of the different elements in the HFC plant, including the inside and outside plant devices, real-time exception reporting, and easy interfaces to the operators."

VTR purchased the Cheetah system in December 1997 and started installing and using the system in February 1998. Cheetah currently is installed in VTR's network operations center (NOC) in Santiago and monitors its bidirectional HFC network passing more than 91,000 homes.

VTR uses a number of Cheetah status monitoring hardware and software components in its system. "In the outside plant, we are using transponders for the monitoring of power supplies and optical receivers," explains Benavides. "In the inside plant, we will start using General Purpose Monitor (GPM)-4 , which is used for status monitoring and fault detection for multiple headend and hub devices."

Additionally, Benavides' team uses the Cheetah HE-1000 headend spectrum analyzer for RF downstream analysis. All of these activities are controlled by the HEC-3 headend controller at each location and connected to the master server in the NOC to collect the data and alarms.

VTR's Cheetah system controls the device alarms to alert the operators when it has a problem or failure in any of the equipment.

VTR also uses Cheetah-generated statistics in its engineering processes. Benavides explains: "We monitor the capacity of the power supplies in order to determine when new power supplies are needed, or when to slow sales in a certain subnode."

Cheetah has simplified Benavides' job. "With one screen and a couple of commands, we have our critical devices under continuous monitoring," he says. "This is a lot of help when your service depends on the status of 250 power supplies and 150 optical nodes."

> "With one screen and a couple of commands, we have our critical devices under continuous monitoring."

He adds, "We also have experienced improvements in the network maintenance routine, reducing time and costs."

VTR has future plans for the Cheetah system as well. VTR is installing Cheetah in a new system in northern Chile that will be monitored from Santiago's NOC. "We are considering going deeper into the network and monitoring additional devices," he says. ■

VTR's NOC in Santiago, Chile

Japan's Titus Rolls Out Enhanced Services with NetMentor

By Doug Larson

Titus Communications, one of Japan's burgeoning cable TV operators, has been busy. In June 1997, Titus launched its Alltel voice service, breaking Nippon Telegraph and Telephone Corp.'s virtual monopoly on the local telephone market and becoming the first Japanese cable TV operator to offer telephony service.

In October 1998, Titus launched its AllNet high-speed data service in Kashiwa, Japan, reaching another milestone by becoming the first Japanese cable TV operator to offer video, voice and data services over its 750 MHz HFC plant.

These successes created new challenges for Titus. "When you compete against a company like NTT, you need to make sure you are doing things right," explains Jeffery Kline, Titus' manager of technical operations. "Changing the mindset of a customer that has had a good, reliable system for such a long time can be a hard sale."

Titus turned to Cheetah for assistance.

Titus was searching for a number of features in its network monitoring solution. "We were looking for a product that would monitor nodes, end-of-lines and power supplies, and something we could grow with in the future," says Kline.

They also needed the ability to integrate equipment from other vendors into the network monitoring solution.

Multi-user access and scalability set the Cheetah system apart from its competitors. Although the Titus system is centrally powered, service-provisioning demands require its technicians to have concurrent access to the monitoring system from multiple locations.

The decision to purchase the Cheetah system was facilitated by Cheetah's customer-focused approach. "Cheetah was willing to work with Titus Communications toward an end goal that would remain within our budget parameters," Kline says.

Titus currently uses the Cheetah system to monitor the status of its power supplies. "With a standby power supply, it is important to recognize whether there is a problem with the unit before a power outage occurs," explains Kline. "Normally you would need to send a technician to visit these units every month to do the testing. When you have over 1,000 power supplies to visit, this can be a lot of time and money. Cheetah status monitoring reduces a lot of this work."

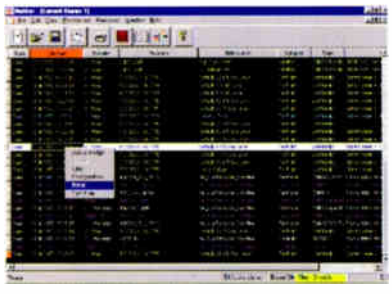
And they already are experiencing results. "We have found and corrected many power supply problems before they have affected our subscribers," says Kline.

In the near future, Titus plans to install fiber-optic node monitors to proactively monitor the voltage and RF levels. Kline considers them a critical piece of the puzzle, as commercial power loss is one of the most common types of outages in cable systems. "Due to the fact that we also deliver telephony, we need to understand when our system is out," explains Kline. "This is not like running a CATV system only, where you waited to get calls from your customers to recognize there is an outage."

The Cheetah system currently is being deployed in four Titus cable systems: Chiba, Kodira, Sagamehara and Yamoto. Passing about 500,000 homes and counting about 50,000 subscribers, these systems are growing fast, as are their network monitoring needs. "Our end goal," explains Kline, "is a system which will monitor our network at each system operation during work hours and also monitor the network at a central location during non-work hours."

Kline is pleased with the system's progress. "Things are moving forward here, and we have seen some good initial results with this product," he says. "Once this unit is in place and fully operational, I feel everyone will begin to see the long-term benefits of using such a system." ■

> "Cheetah was willing to work with Titus Communications toward an end goal that would remain within our budget parameters."



Cheetah NetMentor Notifier

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Reader Service Number 56

Commercial customers often can provide the needed subsidy for residential service. That's because business users often demand services that will be priced higher, along the lines of high-speed services offered by the phone company.

Commercial rates vary, but could begin at $200 per month and reach more than $4,000 per month.

Network management costs

The day-to-day monitoring and management of the cable modem network and all the peripheral servers, routers and ancillary equipment is a significant investment in personnel and equipment. The individual cable operator would be hard pressed to pay to maintain a 24/7 staff to handle this important customer-oriented function.

The monitoring that is required to maintain a high-reliability network for cable modem subscribers involves more than simply monitoring system alarms. To truly keep the subscribers' modems "online, all the time" requires monitoring of Internet traffic, routing, supporting equipment and even the cable system itself. To build an entry-level network management center for these functions would cost in the neighborhood of $80,000. And that's not to mention the 24/7 staffing costs.

The development of a network management center to monitor numerous sites takes advantage of the economies of scale. For example, a network management center to handle more than 20 sites can be built for less than $600,000.

With state-of-the-art network management and monitoring systems, this particular NOC can do diagnostics down to the subscriber modem level, and when associated with a help desk/call center (HDCC), the close association between them provides for a high level of interactive customer service.

Help desk

A 24/7 help desk can provide customer assistance via an 800 (toll-free) service and e-mail. Both cable modem and dial-up services could be supported. In order to meet the needs of customers, it is important to provide trained help desk labor with Internet skills. Not only is the labor cost approximately twice that of a cable TV customer service representative (CSR), but there also is the additional cost of software to support the customer help desk representative and management of the software.

Partnering with an ISP

The business will thrive only through powerful sales and marketing. That's where an Internet turnkey service provider can make the difference. Such companies can market the service and employ local sales staff in each market who are solely devoted to selling high-speed access. Their experience in preparing for cable modem service can help make high-speed access a reality. CT

Ron Pitcock is president and chief operating officer at High Speed Access Corp. (HSA). He may be reached at (303) 256-2000.

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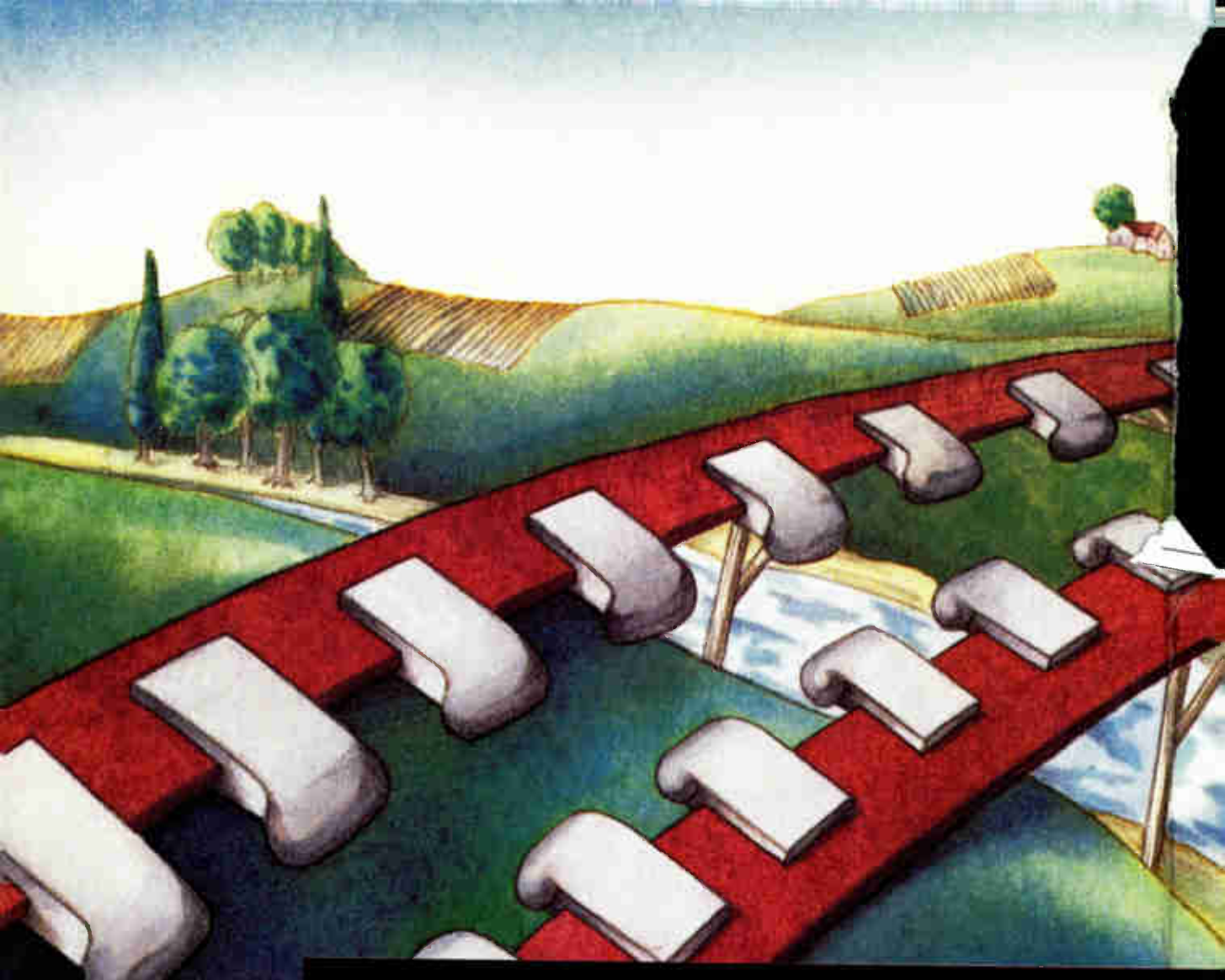

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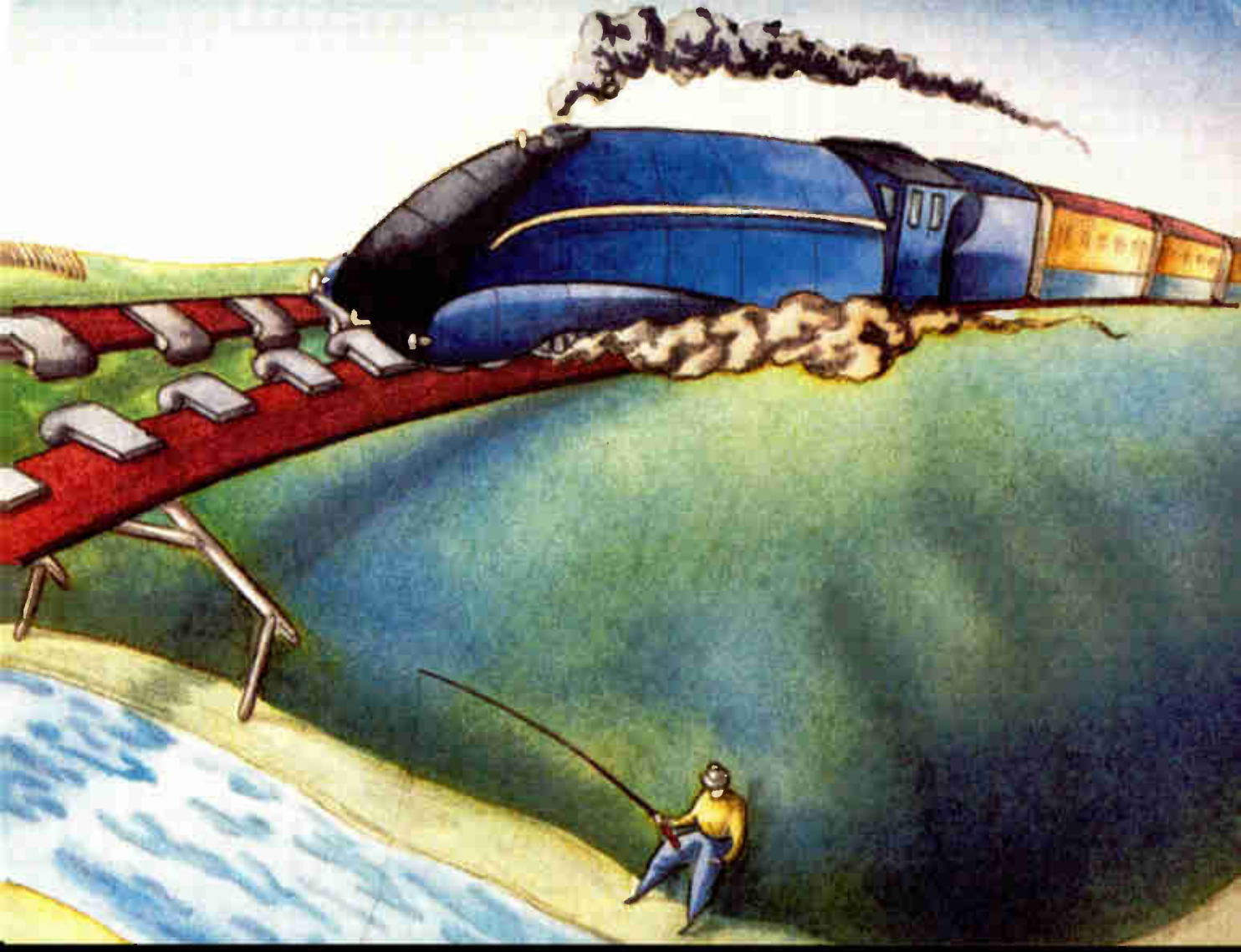

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CHEETAH™ TECHNOLOGIES

Reader Service Number 59

By Jim Daly

Silicon vs. Gallium Arsenide

Evaluation of Silicon and GaAs Gain Stage Technology

Gallium Arsenide Is Good, but Not Good Enough Yet

Over the past few years, Gallium Arsenide (GaAs) gain stage technology has been touted as the next technology that will provide cable TV amplifier bandwidth expansion and bring performance improvement to a new level.

Recent product announcements declare these advantages have now been realized and that GaAs devices are available to replace the traditional silicon-based gain stages that have been used reliably for many years.

As part of our ongoing study of new technology, Philips Broadband Networks evaluated the latest GaAs devices. We found that GaAs gain stages exhibit many advantageous characteristics under ideal conditions, but under real-world conditions the GaAs devices exhibit characteristics that may degrade overall system performance.

This article serves as a status report and will bring to light these findings to enable a broader understanding of the additional parameters that affect performance in cable TV systems.

Robustness

When we evaluated some GaAs devices that were introduced early in the market, we discovered that they exhibited weaknesses over silicon devices in terms of robustness. For example, some of the GaAs devices were susceptible to electrostatic discharge (ESD) damage, failing unit and station surge tests.

Other devices tested failed temperature cycle testing, in which the unit under test is shocked to uncover design weaknesses. These issues related to the electrical robustness now appear to be solved.

As the first level of verification, we performed several measurements to test the ruggedness of silicon and GaAs gain stages, and the test results show GaAs suppliers have corrected a number of the physical properties problems. Although the GaAs devices have been passing our standard factory device tests, there still is concern that all of the field reliability issues have not been analyzed.

At this time, there is not enough field data comparing GaAs to silicon in actual operation, so operators still should consider the potential reliability risks of using GaAs devices in the field.

Like silicon devices, GaAs devices have passed the following Philips Broadband Networks' standard factory tests:

- Module bootstrap (output connected back to input or feedback test)

- In-station DC transient
  400, 10 msec, 24 to 36 VDC spikes
  10, 250 msec, 24 to 36 VDC spikes
- Hot swap
- In-station surge (input and output with gas tubes)
  5, 1.5 x 50 microsec, 6 kV, 3 kA spikes
- In-station surge (input and output without gas tubes)
  1.5 x 50 microsec, 3 kV spikes, input and output without gas tubes at 0.5 kV, 1.0 kV, 1.5 kV, 2.0 kV, 3.0kV, 3.5 kV and 4.0 kV

Problematic GaAs characteristics

We have found that the GaAs gain stages we evaluated exhibit some characteristics that make them less desirable for use in cable TV amplifiers. The first relates to stability of the devices, and the others relate to gain.

Electrical instability: In evaluating the gain stage performance over frequency, GaAs devices individually evaluated in a terminated test fixture at room temperature had a tendency to oscillate at high frequencies of approximately 1.4 GHz.

While this oscillation is outside the band of normal operation, its amplitude indicates that it will significantly degrade the in-band distortion performance. In our tests, the GaAs gain stage exhibited marginal stability in that not all the gain stages oscillated, but when they did, the oscillations appeared and disappeared with time.

Figure 1 (on page 88) and Figure 2 (on page 88) show a typical example of an oscillation that disappeared after five minutes of operation and then reappeared after 10 minutes.

The instability of the gain stages also appeared when we evaluated the frequency response of the GaAs devices. Once again, this dramatic out-of-band (OOB) gain variation indicates the potential for instability in the GaAs devices. The gain curve plots of two devices shown in Figure 3 and Figure 4 (on page 88) demonstrate this phenomenon just above 1.4 GHz.

OOB gain variation: Another issue with GaAs devices is that they tend to have significant OOB gain that increases by as much as 5 dB when the temperature rises from room temperature to the top of the operating range.

The extent of the OOB gain, seen in the prior plots, is emphasized in Figure 5 and Figure 6 (on page 90). While this characteristic is evident OOB and can be filtered, its high amplitude level increases the likelihood of oscillation because of the feedback mechanisms within the amplifier. The plots in Figures 5 and 6 illustrate OOB gain differences between silicon and GaAs devices at room temperature.

In-band gain variation: As shown in Table 1 (on page 92), we have observed excessive in-band gain variation of the GaAs device amounting to twice that of silicon devices over temperature range of -10° C to +90° C, which translates to a cable TV amplifier environmental temperature of -40° C to +60° C.

The gain of GaAs devices has been found to vary by as much as 2 dB over the temperature ranges stated. Note there is

BOTTOM LINE

Silicon Benefits

Gallium Arsenide (GaAs) technology is one of many that offers a possible solution to reach a new level of performance in cable TV systems.

While GaAs seems to be the closest to achieving this goal, some issues still are unresolved and should not be ignored. Stability issues indicate a possible weakness in the design that may cause unexpected performance degradations or device failures. Excessive variation over temperature of in-band and out-of-band (OOB) gain may affect end-of-line performance. Finally, GaAs technology does not have an established performance record in the extreme environments present in cable TV systems.

Meanwhile, silicon gain stage amplifiers have been installed and operated in cable TV systems with extreme environments for decades. It is common for amplifiers to operate reliably for more than 20 years. This in itself is a tremendous advantage and should not be overlooked when considering the introduction of a new technology. Silicon gain stage technology can give equivalent end-of-line performance to commercially available GaAs devices with less potential risk.

Figure 1: Typical GaAs device reponse without oscillation (after five minutes of operation in a terminated test fixture at room temperature)

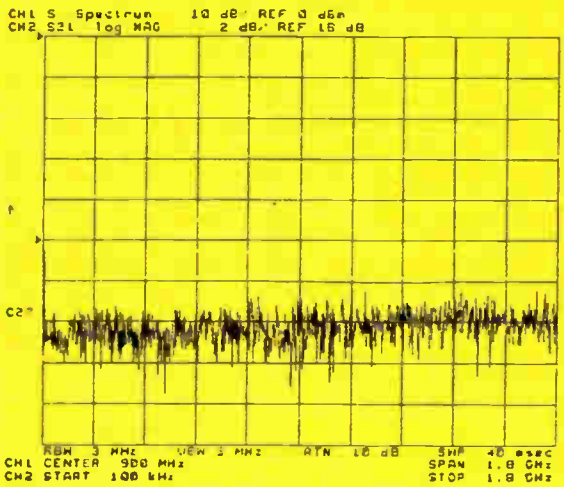


Figure 2: Same GaAs device oscillating after 10 minutes of operation in same environment

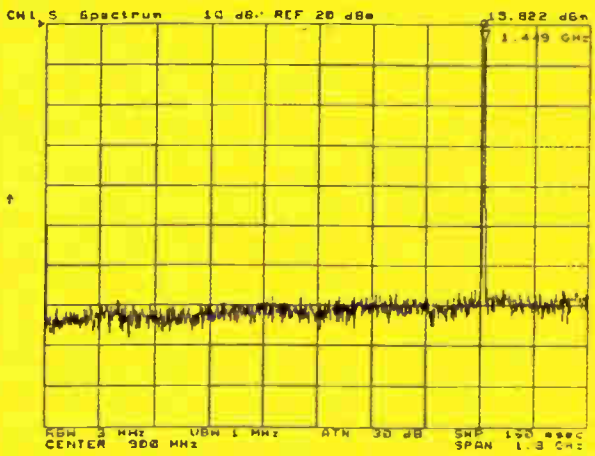


Figure 3: GaAs device Sample A at room temperature illustrates unstable, high-end response above 1.4 GHz

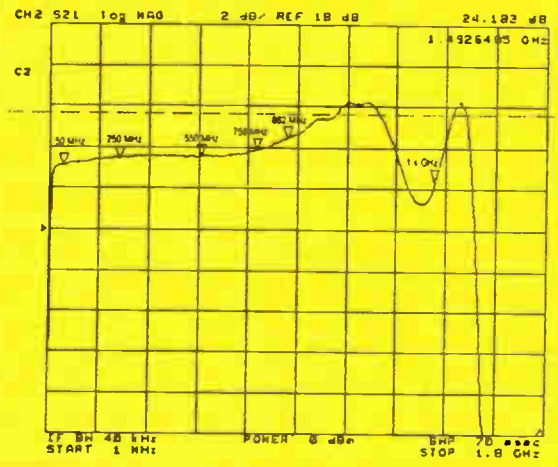
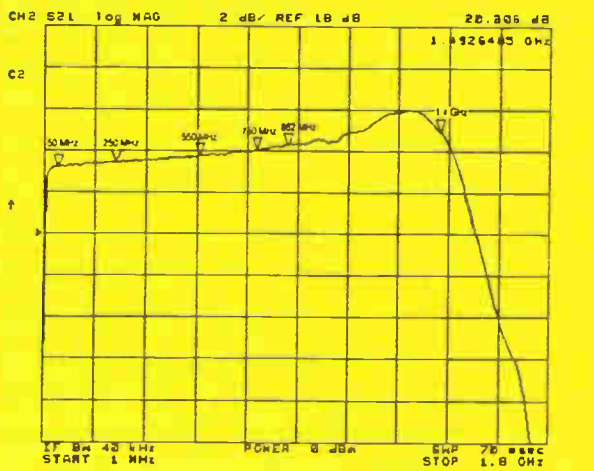


Figure 4: GaAs device Sample B at room temperature indicates stable amplitutde roll-off above 1.4 GHz



an approximately 30° C temperature difference between the gain stage of an amplifier and the amplifier's outside temperature. Given that there are two to four gain stages per amplifier, it would challenge the ability of automatic level and slope control (ALSC) circuits available on the market today to provide this type of compensation. Silicon devices vary approximately 0.5 dB over the temperature range.

In addition, for ALSC circuitry to compensate for large gain variations, the ALSC would need to add interstage losses that would result in an overall additional reduction in the amplifier distortion performance. The graph in Figure 7 (on page 90) depicts an example of silicon and GaAs gain vs. temperature.

Distortion improvement with output tilt: The next issue for consideration is related to distortion improvement with output tilt. Silicon devices provide approximately twice the distortion improvement for every 1 dB of output tilt over GaAs devices.

While typical comparison sheets for gain stages are shown at 0 dB of output tilt over the frequency range, cable TV systems generally operate with an output tilt. If the comparison were made at the tilted output, there would be substantially less difference in gain stage performance.

Table 2 (on page 92) shows the change in distortion for 10 dB change in output tilt, and Figure 8 (on page 90) is a graphic example of silicon and GaAs composite triple beat (CTB) improvement vs. output tilt. These values are calculated at room temperature and 110 channels of analog data.

System performance

Finally, we compared the end-of-line performance of two identical systems over the temperature range of -20° C to +60° C

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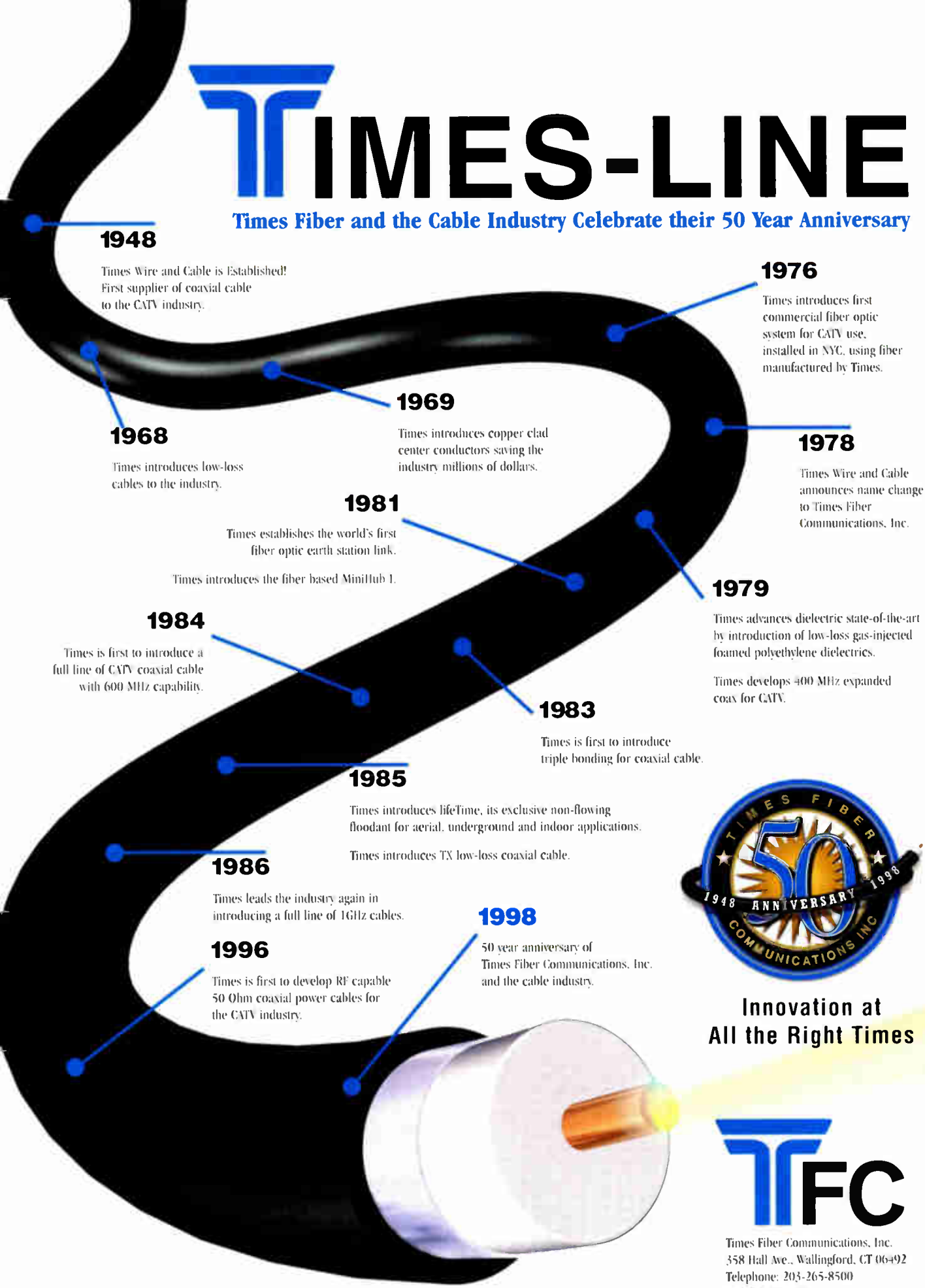

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Figure 5: Gain of high performance silicon device

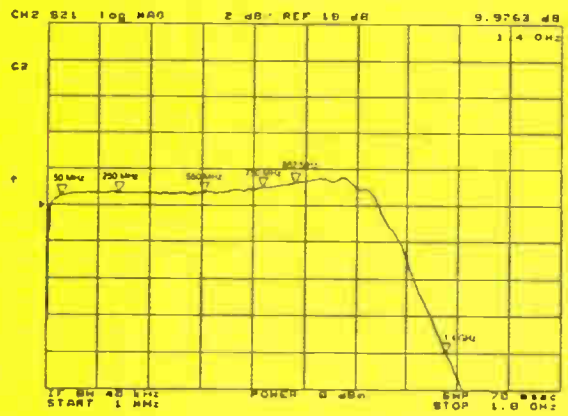


Figure 6: Gain of GaAs device showing out-of-band, high-end gain of an additional 4 dB

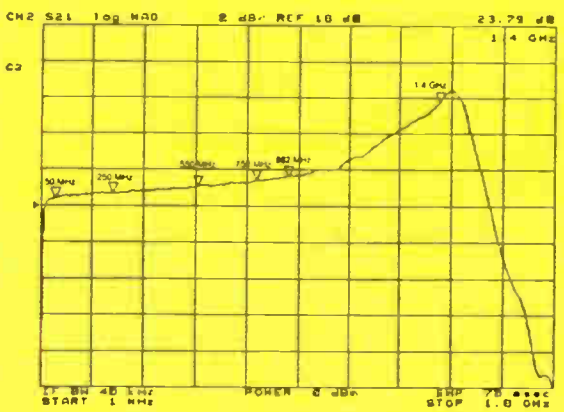


Figure 7: Typical variation of gain change over temperature for silicon and GaAs devices as measured in terminated test fixtures

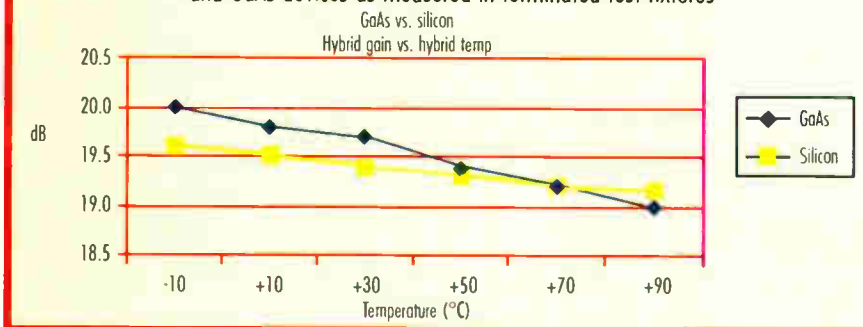
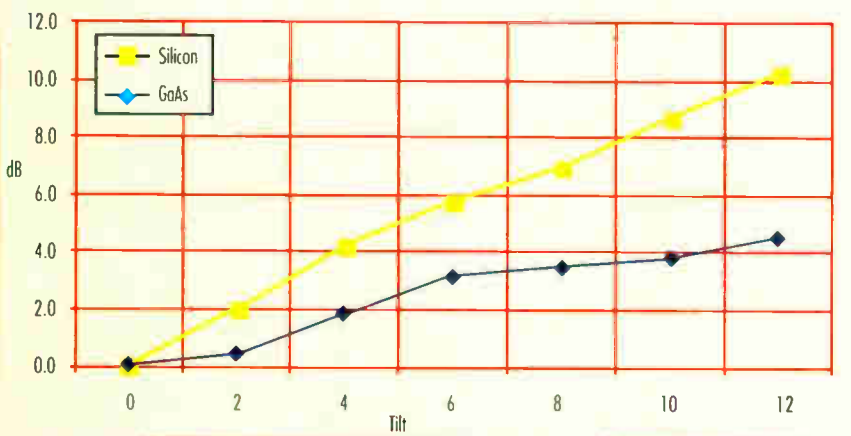


Figure 8: Silicon vs. GaAs CTB improvement with output tilt



for GaAs devices and -40° C to +60° C for silicon devices. The baseline system used GaAs gain stage technology in the cable TV amplifiers, and the other used silicon gain stages. The system consisted of three fiber links, a node and five amplifiers in cascade. They were set to identical input and output levels and operated at 110 analog channels.

Both GaAs and silicon systems achieved the same end-of-line performance. The end-of-line distortion performance is shown in Table 3 (on page 92).

System costs

Costs often are thought of as individual amplifier purchase prices. In a cable TV system, the real cost includes the total cost of ownership (from purchase price to installation to system maintenance) as well as potential loss of revenue due to system downtime.

> "End users of cable TV systems, cable TV customers, do not pay for new technology; they pay for new and reliable services."

Regarding the operating costs between the two technologies, a system with GaAs devices may require additional periodic system balancing to maintain output levels because of changes in ambient temperature or amplifier failure.

In terms of the amplifiers, the cost of the two products is similar. Therefore, in terms of the system, given that the end-of-line performance is the same for both technologies, the number of amplifiers per mile should be equal.

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Hence, there is no initial cost advantage with either technology.

Silicon, however, has a well-known track record and should lead overall cost of ownership when reliability and maintenance are considered.

Conclusion

Ultimately, operators are concerned with achieving a given end-of-line performance target at the lowest cost, which is measured in greater terms than simply the cost per mile. System failures and inadequate services also contribute to cost and are not always recognized until a system is installed and operating for several months or years.

> "GaAs gain stages exhibit many advantageous characteristics under ideal conditions, but under real-world conditions the GaAs devices exhibit characteristics that may degrade overall system performance."

End users of cable TV systems, cable TV customers, do not pay for new technology; they pay for new and reliable services.

In the absence of a clear performance advantage of GaAs gain stage technology over silicon devices combined with the system reliability uncertainty of the new technology, silicon gain stage amplifiers appear to maintain the position as the best solution for cable TV operators today.

While GaAs suppliers are addressing the issues presented in this article, silicon device suppliers are steadily improving their products, raising the bar in performance.

Table 1: Gain change over temperature

	High performance silicon	GaAs
Typical	.5 dB	1.0 dB
Worst-case	.75 dB	2.0 dB

Table 2: Approximate distortion improvement with 10 dB of output tilt

	Silicon devices	GaAs devices
CTB	8	4
CSO-high	11	6
CSO-low	4	2
X-mod	7	4

Table 3: End-of-line distortion requirements of a baseline system

	End of line
CTB	-53 dB
X-mod	-53 dB
CSO	-53 dB
C/N	48 dB

Though GaAs holds promise for the future, at present GaAs is still an emerging technology for cable TV applications. We believe more work is needed on device development before it can outperform silicon as the technology of choice for reliable outdoor networks. Cable TV system operators should compare the two technologies at a system level to determine which will provide the best return on investment.

I would like to thank my Philips Broadband Networks colleague Dave Kelma, senior project engineer, for his technical support in the product evaluation. CT

Jim Daly is product manager, RF systems, for Philips Broadband Networks. He can be contacted at the e-mail address: jim.daly@pbn-us.be.philips.com.

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Silicon vs. Gallium Arsenide

The Advantages of Gallium Arsenide Hybrid Power Amplifier Technology in Cable TV

By Phil Miguelez, Gary Picard and Fred Slowik

Gallium Arsenide field effect transistors (GaAsFETs) were first introduced 30 years ago[1]. Initially developed for military microwave applications such as traveling wave tube (TWT) solid state replacements, GaAsFETs have improved steadily over the years in cost, performance and reliability.

Over the past 10 years, GaAsFETs have gained increasing commercial acceptance in applications ranging from satellite receivers to cellular handsets to advanced cable TV set-top receivers. According to a 1996 DataQuest survey, GaAs devices comprised 35% of the total semiconductor market and were designed into 69% of all wireless applications[2].

In the last few years, a number of new as well as traditional cable TV hybrid manufacturers have announced hybrid amplifier products or development plans incorporating GaAs semiconductors. The package styles, operating voltage and RF performance targets have varied quite a bit from vendor to vendor as each manufacturer adapts its specific GaAs process to the demands of the cable TV environment.

In June 1994, NextLevel Systems began a research and development program to develop improved hybrid amplifiers. The motivation for this effort was the need for higher performance gain blocks providing fewer actives per mile and higher channel capacity.

After an investigation of all potential technologies available, GaAs metal-semiconductor field effect transistors (MeSFETs) emerged as the clear design choice. In 1997, NLS began product testing using our in-house GaAs hybrid design. The NLS GaAs hybrid is a form-fit-function high-performance alternative to the silicon power doubler (750 MHz and 860 MHz). The performance comparisons to silicon presented here are based on measurements incorporating the NLS GaAs hybrid.

GaAs properties

From a materials comparison standpoint, GaAs offers two significant advantages over silicon. The first is the semi-insulating property of GaAs due to its higher bandgap energy potential. Both GaAs and silicon are considered semiconductor materials, meaning the conductivity of the material increases with temperature. The atomic structure of GaAs provides a higher energy bandgap than silicon (1.42 eV vs. 1.1 eV). Intrinsic GaAs crystals therefore are much better insulators at normal temperatures than silicon because of this higher gap energy. This allows GaAs devices to operate safely over a higher temperature range.

The second advantage, carrier mobility, provides the major RF enhancement of GaAs vs. silicon: GaAs has a higher electron mobility than any other semiconductor material commonly used today. The upper frequency limit of a transistor is proportional to the charge carrier mobility, and thus GaAs devices are usable at higher frequency bandwidths. Higher carrier mobility also results in lower resistivity and therefore lower loss, providing improved noise figure and higher dynamic range.

The next significant property of GaAs is its higher thermal resistance. Although not normally considered an advantage, in combination with a properly designed package, the higher thermal resistance of GaAs can be managed effectively.

Although GaAs has a thermal resistance that is three times higher than that of silicon, the FET structure allows the GaAs substrate to be directly soldered to the heat sink without the additional electrical insulator common in bipolar device circuit layouts.

Unrelated to the starting material, the FET configuration has a unique benefit compared to a bipolar. The FET structure has a lower third order distortion potential than a bipolar transistor. This is primarily because the FET is a square-law device, with its drain current proportional to the square of the ratio of the gate voltage to the pinchoff voltage.

ID = Idss (1- Vgs/Vp)^2

It generates little odd order distortion, and the even order distortion that is generated can be suppressed with a standard balanced amplifier circuit design.

Another benefit of GaAsFETs is that they do not exhibit thermal "run away." While a bipolar transistor gain (Beta) increases with increasing temperature and can eventually "run away" causing device failure, the FET carrier mobility decreases with increasing temperature and acts to stabilize the device current draw.

Is GaAs reliable?

When most people consider using a GaAsFET, they immediately think about electrostatic discharge (ESD) problems and handling issues associated with all GaAs devices. And with good reason. As a discrete device, the gate terminal of a GaAs MeSFET consists of a Schottky diode barrier formed by depositing metal directly onto the semiconductor channel. A positive voltage applied to the gate would cause direct current to flow through it, and because the gate contact is quite small (1 µm or less), the gate electrodes would fuse completely.

Once the MeSFET is connected to the hybrid circuit, the situation becomes much more manageable. In a hybrid circuit, the gate is protected by DC blocking caps, input and output transformers, and since the MeSFET is typically self-biased, the gate is shunted to ground with a low impedance, further reducing the potential for a life-threatening voltage spike. Our in-house DC surge testing and RF overdrive testing has shown that a properly designed GaAs hybrid can withstand the same levels of electrical over-stress as an equivalent bipolar hybrid.

> "Both GaAs and silicon are considered semiconductor materials, meaning the conductivity of the material increases with temperature."

RF overdrive = +75 dBmV input
DC overvoltage = +32 V
Operating temperature = -30° C to +100° C (case temperature)
Hybrid transient surge = +69 V (+5 V surge + 24 V supply voltage) applied to the DC bias pin, 5 pulses, 5 µsec transient time period.

The mean time to failure (MTTF) for every active semiconductor is a strong function of the device junction temperature. As previously stated, the thermal resistance of GaAs is higher than silicon, but unlike a bipolar transistor, the GaAs MeSFET can be bonded directly to the heatsink without the use of an additional electrical insulator. Using this method, a maximum hot-spot temperature of +145° C (measured with a case temperature of +100° C) has been verified with infrared scanning equipment. Competitive silicon hybrids that use alumina substrates or combinations of heat spreaders on alumina have shown consistent hot-spot temperatures of 150° C to 185° C, depending on the manufacturer.

NLS has performed numerous tests on our GaAs hybrid design to the same operating and storage conditions as competitive silicon hybrids with equal or improved results. We also have initiated long-term life testing on a sample population of GaAs hybrids with zero failures to date.

Does GaAs improve hybrids?

Based on the typical push-pull, cascade circuit that has been so successfully used with silicon bipolar transistors, NLS produced a GaAs MeSFET hybrid with equal or better return loss and comparable gain and slope characteristics. Good device balance and circuit layout design assures a low composite second order distortion (CSO).

The areas where GaAs distinguishes itself from its silicon predecessor are noise figure and third order distortion or composite triple beat (CTB). Figure 1 (on page 96) shows the noise figure comparison between the NLS GaAs power-doubled hybrid and a competitive silicon hybrid.

The measured CTB of the NLS GaAs hybrid provides a 5 dB to 6 dB improvement over a competitive silicon design at the typical output level operating point. The main advantage of the NLS GaAs design is that the improvement in CTB is sustained at increased output levels. Figure 2 (on page 96) compares the linearity slope or "crash point" of the NLS power doubler and a competitive silicon design with 110 analog channel loading operating at 10 dB output slope. ➤

Figure 1: Noise figure comparison

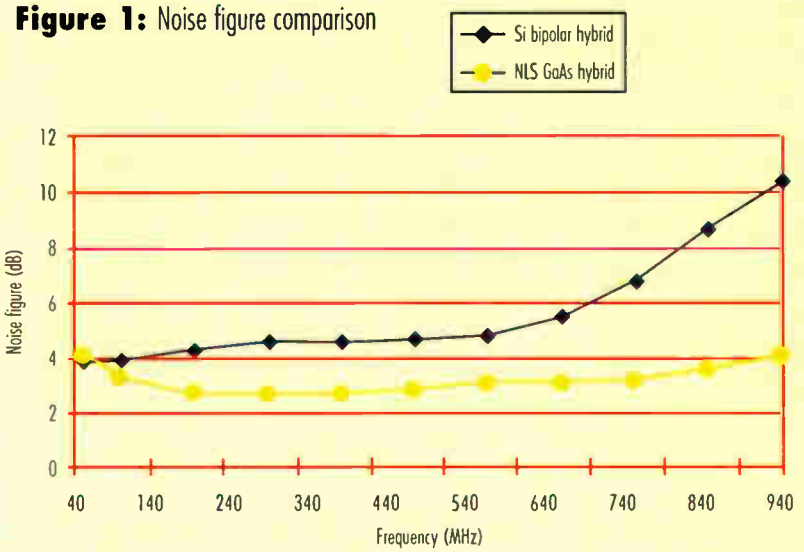
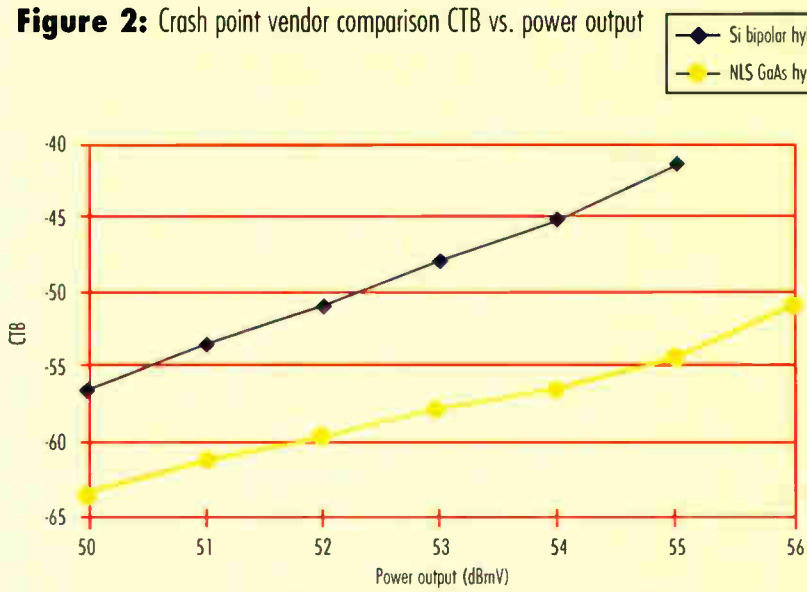


Figure 2: Crash point vendor comparison CTB vs. power output



Amplifier performance comparison

When evaluating potential new technologies for use in broadband amplifiers intended for hybrid fiber/coax (HFC) applications, there are several criteria to consider. These include distortion, performance (CTB, CSO and XMOD, or cross modulation), surge resiliency and thermal stability. The following is a summary of how amplifiers equipped with GaAs MeSFET hybrids developed by NLS compare to the same amplifiers employing industry-standard silicon technology.

Distortion

The distortion performance achievable in broadband HFC distribution equipment has placed limitations on system designers. In particular, the CTB performance achievable in amplifiers utilizing currently available silicon hybrid technology has limited the analog channel capacity and operational output levels at which the amplifiers can be utilized in cascaded systems. The advent of the GaAs MeSFET-based amplifier has eased this limitation by giving the system design additional "headroom" as an effective new design tool.

The inherently better distortion performance of these new amplifiers can be viewed in several different ways.

Figures 3, 4 and 5 (on pages 97 and 98)

Figure 3: CTB distortion performance for various channel loadings

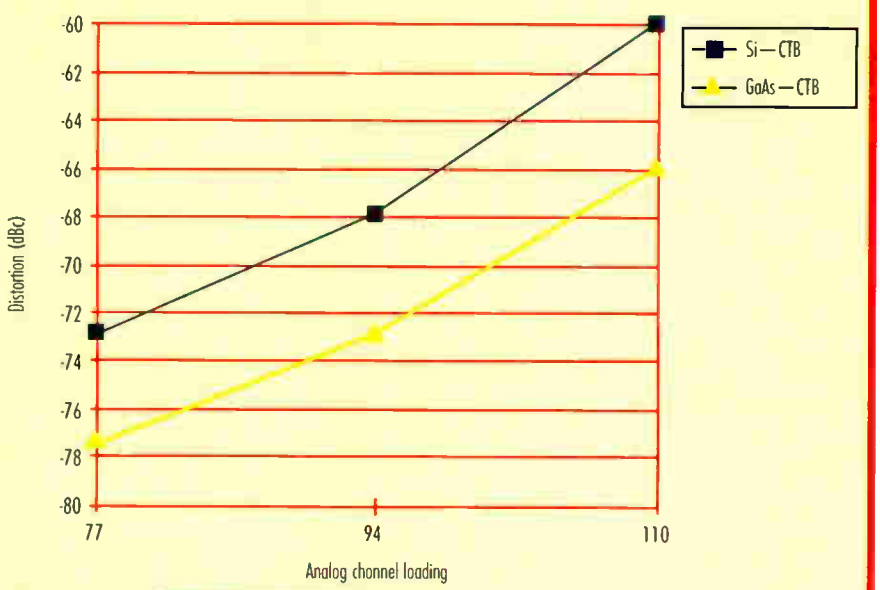
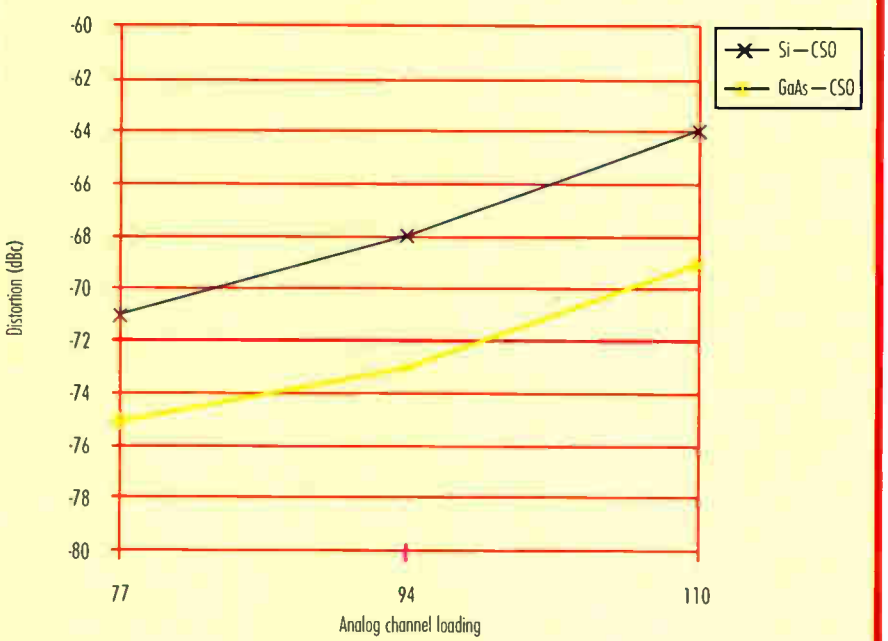


Figure 4: CSO distortion performance for various channel loadings



show the measured CTB, CSO and XMOD distortion performance at 25° C. They illustrate various analog channel loadings of a 750 MHz distribution amplifier populated with silicon and GaAs hybrids.

The remaining operating conditions are held constant at +47 dBmV output at 750 MHz and 10 dB tilt from 50 MHz to 750 MHz. Three major points should be gathered from this data.

First, the GaAs-based amplifier demonstrates improvements in the order of +-5 dB for CTB with equivalent XMOD for a 77-channel scenario. CTB followed by CSO are the dominant distortions affecting picture quality. In higher channel applications, XMOD is a relative nonfactor. Subjective testing indicates that XMOD can be as low as +0 dB on a system performance basis before it becomes

Figure 5: XMOD distortion performance for various channel loadings

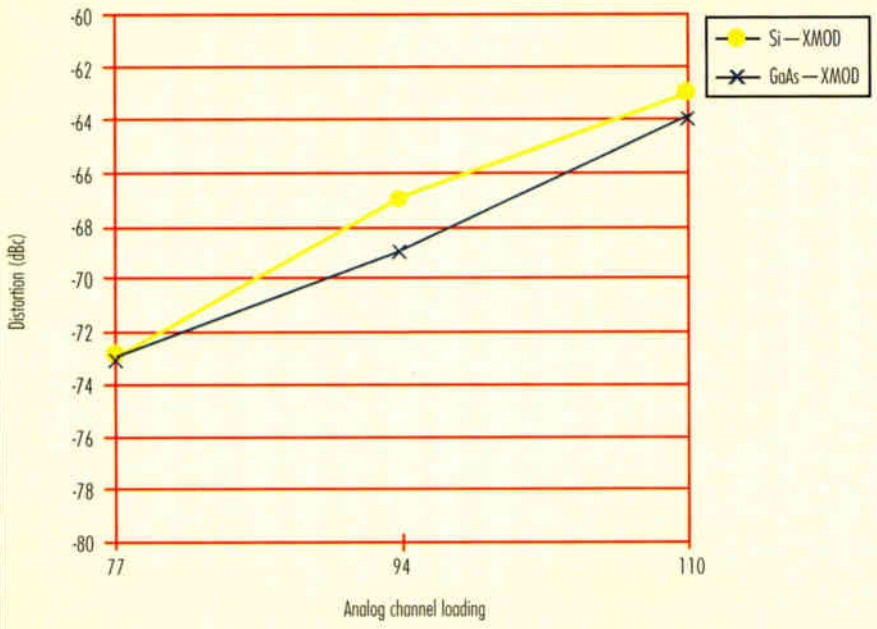
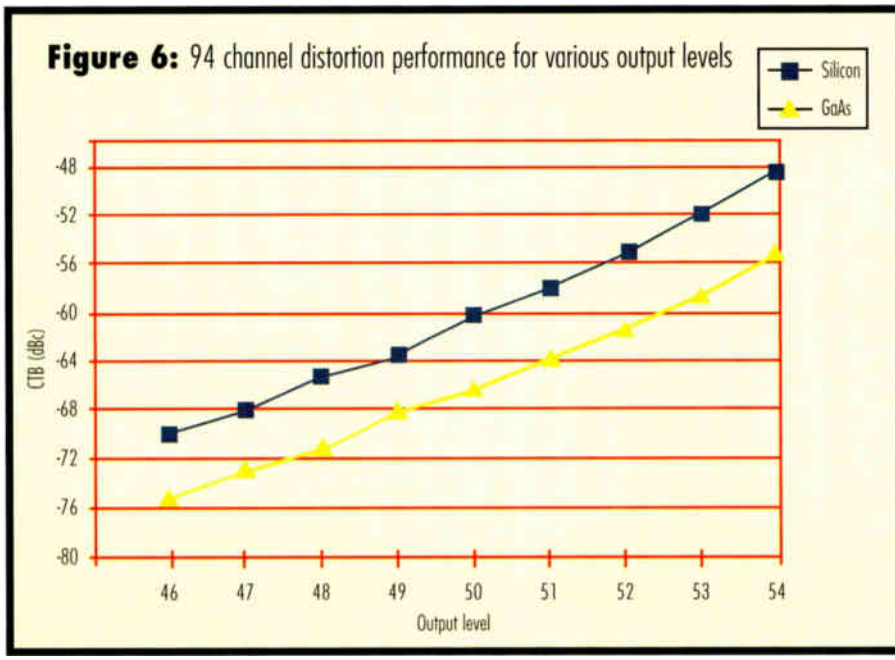


Figure 6: 94 channel distortion performance for various output levels



noticeable. For systems running under these conditions, the distortion improvement can be utilized to make up for shortcomings elsewhere in the system or simply as design margin.

Secondly, as analog channel loading is increased, the margin of improvement of CTB and CSO increases. The GaAs-based product degrades to silicon 77-channel performance levels at point equating to 94 channels. The practical meaning of this is an increase in capacity of 17 analog channels for the same coaxial system design.

Third, at channel loading much beyond 94 analog channels, the GaAs-based amplifier still offers the ability to produce reasonable system design results. Figure 6 shows the distortion performance of these amplifiers vs. output level with 94 analog channel loading and 10 dB of output slope.

Figure 6 shows the ability to operate the GaAs-based product at 3 dBmV higher output level than silicon for the same end-of-line performance. This increased output capability can be used to increase amplifier spacing, thus decreasing the overall number of system actives. Additionally, in an upgrade situation one may be able to hold existing amplifier locations, thus reducing labor and material costs.

Surge resiliency

Both silicon and GaAs-based products were subjected to the standard NLS surge test procedure. This procedure references IEEE C62.41-1991 and Belcore GR1089-CORE Issue 1, Nov. 1994 test methods.

These conditions include subjecting each amplifier port sequentially to a 6 KV pulse. The pulse has a rise and fall time of 1.2 and 50 microseconds respectively. Both products were able to withstand the surge without degradation to any operating parameter.

Thermal stability

Thermal stability is a major consideration in the evaluation of hybrids to be used in outdoor cable TV distribution equipment. In particular, S21 (gain) and distortion variations from room ambient conditions are of interest.

Outdoor distribution equipment must operate, at a minimum, over the industry standard ambient operating temperature range of -40° C to +60° C. To ensure proper operation of the hybrids in various platforms, the hybrids are evaluated -30° C to 100° C. This range accounts for internal equipment temperature increases. Distortion variation due to temperature is equivalent for both the industry standard silicon power doubler and the NLS GaAs hybrid. Delta S21 gain over the range of -30° C to +100° C is 0.3 dB to 0.4 dB greater than a silicon doubler but well within the correction range of the broadband amplifier circuitry.

Network implications

The advantages afforded by GaAs create a new horizon for system operators. GaAs technology, when implemented into an RF amplifier product line, may be deployed in numerous ways to reduce system cost, improve performance, enhance reliability and increase capacity.

Since operators have different objectives and business models that require flexibility in the products they employ,

roduces a completely new toolkit
a optimize the network to meet in-
al objectives. Let's examine the al-
tives available prior to discussing a
ed case study.

can GaAs be applied?

amplifiers equipped with Gallium
ide technology produce a 5 dB to 6
provement in distortion while pro-
quivalent gain and noise figures
parable silicon products available
. An added advantage of GaAs is the
to operate amplifiers at higher out-
vels due to the increased "crash
—typically 3 dBmV higher than sil-
ducts. This performance im-
ent generates several
nities for network architects to
r that were not previously avail-
using silicon technology.

One alternative that stimulates the in-
erest of many system operators is to uti-
ize the performance "headroom" of GaAs
order to increase RF amplifier operat-
g levels in the coaxial portion of the
twork. This approach reduces the num-
of amplifiers required in the system
s much as 25%.

While allowing amplifiers to operate at
er levels, GaAs maintains equal or bet-
istortions for equivalent bandwidth and
el loading as silicon products. The
operating levels of GaAs improve the
-to-noise ratio (C/N) as well.

e 1 presents a comparison of a typ-
plifier equipped with silicon vs.
er the operating temperature
-40° C to +60° C. Notice the in-
output level for the GaAs prod-
he resulting C/N improvement
intaining equivalent distortion
nce.

hat the improvement in C/N due
crease in RF operating levels re-
n improved coaxial C/N contri-
hat can benefit the overall system
ormance. This is important to re-
use, depending on the architec-
oyed, the C/N "headroom" may
to significantly reduce the cost of
al network. This is an advantage
be easily overlooked if the total
rchitecture is not considered in
tion with GaAs technology.

e 7 illustrates this example in
r detail. It presents a comparison of

Figure 7: Coaxial vs. optical C/N

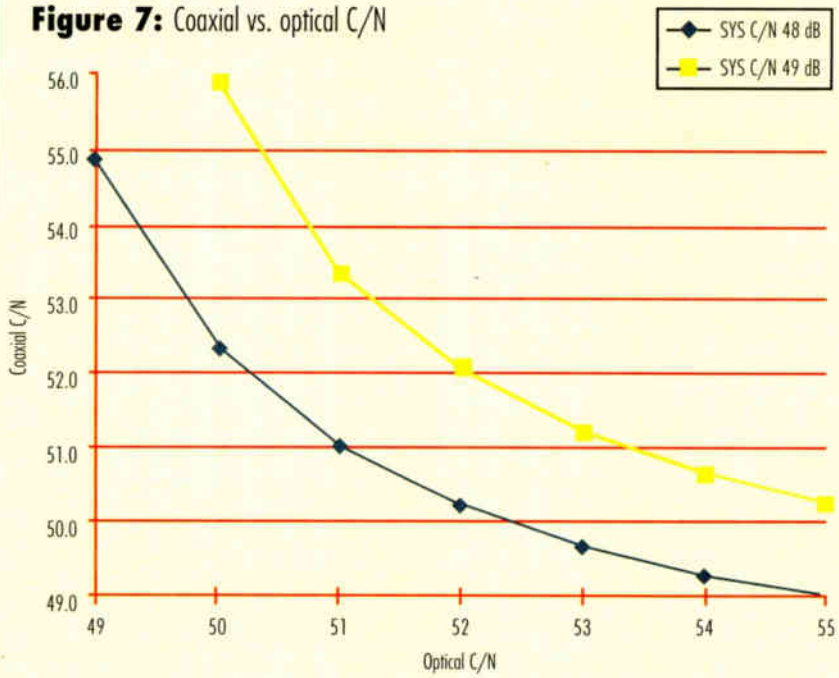


Table 1: Output level vs. distortion performance

Technology		Silicon	GaAs
Frequency (MHz)		52-750 (860)	52-750 (860)
Channel load			
	Analog	77	77
	Digital	200 MHz	200 MHz
Gain (dB)		35	35
Output (dBmV) (52/550/750 MHz)		37/44/37	39.5/46.5/39.5
Noise figure (dB)		11	11
C/N (dB)		60	62.5
CTB (dB)		-69	-69
CSO (dB)		-68	-70.5

*Note: 860 MHz product illustrated @750 MHz

the coaxial C/N contribution vs. the optical link C/N contribution for both a 48 dB and 49 dB total system C/N. HFC networks begin with an optical link providing a C/N of 51 dB to 54 dB, depending upon the application.

Using this range as a starting point, it becomes quite clear that by improving the coaxial C/N contribution by the 2.5 dB that GaAs illustrated in Table 1, a reduction in the optical link C/N contribution ranging from 1.5 dB to 3.6 dB may result. This reduction in optical C/N contribution is relative to the specific application, but it can be used to the operator's advantage in a few different ways.

Use of optical C/N "headroom" includes methods such as increasing optical loss budgets to extend reach, or increasing optical splitting ratios to service more nodes from a laser, or reducing the laser power required—equivalent to as much as a two laser value reduction.

The net result can be a more cost-effective optical network design requiring either lower-cost lasers or fewer lasers, depending upon operator goals.

Combine optical network efficiencies with the savings in the coaxial plant costs due to the reduction in active devices required, and the total system savings can be dramatic.

Based upon sample designs, we've seen reductions in constructed system costs of

Table 2: Output level vs. distortion performance at 94 channels

Technology	Silicon	GaAs	GaAs
Frequency(MHz)	52-750(860)	52-750(860)	52-750(860)
Channel load			
Analog	77	77	94
Digital	200 MHz	200 MHz	100 MHz
Gain(dB)	35	35	35
Output (dBmV)(52/550/650*/750 MHz)	37/44/37	39.5/46.5/39.5	37/44/45.5*/37
Noise figure (dB)	11	11	11
C/N (dB)	60	62.5	60
CTB(dB)	-69	-69	-70
CSO (dB)	-68	-70.5	-71

*Note: 860 MHz product illustrated @750 MHz

as much as $1,000 per mile, directly attributable to GaAs technology. This savings does not include the beneficial effects of enhanced network reliability. As previously stated, a reduction of up to 25% in network amplifiers has been proven in test designs. Add to that the possibility of producing a more efficient optical design that may require fewer lasers and receivers, and we are creating a system with fewer points of failure, a potential for reduced maintenance costs and an overall reduction in power consumption.

Of course, the performance "headroom" that GaAs produces also may be used in other ways dictated by circumstances. We are all familiar with those systems that require "special handling" because of their restrictive topologies.

For example, low density systems, or those with limited strand continuity, may not benefit as much by using the excess performance of GaAs in the form of increased amplifier operating levels. These systems may derive more benefit by applying the more typical operating levels consistent with silicon products and using the performance "headroom" of GaAs in the form of extended amplifier cascades. This alternative application can result in as much as a 40% increase in coaxial reach that translates into more reasonable node sizes and a reduction in optical transmitters and nodes.

Next, we can consider another possibility that GaAs creates: the ability to utilize its performance "headroom" to increase channel loading to 94 analog carriers while maintaining the same system design "footprint" and performance objectives as created by a 77 analog channel silicon design.

Many operators are finding this a worthwhile alternative for an insignificant increase in system cost. Generally speaking, our test designs have indicated that for as little as a 2% to 3% increase in system cost, an increase in analog channel capacity of 24.6% is possible. Having the capability of transporting 17 additional analog channels for so minimal an increase in cost offers many operators a certain peace of mind against becoming "channel bound" in the future as services continue to evolve. Table 2 extends the data presented in Table 1 with a 94 analog channel example.

Note that the operating levels in the fourth column (GaAs 94) illustrate a direct relationship with the second column (silicon 77). This means that a system design footprint created with silicon products for 77 analog channel loading to 550 MHz plus 200 MHz of digital loading to 750 MHz can be maintained and extended to 94 analog channel loading to 650 MHz plus 100 MHz of digital loading to 750 MHz. In this instance, using GaAs technology, the active device count and the end-of-line performance remain constant.

Need proof?

Now that we have discussed some of the alternative applications that make GaAs such a valuable tool, we can move on to review the results of an actual sample design case study.

During the past couple of years, General Instrument has conducted numerous sample test designs for various customers as well as for our own research.

These design studies were perfor
upon numerous systems featuring d
variety of topologies and densities. Ma
variables included architectu deta
mance objectives, node sizes
cable types.

The common element in e
was the significant improver
by GaAs over the silicon bas
Each test design exhibited r
active device use, equipmen costs a
constructed system costs.

In order to illustrate an exam
power of GaAs, we have chos
cently performed design. For
customer confidentiality, it would be
propriate to identify the specific loc
of the design; however, all the parame

BOTTOM LINE

GaAs at a Glance

Initially developed for military
crowave applications such as t
wave tube (TWT) solid state
ments, Gallium Arsenide fie
transistors (GaAsFETs) ha
steadily over the years in
mance and reliability.

In the last few years
brid manufacturers h
hybrid amplifier pr d
ment plans incorpor
conductors. The pa e styles,
operating voltage and RF perfor
targets have varied quite a bit fr
vendor to vendor, but all have c
erable potential, including:

- Lower cost optical and coaxial
  works
- Fewer active devices/less respac
  required
- Improved network performan
  reliability
- Reduced power consumption
- Lower maintenance costs
- Increased channel capacity
- Less cable replacement in upgra
  and underground applications
- Expanded reach in low density ar

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Table 3

Scenario	1	2	2A	3
Technology	Silicon	GaAs	GaAs	GaAs
System type	Upgrade	Upgrade	Upgrade	Upgrade
Original frequency	52-450	52-450	52-450	52-450
New fwd. frequency	52-550/750	52-550/750	52-550/750	52-650/750
New rev. frequency	5-40	5-40	5-40	5-40
Channel loading	77A + 200 MHz D	77A + 200 MHz D	77A + 200 MHz D	94A + 100 MHz D
Mileage	14.18	14.58	14.58	14.18
Homes passsed	2,246	2,261	2,261	2,246
Homes/mile	158	155	155	158
Nodes required	4	4	4	4
Average homes/node	562	565	565	562
Cascade	N+5	N+5	N+5	N+5
Performance				
Link C/N	52.0	52.0	50.0	51.0
Coaxial C/N	51.9	55.3	55.3	53.8
System C/N	48.9	50.3	48.9	49.1
System CTB	-53.2	-53.2	-53.2	-54.9
System CSO	-55.5	-57.1	-57.1	-57.8
Nodes/transmitter	2	2	3	2
Transmitters/mile	0.14	0.14	0.09	0.14
Nodes/mile	0.28	0.28	0.28	0.28
Amplifiers/mile	5.43	4.86	4.86	5.43
Total actives/mile	5.85	5.28	5.23	5.85
% Active reduction	Baseline	-10%	-11%	0%
Taps/mile	36.30	35.72	35.72	36.30
Passives/mile	6.76	9.32	9.32	6.76
Power supplies/mile	0.42	0.27	0.27	0.42
New cable/mile (ft.)				
625	274	246	246	274
Fiber sheath/mile (ft.)	588	572	572	588
Installed cost/mile				
Total	$9,964	$9,401	$9,082	$10,190
$ Savings/mile	Baseline	-$563	-$882	$226
% Cost/variation	Baseline	-6%	-9%	2%

Note: Installed cost includes optoelectronic equipment, RF equipment, fiber and coaxial cable, power supplies, connectors and installation labor. Excludes make ready, set-tops and headend.

and results can be discussed in detail.

The case study presented does not represent a preselected optimum design area or best-case result. On the contrary, it represents a system with atypical topology (poor strand continuity with limited cross ties and extensive rear easement construction). More accommodating topological areas would yield substantially better results than those illustrated.

Table 3 summarizes the case study in detail. Scenario 1 presents the results of a silicon design used as a baseline.

Scenario 2 presents the same area optimized with GaAs for the same analog channel loading by increasing RF amplifier levels in the coaxial portion of the system. Note the improvement in C/N.

Scenario 2A further optimizes Scenario 2 by using the C/N "headroom" of the coaxial network to increase optical transmitter splitting ratios.

Scenario 3 presents a GaAs drop-in to Scenario 1's design but increases the analog channel loading. Target system performance for the sample design area was +48 dB C/N, -53 dB CTB and CSO. It should be noted that this case study is based upon an upgrade of an existing 450 MHz system. Additional savings result when a new build system is considered.

Conclusion

GaAs is the next generation technology that can provide a vehicle to more reliable, lower-cost networks. The strength and flexibility of GaAs in various applications indicate that it has the potential to be perhaps the most important technological development for the cable industry since the introduction of fiber-optics into networks.

Once again, consider the potential and the options available with GaAs.

- Lower cost optical and coaxial networks
- Fewer active devices/less respacing required
- Improved network performance and reliability
- Reduced power consumption
- Lower maintenance costs
- Increased channel capacity
- Less cable replacement in upgrade and underground applications
- Expanded reach in low density areas

The technology is now available to fulfill a need that has long existed. Realize the potential and take advantage of the opportunity to deploy this technology to your greatest advantage. CT

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1) C. A. Mead: Proc. IEEE, 54 (1966) 307.
2) E. Lum, Dataquest/Gartner Group: 1997 IEEE GaAs IC Symposium, Anaheim, CA.

Phil Miguelez is senior research and development engineer, Gary Picard is director of hardware engineering, and Fred Slowik is director of systems marketing, at General Instrument. They can be reached at (800) 523-6678.

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How TV-Based Internet Services CAN BE DELIVERED *Over a* Cable Network

By Paul M. Zislis

Internet growth has been phenomenal in terms of information content and services, as well as public acceptance. With the large deployment of personal computers (PCs) in homes, Internet access is easy and affordable for consumers with PCs. However, the majority of Americans do not have PCs in their homes because of cost, limited knowledge of technology or both. For Internet access to become really ubiquitous, these barriers must be overcome. ➤

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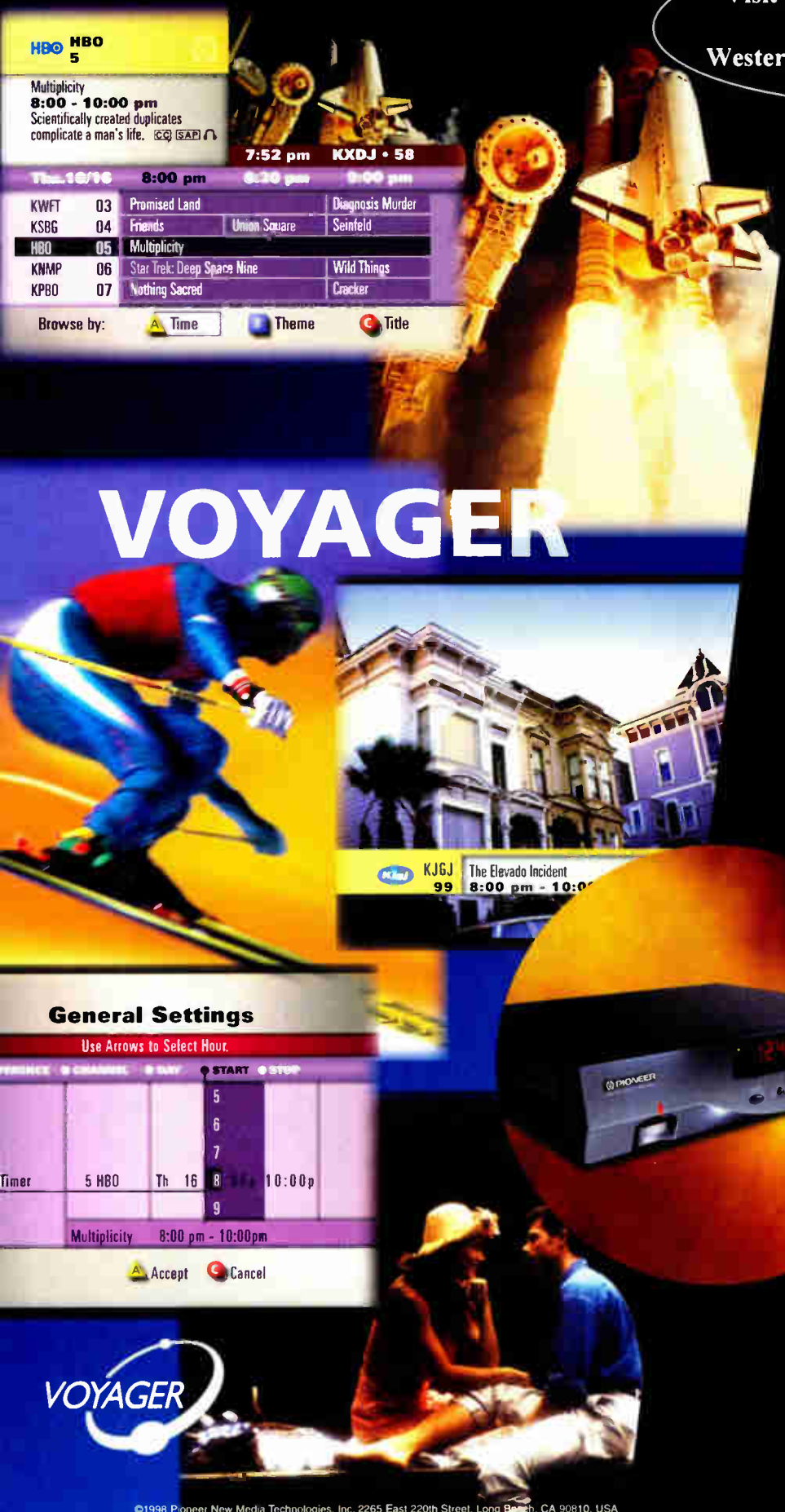

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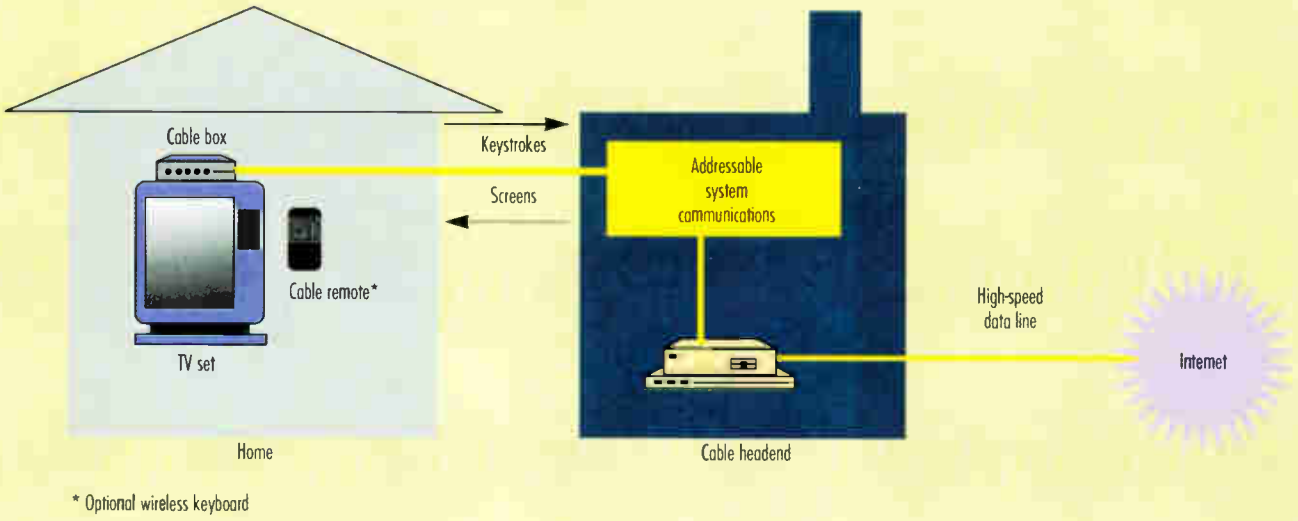
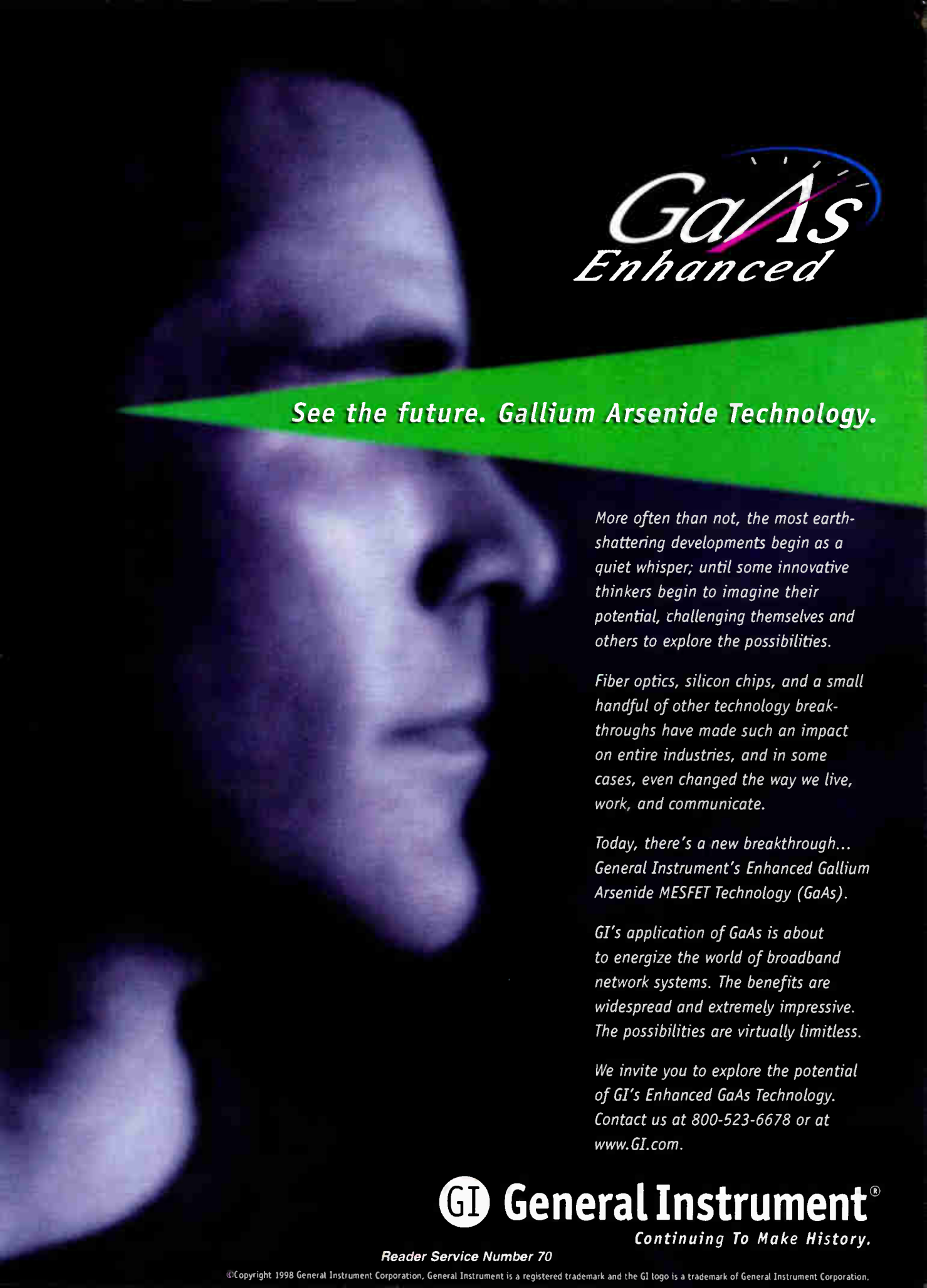
Figure 1: TV-based Internet service system architecture



The cable industry is uniquely capable of providing Internet services to the mass consumer market. Existing two-way cable distribution infrastructure can be used for communications between the consumer and the Internet.

The cable headend can provide processing and storage resources shared by multiple consumers to provide a highly cost-effective deployment. Standard advanced analog and digital cable converters have sufficient local processing power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to act as remote display controllers and communications devices. TV sets can act as displays, and cable remote controls or wireless keyboards can be used for consumer input.

For discussion purposes, this article is based on one type of TV-based Internet service available today.

The service

With a TV-based Internet service-enabled cable system, cable subscribers access the Internet through their cable converter boxes. Using a remote control or optional wireless keyboard, surfing the Web is as easy as switching the channel.

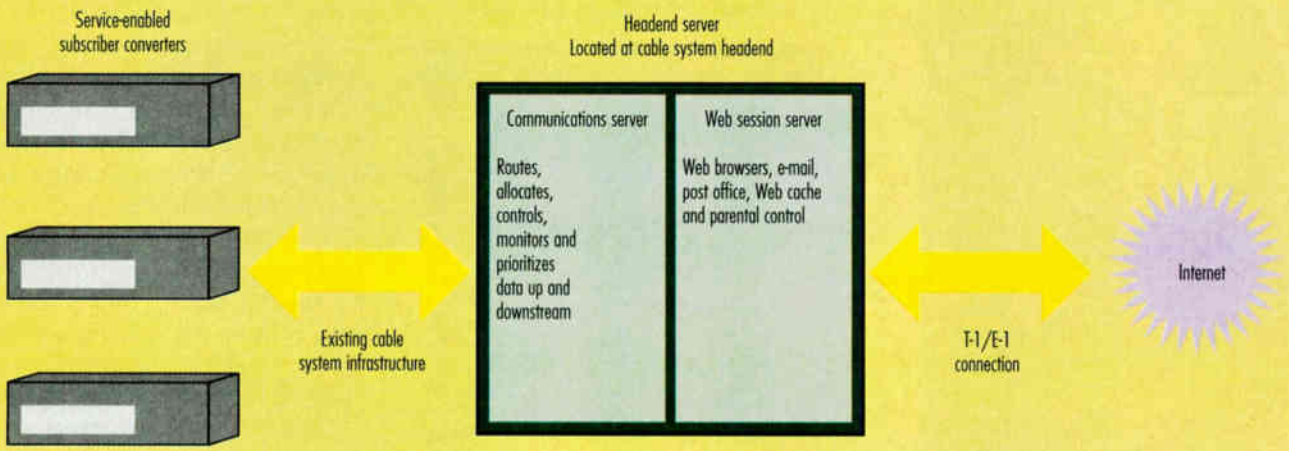
> "The TV-based Internet service can coexist with cable modem installations for operators interested in deploying both technologies."

With Internet access software and hardware located at the cable system headend, subscribers don't have to worry about upgrading equipment at home. Upgrades and performance enhancements occur at the cable system level, so only a single upgrade at the headend is needed to serve all service subscribers.

While the service supports general Internet access, it also provides access to an extensive content package, provided by partners who tailor their content for operation with the service.

Additionally, it includes a unique means of linking TV content with Internet content, enabling the cable subscriber to move directly between TV programming and related content on the Internet with a single keystroke on a standard cable remote. Currently, more than 80 cable networks are working to establish the enhanced Web

Figure 2: Centralized headend processing



content that will be associated with their TV content.

The TV-based Internet service operates on advanced analog as well as digital service platforms in order to support a variety of cable system configurations. Specific configurations can be engineered in cooperation with cable operators.

System architecture

The technology underlying the service was designed to provide inexpensive, sustainable, high-performance Internet access that is scalable, easy to use and requires no additional equipment investment by consumers. It consists of three components:

- Hardware and software incorporated into the cable converter box
- Hardware and software connected to the cable headend
- Wireless infrared (IR) cable remote control or optional keyboard

Figure 1 (on page 106) illustrates the system architecture at a high level. Two key features of the architecture are:

1) The centralization of client-related processing at the cable headend with minimal functionality in the cable converter
2) The conversion of the two-way addressable communications system currently implemented by many cable converter manufacturers from a non-real time (store and forward) to a real-time communications system

Centralized headend processing

At the cable headend, the architecture includes a server connected to a local area

network (LAN) and to the Internet. At the cable headend, data input from subscribers is processed by the system hardware and used by a communications server and a Web session server to establish an Internet session.

The Web session server also processes session data from the Internet and sends it to a TV-based Internet service-enabled converter for presentation on a TV screen by rendering and resizing the graphics and text. Figure 2 (on page 109) shows the primary control functionality implemented at the cable headend.

The headend server has a multi-processor architecture, allowing for many simultaneous active Internet sessions. The system is specifically designed to scale for increases in cable system usage.

Loading it with more than the number of Internet sessions for which the service is sized will not block any log-in attempts, a problem often associated with telephony-based systems. Instead, excessive load results in proportionately longer graphic rendering times.

The scalable system architecture allows cable system operators to respond to such an increase in subscriber demand by simply adding headend servers.

Converter box platforms

Historically, two-way addressable cable systems have stored data in the converter and held it for an indefinite period of time. An electronic "request for retrieve" message is required for the converter to transmit the contents of the data to the cable system headend.

With the TV-based Internet service-enabled cable system, the subscriber's request transmits in real time to the cable system headend.

The headend immediately processes data requests, sending a response back to the converter in real time using either the vertical blanking interval (VBI) portion of the TV signal (analog systems) or a full-channel quadrature amplitude modulation (QAM) signal (digital systems).

Because all information is located at the headend, the converter maintains only the software and hardware necessary to communicate with the headend server, requiring no additional storage capacity. A headend communications server regulates and monitors upstream and downstream communications with all cable boxes controlled by that particular headend.

BOTTOM LINE

The Benefits Of TV-Based Internet Service

Consumers: Settle back, relax, pick up your cable remote and surf the 'Net. Forget buying a personal computer (PC) or modem or standalone set-top appliance. Forget tying up a phone line. Forget $20+ per month Internet service provider (ISP) subscription fees. Using your standard advanced analog or digital converter, your cable remote and subscribing to the TV-based Internet service from your local cable operator, you can log in to the Internet in a few seconds.

One push of a button on your remote takes you to the Internet or back to television. You can check sports scores, stock prices, the weather, find information about local restaurants or community events, e-mail, shop, and access the vast array of information and services available on the Internet. A single button push also will take you from the TV program you are watching to a Web site that provides additional program-related information. The Internet now can be as easy to use and affordable as cable TV.

Cable Operators: Here is a technology that will enable you to tap into new revenue streams. It leverages your existing, costly cable infrastructure. It is easily integrated with a cable modem deployment. Providing branded local community information and e-mail addresses will help you build consumer loyalty. You can gain additional community appreciation via the affordability and ease of use by consumers that makes the Internet accessible to the mass market.

A series of bit maps, each representing the content of a single TV screen, are compressed, encoded and transmitted to the converter. After decrypting and decompressing the data it receives, the converter displays the image on the TV screen.

Both the analog platform and the digital platform have a robust return path to facilitate operations in standard two-way plant.

Analog service platform

The analog platform uses VBI encoding for its downstream path, offering peak speeds of 128 kbps downstream and 14-20 kbps upstream, up to 16 million colors, as well as a very small software client of approximately 64 kB in the cable box.

The relatively slow upstream data path is entirely adequate to support the TV-based Internet service since only keystrokes are sent from the cable converter to the headend.

Digital service platform

The digital platform uses the MPEG-2 (Moving Pictures Experts Group) stream for its downstream path, providing peak speeds of 27 Mbps downstream and 256 kbps upstream, with 16 million colors, maximum TV resolution, and audio and video streaming. In addition to Internet access, the installation of the digital platform facilitates the cable operators' ability to provide other services, such as video-on-demand (VOD).

Integration with cable modems

The TV-based Internet service can coexist with cable modem installations for operators interested in deploying both technologies. However, it can operate with a much noisier return path than cable modems.

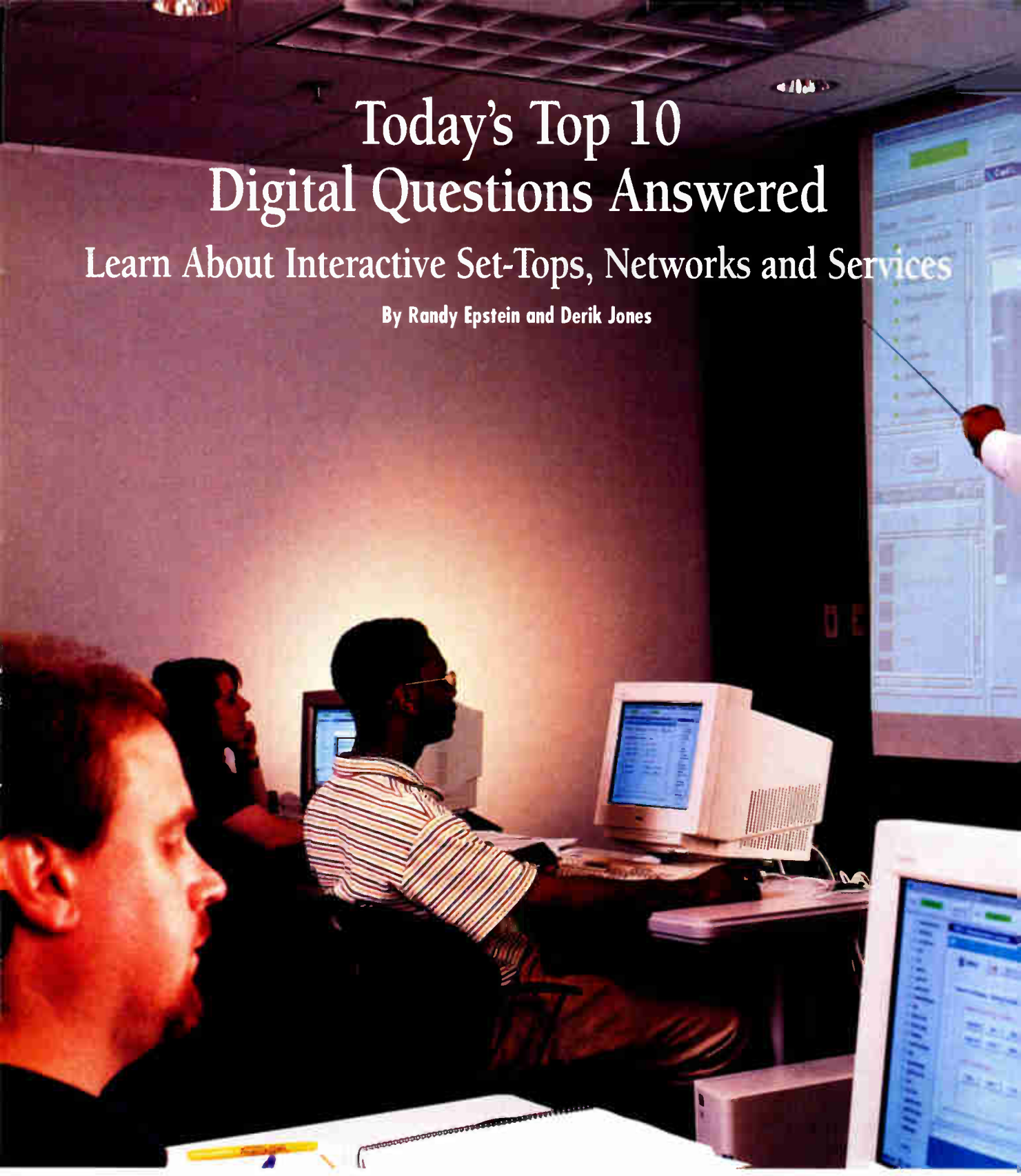
It can share servers and Internet connections with cable modems. In the cable distribution plant, the cable operator can allocate different frequency ranges to the service and to cable modems in order to ensure collision-free, simultaneous operation of the two services. CT

Paul Zislis is vice president of strategic systems at WorldGate Communications. He may be reached via e-mail at pzislis@wgate.com.

Today's Top 10 Digital Questions Answered

Learn About Interactive Set-Tops, Networks and Services

By Randy Epstein and Derik Jones



Derik Jones instructs his students about the digital network control system (DNCS) during a class at Scientific-Atlanta Institute. Among the courses Jones teaches are "Introduction to Digital Video" and "Activating and Operating Digital Systems."

With digital interactive networks rolling out throughout the United States and Canada, operators are preparing all levels of personnel to understand these new technologies.

Digital interactive networks will enable a host of revenue-generating services including video-on-demand (VOD), e-mail

and e-commerce. And with true interactivity comes a sea change in the way operators are designing, implementing and managing the network.

In response to the implementation of digital interactive technologies, a new set of frequently asked questions (FAQs) is emerging. Listed below are questions that often are asked of instructors at digital training programs.

1) How will the introduction of digital interactive networks change job skills requirements?

As operators install end-to-end digital networks, employees working in today's analog environment will need to learn new network architectures and applications. Concurrently, members of the staff who traditionally specialize in management information system (MIS) or information technology (IT) areas will need to learn fundamentals of the cable network. That's why it's important for operators to provide training courses for all skill levels and prepare their workforce for all aspects of the digital equation.

2) What role does the digital network control system (DNCS) perform, and how does it control the network?

The DNCS is a next-generation element and network manager for digital cable networks. It brings modern software, networking and network management technology to bear to control all aspects of the digital interactive network.

Running today on a Unix/Sun platform with a highly graphical user interface (GUI), the DNCS executes applications, provisions advanced digital set-tops and system components, creates services and performs network management. DNCS now allows operators to proactively manage a client/server-based network.

3) What are the network requirements for offering interactive services?

Networks offering interactive services require implementation of a fully operational two-way digital network. Delivering interactive services requires integration of the traditional hybrid fiber/coax (HFC) architecture with a high-speed Internet protocol (IP) data network architecture.

4) What's different about new advanced digital set-tops?

These set-tops feature advanced communications interfaces necessary for processing various interactive applications such as VOD. In addition, each advanced digital set-top has an IP address, a 54 MIPS (million instructions per second) processor, resident flash memory and dynamic random accesss memory (DRAM), which provides ample processing power and memory to support interactive applications and provide room for accommodating future applications.

5) Do new networks support both analog and digital services?

Digital and analog services will co-exist on future networks. Although they each have their own management systems, it is possible for set-top terminals of both the digital and the analog or advanced analog

BOTTOM LINE

Digital Q&A

Digital interactive networks are launching all over, and operators are preparing all levels of their personnel to understand these new technologies.

In response to the emergence of digital interactive technologies, certain questions appear repeatedly. Listed below are 10 that often crop up in digital training programs. Get the answers to these common queries in the accompanying story.

- How will the introduction of digital interactive networks change job skills requirements?
- What role does the digital network control system (DNCS) perform, and how does it control the network?
- What are the network requirements for offering interactive services?
- What's different about new advanced digital set-tops?
- Do new networks support both analog and digital services?
- How do you differentiate between various pay-per-view (PPV) services?
- What new services will be available?
- How will the user operate an advanced digital set-top?
- What is the role of IP on these new digital networks?
- How does network security differ in a digital cable network?

variety to be deployed simultaneously.

To augment their customer bases and provide additional set-tops for subscriber homes, operators will offer a mix of analog and digital set-tops on their networks. Soon, newer digital service offerings will include VOD, e-commerce and Internet access.

6) How do you differentiate between various pay-per-view (PPV) services?

PPV permits subscribers to place a phone call to order and receive a video event at a predetermined time.

Impulse pay-per-view (IPPV) permits the subscriber to purchase a video event at a predetermined time using the remote control.

True VOD will deliver subscribers immediate access to a library of video events. Subscribers can play, pause, fast-forward and rewind in real time during a video event.

7) What new services will be available?

The digital network platform is an open system that supports the development of new applications beyond what traditionally has been offered by cable operators.

New services are the key to increasing revenue through the digital interactive cable network. In fact, most digital systems will have an application server at the headend designed to run third-party applications. Because the advanced digital set-top supports hypertext markup language (HTML) and other middleware scripting languages, many applications written for the personal computer (PC) can be transferred to the TV environment.

New software applications can be written to enable subscriber services such as home banking, home shopping, video teleconferencing and unified messaging.

8) How will the user operate an advanced digital set-top?

A remote control device is designed to work in tandem with an advanced digital set-top. The remote control is similar to the one used with advanced analog set-tops. It is highly customizable to enable features such as parental controls, establishing a favorite-channels lineup, setting timers, viewing program descriptions and browsing through channels while watching a screen-in-screen program.

In addition, for Internet browsing and e-mail services on the TV set, there is an optional infrared wireless keyboard that subscribers may use as an interface to the advanced digital set-top.

9) What is the role of IP on these new digital networks?

Most devices in an advanced digital interactive cable network, including the set-top, have an IP address. Transmission control protocol/Internet protocol (TCP/IP) is used to provision and control network elements.

Following the model of a local area network (LAN), a cable network uses TCP/IP to relay video, voice and data messages between the client (advanced digital set-top) and the server (digital network). IP provides a network-level protocol for digital networks. It facilitates the addressability of the set-top and allows a greater level of flexibility in managing, maintaining and monitoring the network.

10) How does network security differ in a digital cable network?

The digital interactive cable network features conditional access (CA) systems for selective access and denial of specific services. Signal security techniques such as encryption prevent a signal from being received by anyone other than authorized users.

Contemporary CA systems use a public/private key (PPK) to support authentication of content and its source through "digital signatures." Just as written signatures verify the author of a document, digital signatures identify the sender of a message and verify that the received message is the unaltered original. A PPK CA system paves the way for scalable, spontaneous e-commerce with secure messages to and from subscribers. This security method is the only way to take full advantage of the interactive network.

Issues such as security will be top priorities as the digital interactive network continues to expand with new deployments and services. With proper training about these new technologies, operators will stay ahead of the curve and lead the charge in providing digital interactive services to subscribers. CT

Randy Epstein and Derik Jones are senior training specialists at the Scientific-Atlanta Institute in Norcross, GA. Epstein can be reached via e-mail at randy.epstein@sciatl.com, and Jones can be reached via e-mail at derik.jones@sciatl.com.

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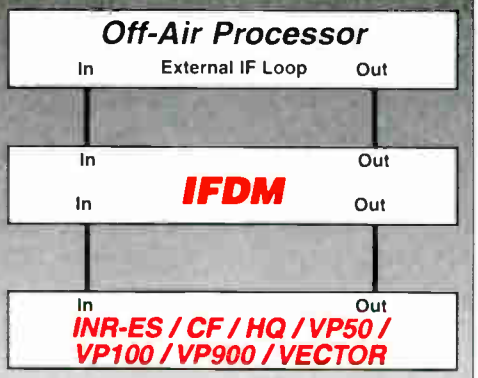

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Reader Service Number 78

There is No Quick Fix in Training

Why You Must Invest the Time and Money

By Rod Bennett

If you're looking to make a positive impact on your bottom line, your first consideration should be your training budget. Increase it!

The need for experienced technicians is paramount to the success and survival of a cable operation. Think back to as recently as five years ago. The Internet was just being embraced by the world, most of our cable systems were operating between 300 MHz and 450 MHz, and "fiber-optic" was the buzzword. Things have changed a lot in that short time, and training has had to keep up.

Technology is changing faster than at any other time in cable's history. And if a company fails to continually train its people, its very future is at great risk.

Start with the management staff

Proper planning and development of a company's training program is vital from the get-go.

And what's most imperative to remember is that before the program even gets off the ground, training will have to have the total support of management. If the management staff isn't behind it 100%, the project is destined for certain failure.

Definitive goals must be established. It is necessary to take the time to decide where management wants the training program to be one, three and five years down the road. Once they decide where they want the program to be, it's time to get them to commit a place in the budget for it.

Training turmoil

How many times over the years have we all seen a classic example such as this: A new cable technician comes into work his very first day and is eager to start training. He rides with an experienced technician who is supposed to do that training. Then an outage occurs, the truck breaks down, or a sudden crisis in the network arises.

So now the last thing the experienced technician has time to do is train the new tech. Unfortunately, because of these outages and other crises that take up the experienced tech's time, it turns out that the new tech is trained in only a few of the basics over the next two weeks.

Now it's time to go out on his own. After all, he is costing the company money if he's not out in the field being productive.

After his two weeks of "training," the new tech starts to work on his own trying the best he can to complete a service call. What happens if he encounters an ingress call on a big-screen TV set with picture-in-picture capability and a couple of videocassette recorders (VCRs) connected to it, plus three additional outlets in the home?

While this hypothetical service call isn't typical, it's fair to say this new technician has very limited ability to successfully complete all the service calls he receives. Our new technician needs further assistance in completing these calls.

We all have lived or seen scenarios like this in our cable careers. What's the solution? Take some time from the start and invest in the technician. And the best place to begin is at the beginning. Start your training program with the basics of what the industry is all about.

SCTE can help

The Society of Cable Telecommunications Engineers Installer program manual is packed with 560 pages of information on how cable works from the back of a TV set to the tap. (Remember that more than 75% of service calls are situations that can be corrected from the back of the TV set to the tap.)

Think how much more knowledge the technician would have at the end of one week of studying the SCTE Installer Manual as compared to riding two weeks with a technician. If you have the new tech

BOTTOM LINE

Support Training Programs

With training, there's really no such thing as a "quick fix." It is an ongoing investment and commitment. Technology is changing faster than at any other time in cable's history. And if a company fails to continually train its people, its very future is at great risk.

Proper planning and development of a company's training program is vital from the get-go.

And what's most imperative to remember is that before the program ever even gets off the ground, training will have to have the total support of management. If the management staff isn't behind it 100%, the project is destined for certain failure.

Definitive goals must be established. It is necessary to take the time to decide where management wants the training program to be one, three and five years down the road. Once they decide where they want the program to be, it's time to get them to commit to a place in the budget for it.

study the manual first, then ride in the field with an experienced technician, you will see immediate results in how he or she performs the job.

It's important not to skip over the basics. Start the training at the most primary level of our industry. From there, develop a progressive program designed to build on the skills and craftsmanship of the technician.

Take some time to decide what technicians should know, and guide them with clear, obtainable objectives. For example, when they understand the workings from the TV set to the tap, proceed to the workings of the feeder, then to the amplifier.

Over the last five years, technology has changed so much that you can no longer use all the training material you have in the past. Today, for your organization to be successful, you must have the latest information concerning what is new in the marketplace.

One way to keep up is to take advantage of the trade publications available in the industry. Use the articles within them as a training tool. Also take advantage of the latest SCTE materials and resources. Implement a regular training time each week to study these materials.

"Remember that more than 75% of service calls are situations that can be corrected from the back of the TV set to the tap."

Learning styles

The way each tech learns and develops his or her craftsmanship is always different. Some people can learn by reading a book, others learn by observing, others learn by doing, and still others learn through various combinations of all three.

There are many different styles of seminars, workshops, regional training sites and correspondence courses you can take advantage of. And don't forget that most vendors are more than willing to talk about their products and demonstrate how they work.

With training, there's really no such thing as a "quick fix." It is an ongoing investment and commitment.

The cable industry is at the cutting edge of technology. Everyone wants the bandwidth capacity and the unlimited potential offered by cable today. Regardless of who the company is, there always will be a need for quality technicians. The only way to achieve these results is through training.

Rod Bennett is technical training manager at the Kansas City division of Time Warner Cable. He may be reached at Rod.Bennett@tw.com.

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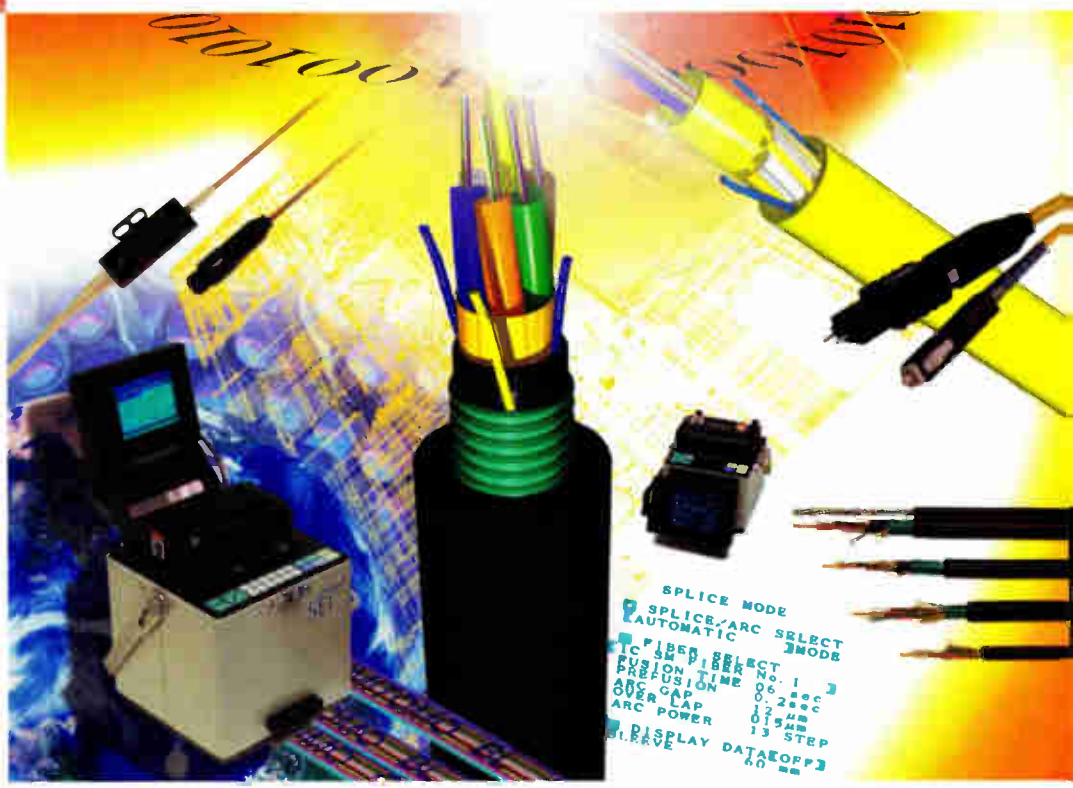

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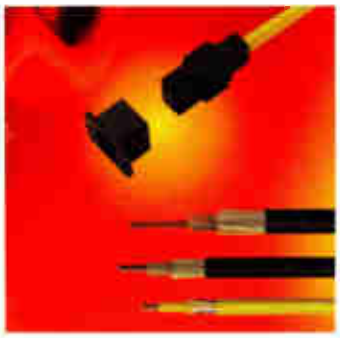

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Keep Field Test Gear Healthy and Productive

Self Tests Can Augment Factory Calibration

By Erney Nikou

I have been involved with testing and calibrating test equipment for more than 20 years. One of the most frequently asked questions from my customers is, "How often should I check and how often should I calibrate my field test equipment?"

The bottom line is that there is a different answer for almost every situation. There must be a balance between productivity and quality (perfection) to allow for a good bottom line (happy customers and good profit).

Greater demands

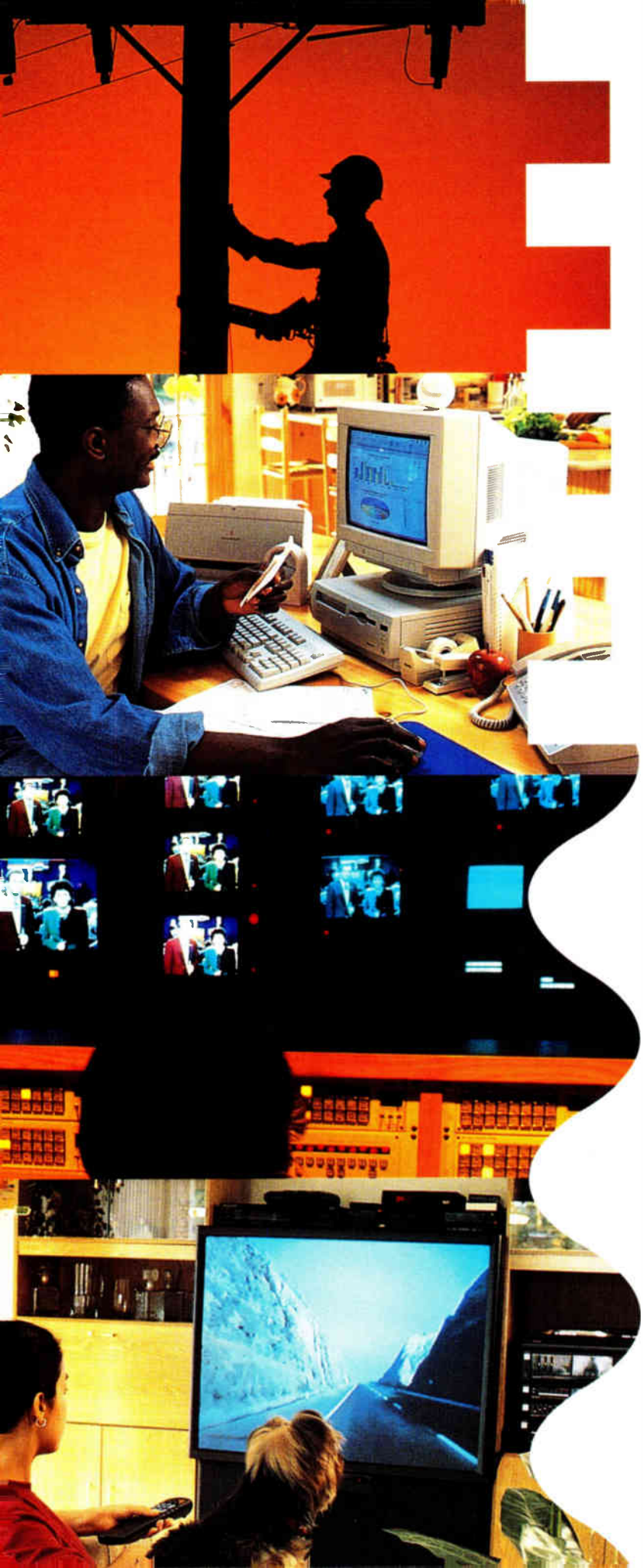
The cable TV industry has become more technologically sophisticated in the past several years. Today, the use of out-of-tolerance equipment to align a system can be devastating.

Customers are more demanding of the picture quality and system availability. The high-speed digital services destined to be offered, and the return path where they will travel, require accurate measurements and precise adjustments to perform properly.

This combination of critical requirements has pushed the cable TV industry into a similar situation as the test and measurement (T&M) industry. Both require extremely accurate test equipment with guaranteed traceability to national standards to meet customers' demands. In addition, cable TV field test equipment is exposed to extra stresses introduced in the field. This environment requires extra testing or "quality checks" between factory calibrations to help ensure proper performance.

Stresses from the environment or field situations such as temperature extremes, drops or over-voltages can cause changes in equipment accuracy. This is where some manual checks might just help eliminate misalignment, major system problems, customer complaints and expensive rework.

This article explains some simple manual tests the user can perform to help gain reasonable confidence in instrument performance between factory calibrations. ➤



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BOTTOM LINE

Check Gear Between Calibrations

"How often should I check and how often should I calibrate my field test equipment?"

The bottom line is that there is a different answer for almost every situation. There must be a balance between productivity and quality to allow for both happy customers and good profit.

In general, a regular self-test will help you better define how often to verify field test equipment operation (between specified factory calibration intervals). This self-test also may help you to reduce the risk of out-of-tolerance equipment being used out in the field.

The examples and suggestions offered are "rules of thumb" and should be adjusted to satisfy your exact needs. Trial and error and careful, accurate data collection can yield a good quality self-test system. This in turn will increase your confidence that proper measurements are made during system testing and alignment.

Finally, there is no substitute for a complete factory-approved calibration. The self test described can be a valuable tool for weeding out major accuracy problems between calibration intervals, but is not a substitute for an annual factory approved calibration and performance test.

In addition, this article includes several cautions that stress the limited capability of manual equipment testing. The user must understand that there is a greater chance for errors when performing manual tests to verify the accuracy of highly sensitive test equipment.

How the factory does it

Typical test equipment manufacturers have departments staffed with engineers and technicians devoted to developing and maintaining accurate test systems. Factory calibration systems with calculated accuracy and uncertainties are very complex and require regular calibrations and quality checks to guarantee proper performance.

Keep this in mind while determining what manual tests to perform and how much trust is placed in those tests. If there is any concern, use the manufacturer's calibration service for a complete calibration.

Doing your own testing

In general, a regular self-test will help you better define how often to verify field test equipment operation (between factory calibrations). This self-test also may help reduce the risk of out-of-tolerance equipment being used in the field.

The examples and suggestions offered are "rules of thumb" and should be adjusted to satisfy your exact needs. Trial and error, and careful data collection, can yield a good quality self-test system. This, in turn, will increase your confidence that proper measurements are made during system testing and alignment.

The following environmental stresses play an important role in determining how often to perform a self test.

Harsh use: Unsecured rides in the back of vehicles, drops on concrete, use as a chair or footstool on occasions (don't laugh), exposure to heavy rain and regular exposure to temperatures outside the 0° C to 50° C range.

Moderate use: Rides in the front or back seat secured, occasional falls on floorboards, exposure to light rain, occasional exposure to temperatures outside the 0° C to 50° C range.

Pampered: Never rides without a seat belt and airbag, never experiences a drop to the floor, never given a bath (only wiped off gently with a warm wash cloth), never exposed to temperatures outside the 0° C to 50° C range. For all intents and purposes, this equipment is treated like lab-grade test equipment.

Drift: Equipment drift sometimes is difficult to specify, but basically, everything ages and changes. Most manufacturers of measurement-grade test equipment recommend factory calibration at intervals ranging from six months to two years, depending on the type of equipment and its design. This calibration helps to "compensate out" the effects of aging components and mechanical stresses throughout the life of the test equipment.

Frequency of checks

If a pampered unit should be calibrated one time per year, a moderately used unit should be calibrated 12 times per year, and a harshly used unit should be calibrated 52 times per year.

This point is a bit exaggerated, but how frequently a unit is calibrated really is a function of the manufacturer's recommended calibration interval considering any acceleration factors that the environment adds (shock, vibration, moisture, temperature, pole drops and so on).

It isn't practical to calibrate an instrument every week, but if harshly used equipment isn't checked on a regular basis, it will cost you money and customer satisfaction.

So what do you do? It is possible to get a reasonable level of confidence in the accuracy of test equipment by doing some fairly simple checks on a regular basis. However, remember that this is not a 100% perfect solution.

Even with good self checks, it is probable that out-of-tolerance equipment can be missed. There is risk involved with an incomplete test, but remember that a basic test, performed between complete factory calibrations, is designed to help reduce the risk of out-of-tolerance equipment being used in the field.

One method

Although manual self tests encase a small subset of the tests run at a calibration lab, they can be helpful in determining when to continue and when to stop using the field equipment.

RF level accuracy is a common test and the subject of many questions. It is an important measurement throughout many points within a cable TV system.

A host of issues must be considered when choosing test equipment that is used to test other equipment: correct impedance, good return loss, accuracy, level range and so forth. This information must

be determined by the user before putting together a list of the equipment required for the self test.

One method for testing RF level accuracy is to use an accurate power meter. The power meter must be calibrated and traceable to National Institute of Standards and Technology (NIST). It also must be four to five times more accurate than the equipment you are testing. For instance, if your signal level meter (SLM) accuracy is ± 1.5 dB, your power meter must be ± 0.3 dB.

This "higher accuracy" allows for a high confidence level in your manual self test. The higher the accuracy of the power meter, the higher the confidence in the accuracy of your self test. You also will need an RF signal generator. The frequency range depends on your needs. (See the accompanying figure on page 124.)

Checking RF accuracy

Determine critical frequencies and levels used when making day-to-day tests within your system, such as Chs. 4, 10, 40, and 60 at -20, 0, +10, +20, +30, and +40 dBmV. Many more points are required than are shown here.

Make a simple frequency vs. level chart to record your test results.

For this example, we want to test 45 MHz at 30 dBmV. Set the signal generator to 45 MHz and 30 dBmV (-18.75 dBm).

Connect the calibrated power meter directly to the end of the cable that is used to connect to your device under test (DUT). You must "calibrate out" any cable or matching pad losses. You also must verify that the output of the signal generator and the input of the power meter are at the same impedance (such as 75 ohms) as the DUT.

If required, adjust the level of the signal generator to read 30 dBmV on the power meter.

Connect the cable from the signal generator to the DUT and record the measurement.

Repeat these steps for all required measurements.

Unfortunately, there is no magic number of test points that will ensure complete confidence in a field test. If it has been a year since the last factory calibration, it is time for a complete calibration and performance test.

Documentation

Another key for a successful field test process is documentation. In addition to accuracy of the current measurement, you must look for any change from the last set of measurements performed.

Let's assume that the DUT is within published specifications, and within a window (say, less than 0.3 dB) of the last field calibration test. This data gives you reasonable confidence that the equipment is functioning as it did the last time it was tested—at that same frequency and at that same RF level. (See the accompanying table on page 124.)

The table can be organized in many ways. This example shows possible differences in test equipment. Considering the table, units 2, 4 and 5 look normal. Units 1 and 3 have either developed an electrical problem or a physical disturbance causing a shift in measurement accuracy. There also are tolerance build-up problems associated with the test equipment and the cabling used for testing the field gear.

In either case, the out-of-tolerance equipment should be returned to the manufacturer for calibration and/or repair. ➤

Typical signal generator, matching pad, cable and power sensor/meter block diagram

Example of one frequency table required to properly record a field level accuracy check

DUT @ 52 MHz	6-15-98 (10 dBmV)	9-15-98 (10 dBmV)	12-15-98 (10 dBmV)
SLM SN 1111111	9.5	9.6	9.9
SLM SN 1111112	9.7	9.7	9.9
SLM SN 1111113	9.6	9.7	10.5
SLM SN 1111114	9.9	9.9	10.0
SLM SN 1111115	10.2	10.2	10.4

If a measurement is out of tolerance during testing, or changes in excess of 0.3 dB occur within a month (or given time period), it's probably time to send the instrument in for a factory calibration. Drift is very predictable in a lab environment, but somewhat unpredictable in a changing field environment.

Setup tips

There may be a bit of trial and error required to "iron out" a reliable manual self test. I suggest that new or recently calibrated equipment be used to design your self test process. This can help eliminate the problems that can occur by using an old (out of calibration) piece of equipment. Once you verify your test process repeatability and accuracy, you can use the system to check all of your test equipment.

One key to the accuracy of the entire process is tied to the accuracy of the RF power meter used to check power levels from the signal generator. This particular power meter must be pampered and

calibrated according to the manufacturer's recommended schedule at a factory-approved center to keep good confidence in your manual self test system. Remember to use only NIST traceable calibration laboratories. This point is critical for high confidence in your self tests.

Please be aware that passing the simple field verification test is an acceptable way to verify that no major drift has occurred at a few points over some amount of time, but it is not a substitute for a complete factory calibration and performance test.

Factory advantages

A typical factory calibration on modern RF test equipment will check, adjust and verify critical parameters at thousands of frequency points, at thousands of RF levels, at all attenuation settings, throughout the entire linearity range of the instrument.

There typically are other test requirements (hum, carrier-to-noise ratio, spur levels and so on) well beyond a simple RF level test. The original manufacturer can perform the tests exactly as designed, make all of the necessary adjustments, and add engineering improvements or modifications. As an example, performing a complete RF linearity check from -30 dBmV to +60 dBmV for every 100 kHz between 1 MHz and 1 GHz could take days to complete with a manual test.

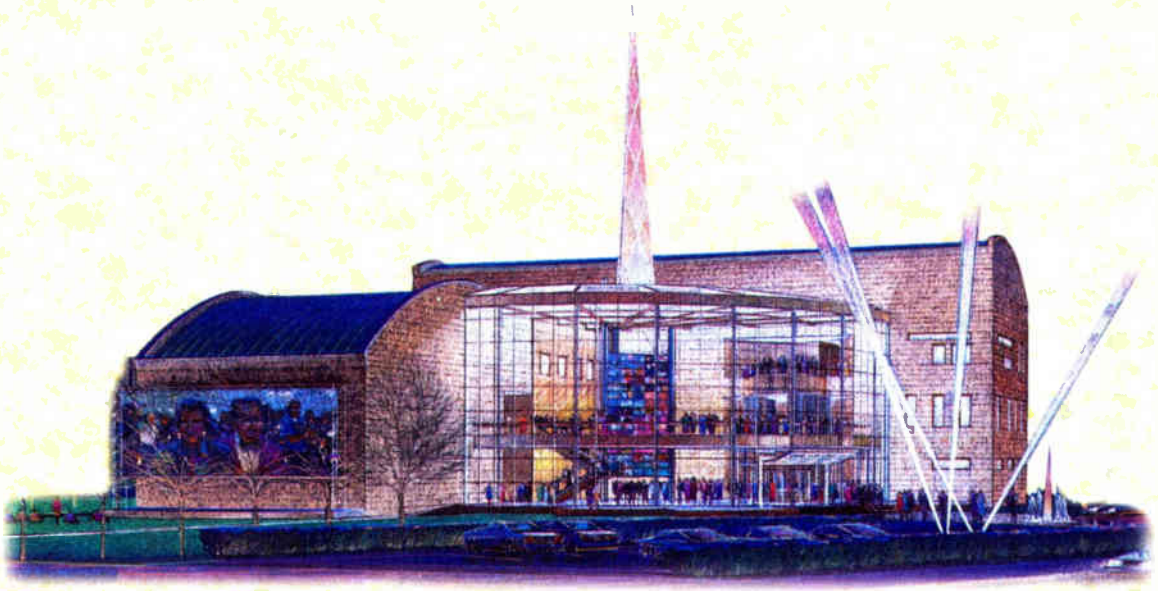
> "It is possible to get a reasonable level of confidence in the accuracy of test equipment by doing some fairly simple checks on a regular basis."

Factory calibration can offer several other advantages including the factory calibration process, installation of the latest software enhancements, engineering hardware improvements and preventive maintenance designed to increase the usable life of your test equipment.

Many factory centers also remove harmful contaminants from the instrument that may cause high impedance shorts and other intermittent problems that can occur in equipment exposed to harsh environments.

Finally, at the risk of repeating myself, there is no substitute for a complete factory-approved calibration. The self test described can be a valuable tool for weeding out major accuracy problems between calibration intervals, but is not a substitute for an annual factory approved calibration and performance test.

Erney Nikou is customer services manager for Wavetek Corp. He can be reached via e-mail at nikoue@wavetek.com.



Denver's Cable Television Center and Museum

Update From the Vortex of the Broadband Universe

By Greta Durr

It began with $1 million and what some critics have called a broadband pipe dream shared by cable industry leaders. Now the National Cable Television Center and Museum's slated 42,000 square-foot facility is mere months away from a springtime groundbreaking in Denver.

The ceremony will mark the birth of a monument to the American spirit embodied for the past 50 years by the pioneers who forged a thriving future for cable telecommunications.

Breaking ground, taking names

"Bill Daniels was the first person to get the ball rolling by donating $1 million to the project to develop a strategic planning analysis for the fundraising part of t[illegible] program which we're in right now," s[illegible] former Society of Cable Telecommunications Engineers President Bill Riker.

Since moving to Denver to work on the project, Riker divides his time between his post as the Center's vice president of operations and engineering and CableLabs, where he is an SCTE liaison on technical standards and development matters.

At the Western Show, we will be announcing the closure of the capital campaign and the official date of the groundbreaking, which will be some time in April. We've been trying to raise in excess of $50 million and have been successful in getting very close to that. Maybe by the Western Show we will be able to hit our mark," says Riker.

As of press date the Center had raised nearly $56 million of its designated $58 million goal, says Riker, and the buzz has it that the facility will be open to the public by the end of 2000.

Where it all began

"It was originally designed to be a museum," Riker says. "That's what the Cable Pioneers had in mind 15 years ago when they started thinking about setting something up to preserve the history of what has been probably one of the very few success stories of industries in this country."

Most technologies, Riker says, came from Europe and were fine-tuned here. Cable TV is unique because it actually is an American-invented industry that has spread worldwide.

"There was an interest on the part of the pioneering community to preserve that heritage," Riker says. "As we did

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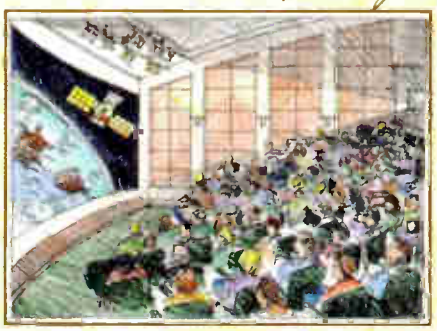
The Hall of Fame

The Library



The Theatre

Center Programming

Outreach Learning Center

The Institute

The Garden

focus groups at different conventions, we realized that the industry was built by entrepreneurs who didn't look back. It shows the mentality of our industry. We've always been looking to the future."

Since the Center has a 200-year lease on the University of Denver campus building site, the location should serve as a permanent beacon to cable industry aficionados and technology enthusiasts everywhere.

"We need to get the word out to the industry as to how much activity will actually take place in this facility," Riker says.

The Hall of Fame Pavilion

"There's a Great Hall, which will be used for temporary exhibits or cleared out for functions such as press conferences, dinners or other presentations," Riker says, adding that upon its completion, it'll seat about 400 people.

"To me, another important section will be the indoor theater, which will have a seating capacity in excess of 200 people. I envision that whenever one of our industry's programmers is going to have a premier, it will take place in the Center Theater."

There also will be an amphitheater on the grounds of the facility. "That amphitheater will be able to accommodate film or live performances. We envision this as a community service to the University and area residents. In the summer, we can show classic films from the industry's past, or host live performances.

Magness Institute

"The Institute will provide extension education programs through not only the University of Denver, but we have affiliations right now with four other universities and hope to expand that ever further."

Riker says he hopes that agreements with DU, Syracuse University in New York, University of Georgia, Pennsylvania State and Michigan State will enlighten future generations of broadband professionals.

"We hope to make the number of schools participating larger as we progress into the future," he says.

To nurture the interactive learning environment, the Institute will house a TV studio. It also will host interactive classes using a return audio line so that questions may be asked from around the country, Riker says.

Demonstration Academy

There will be a demonstration laboratory where the latest equipment can be demonstrated either to a private audience or to the public depending on the equipment that is being evaluated.

"There also will be a number of seminars that will be produced and made available regarding the future of telecommunications," Riker says.

Center Archivist Dave Willis has his eye on the hardware: "It'll have a complete

headend with the latest, state-of-the-art equipment. It'll be a facility that (engineers) can learn a lot from," he says.

Center programs

"This will be the production portion of the center for videotapes that are either created in the Demonstration Academy Studio or from outside locations," Riker says. "Material will be produced and made into usable programs that can then be uplinked to the other affiliate universities or actually any organization interested in receiving them."

This department is expected to engage in partnerships with other organizations, agencies and programmers to produce presentations for global distribution.

Building on an already extensive Web site also will play a major role in the Center's interactive learning repertoire. "Our Web site has gotten more hits per month than any other in the industry," Riker says. "A lot of what we have available can be accessed through our Web site, and further information about the Cable Center's offerings will be updated as we go along into the future."

Diversity on rotation

"We have the Cable Center Museum itself, which will have the themes Freedom in Democracy, Freedom of Choice, Entrepreneurship, Cable Television, the Educational Renaissance, Diversity in Programming and Service to the World. Those are some of the topics that'll be rotated through the exhibits," Riker says.

"Also included will be the Hall of Fame and some demonstrations of, say, a typical house and how cable has affected people's lives who live there," Riker says. Such displays will highlight the positive contributions cable TV and related technologies make to people's everyday lives.

Barco Library and Archives

"The Barco Library is in recognition of George Barco and his family and will provide reference and advisory services to

BOTTOM LINE

Details on the Center and Museum

The National Cable Television Center and Museum aspires to serve the industry and the public by showcasing how the business and the technology have inspired global change.

Leaders from virtually every facet of the industry are working together to make the cable pioneers' dream a reality in the form of a completed edifice in 2000. Groundbreaking at the Center's site on the University of Denver campus is scheduled for April 1999.

For additional information about the Center, call (303) 871-4885 or access its Web site at www.cablecenter.org.

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Reader Service Number 90

individual schools, government agencies and other businesses on the history of the cable television industry," Riker says.

Willis too, has his work cut out for him. "We'll be striving to maintain up-to-date information in the industry as much as possible. I'll be facilitating that to a great degree through the manufacturers who have been very generous with their equipment and their assistance with this whole project. From what I've seen to date, it'll be a significantly dynamic operation," he says, gesturing to the aisles cluttered with historic equipment at the Center's storage area.

Build it, and they will come

Years of careful planning with dedicated staff, volunteers and benefactors will all contribute to the Center's success, Riker says. Members of the cable industry and the general public can share alike in the technological wonders the completed facility will offer. The selection of Denver as the permanent location, he says, enhances the city's reputation as the center of the broadband universe.

"It's been a real hard fight to get people to understand all the things the Center can be," Riker says. "I probably haven't even touched the surface here on what we'll end up doing in the future." CT

Greta Durr is assistant features editor at "Communications Technology." She may be reached via e-mail at gdurr@phillips.com.

Saint Peter of Cable's Gate

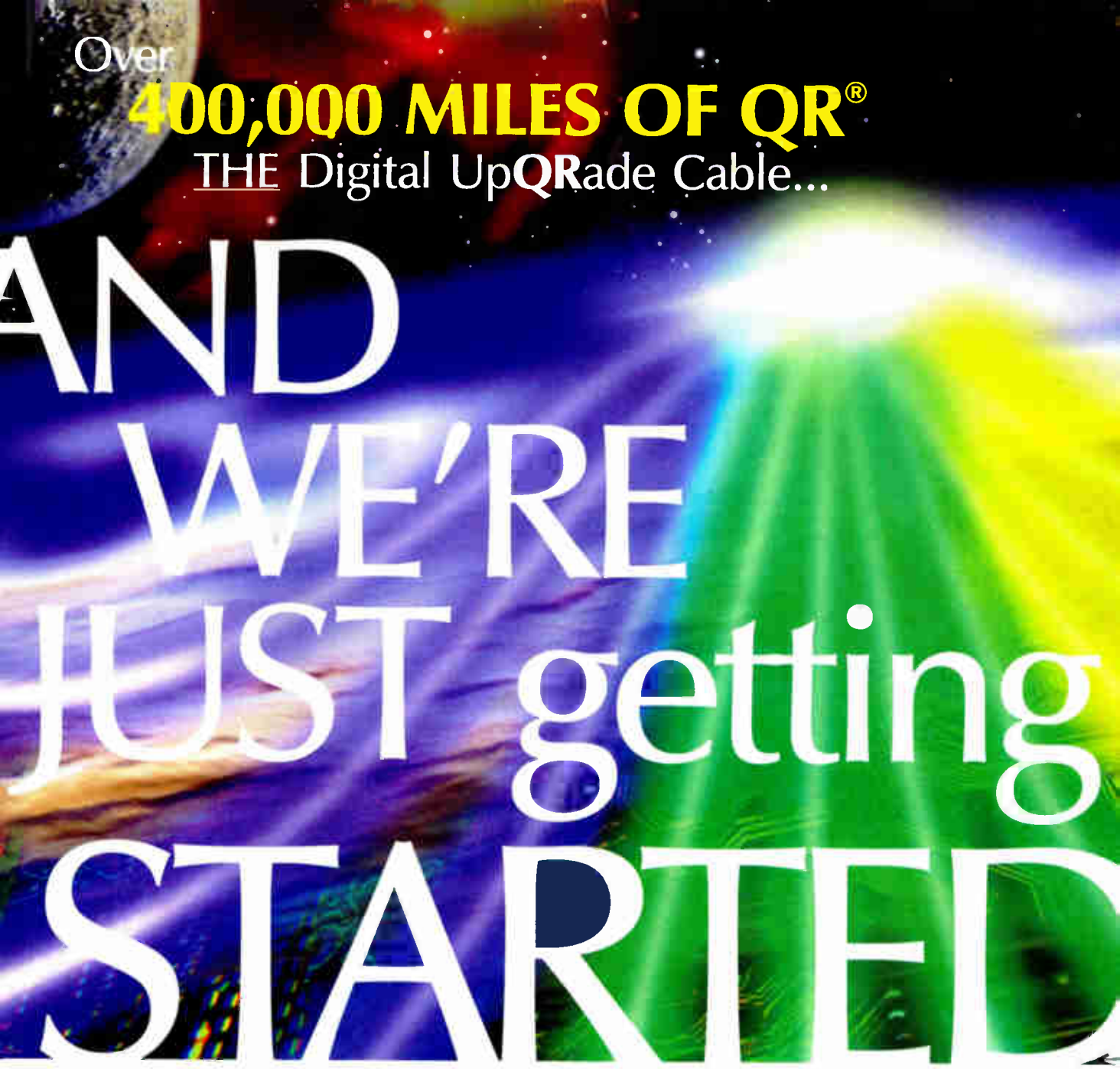
With nearly 50 years of experience in the cable industry, National Cable Television Center and Museum Archivist Dave Willis knows better than anyone where cable TV equipment goes when it dies.

Willis, a retired TCI senior engineer, has volunteered hundreds of hours of his time to organizing the industry's relics. It's a physical record, he says, of what was made, what it looked like and what it was used for.

"I have the first converter built. It was for New York City. It was not used for multiple channels. It was used to get rid of over-the-air pickup. It was a 12-channel converter. It was invented because they would have a channel, and it would come into the set as well as the antenna," Willis explains. "Interference was the mother of invention here."

With all he knows about cable's past, Willis remains focused on what challenges the future will bring to industry engineers and other broadband professionals.

"Most engineers look forward, not backward, particularly when they're concerned with their own plants and their own equipment," Willis says. "I think that while the historic aspect is very interesting to the engineering people, it's not a real challenge, and it's not what they're going to be doing in their systems tomorrow."



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Reader Service Number 92

A Real-World NOC in San Diego

What's in It, How It Works

By Roger Kramer

Editor's note: Because of popular demand from our readership, "Communications Technology" is pleased to rerun this article, which originally appeared in our "1998 Technology Profiles Issue" in May.

In 1994, our network operations center (NOC) was conceived as a headend/hub monitor and communications control center for Time Warner San Diego's soon-to-be upgraded hybrid fiber/coax (HFC) plant. The NOC was to provide a centralized location from which the health of all system operations could be monitored and from which resources could be immediately dispatched to provide reliable service to 190,000 cable customers.

The NOC itself was to provide a number of functions and services all under the following four broad categories:

1) Security: We would have to monitor 14 distribution hubs and three administrative buildings. A Honeywell Excel Security Manager (XSM) would provide system monitors and produce alarms for fire, burglary, access control and industrial processing. We also needed a full step-by-step documentation within the system as well as contact information for the NOC staff and closed-circuit camera surveillance.

2) System and plant monitoring: We planned for monitoring of headend video, audio and digital music services, in addition to 24-hour HFC plant monitoring. Our custom online "Yellow Pages" would allow NOC staff to look up various standby personnel lists, vendor and broadcaster phone numbers as well as construction companies that support our system for emergency restoration. Ad insertion, commercial programming verification, correct channel switching confirmation and system outage detection all fall under this category.

3) Dispatch/communications: A dispatch function was needed for all plant

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Reader Service Number 93

maintenance, headend and information services and the support staff to service all revenue-producing operations, as well as local area networking (LAN). The system had to be capable of notifying appropriate personnel to respond to all security system alarms. The contact personnel include police, fire department, plant maintenance and headend technicians on standby, as well as system management. There would be a 24-hour communication center for system personnel, broadcasters, equipment suppliers and the public.

4) Ad insertion/commercial programming/switching: We planned for a compressed digital commercial insertion system with 500 MB insertion unit storage. We would need an equipment turnaround within 24 hours. Programming and channel switching would be required for up to 128 video sources. We planned for commercial advertising insertion, commercial programming encoding/playback and automatic program tuning, and recording via agile antenna. Also, we would want to communicate with all essential system operations and support personnel while communicating, minute-by-minute, the status of all business operations, including addressability, billing system, phone switch, audio response unit (ARU) and business radio.

The structure itself

In considering the structural requirements for the NOC building, we decided on 2,200 square feet for the NOC, 2,620 square feet for the headend and 450 square feet for the battery/power room.

The NOC would be staffed by no fewer than two trained employees at any time. (The usual staff on duty is five.)

We designed for earthquake construction and bracing to meet AT&T standards (8.0 on the Richter scale).

We elevated the computer floor to accommodate wiring trays to meet fire code and allow air conditioning circulation. We avoided the need for plenum cables.

We decided on a two-level emergency power backup system— batteries and diesel generators.

As noted earlier, because of monitoring requirements, we would need signal distribution throughout three administrative buildings as well as the NOC and headend. A.F. Associates of Northvale, NJ, specialists in design, engineering and fabrication of broadcast communications facilities, was chosen as video services integrator.

Time Base Console of Northvale, NJ, was hired to design and build the monitor wall and NOC consoles.

San Diego Lighting provided glare-free, ergonomically sound lighting, and Electrical Contracting Inc. of Escondido, CA, performed the lighting installation. Acoustical Standards Inc. of Chino, CA, provided and installed acoustical treatment on the walls with a "floating" ceiling.

SeaChange provided digital ad and tape-based commercial ad insertion equipment racks and an encoding station on the lower level.

Current staff is 16 to fill our needs 24 hours a day on full- and part-time shifts.

The structural integrity of the NOC/headend building was re-engineered to meet construction specifications for essential communications facilities. These improvements included:

- Construction of a structural two-hour shear fire wall and foundation
- Installation of a roofing joist system, making the roof an integral part of the building wall structure
- Injection of epoxy compounds into the structural wall seams and cracks
- Installation of a raised computer flooring system (12 inches) throughout the headend and NOC, under-floor cabling to be enclosed with a plenum system, custom-made steel trays with lids provided by ECI
- Installation within the headend space of redundant 20-ton Deluxe System-3 Liebert air conditioning units capable of controlling both temperature and humidity
- Installation of a new electrical service with a Seimens 2,000-amp switchboard
- Installation of an International Power Machine, model BP+75, 75 KVA uninterruptible power supply (UPS)
- Installation of redundant (2 each) 750 kW Onan generators on seismic foundation pads: The system would include Automatic Transfer Switches and a manual Tie-Breaker for shifting entire building power loads from one generator to the other, in case of failures.
- Installation of a Lucent Technologies Lineage 2000 A2 (three 400-amp rectifiers, two 200-amp rectifiers) DC power plant with ECS 12 universal controller (capacity of 1,600 amps), connecting to two battery strings
- Installation of a building ground system conforming to AT&T specifications (Seven satellite antennas, 800 feet away, are tied to the headend ground grid.)
- Installation of an Energen fire suppression system with an Ansul controller in the battery/power room
- Installation of a Honeywell Excel Security Manager (XSM) system for controlling access to buildings, building spaces, monitoring fire and burglary systems, building operating systems (such as incoming power quality), generator operations and alarms, air conditioning systems and fire suppression systems

BOTTOM LINE

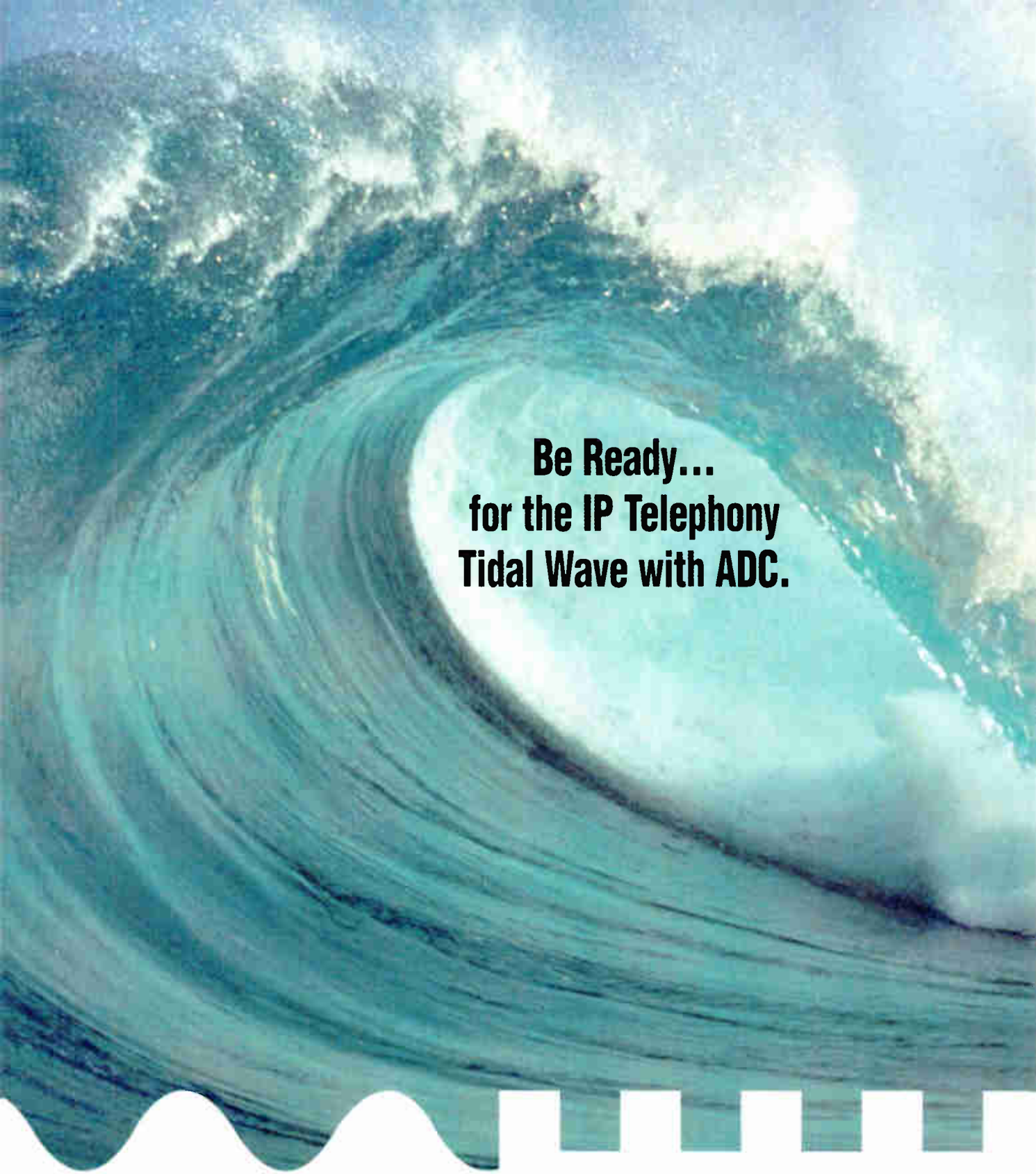
The Making of a NOC

Time Warner San Diego's network operations center (NOC) was conceived as a headend/hub monitor and communications control center the system's soon-to-be upgraded hybrid fiber/coax (HFC) plant in 1994. The NOC was to provide a centralized location from which the health of all system operations could be monitored and from which resources could be immediately dispatched to provide reliable service to 190,000 cable customers.

This article details equipment used to build that NOC.

NOC functions equipment

- Chyron Codi character generators: video bulletin boards, blackout channels accomplished via eight generators, test and graphic message creation, ability to display messages on all channels
- Surround-Sound audio monitoring system accomplished by Dolby Pro-Logic decoder



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- Monitor wall with separate visual and audio monitoring all channels: System uses 120 9-inch JVC color monitors and light emitting diode (LED) audio meters.
- Commercial insertion, community programming playback, three channels of commercial program playback controlled by Channelmatic Adcart system with off-line edit suite, dub rack and tape room
- Adcart automation system used to run four channels of infomercials using 12 decks, four decks per channel
- Leitch digital time/date display unit dials up weekly to set NOC clock accuracy to NIST (National Institute of Standards and Technology)
- Two each 40-inch Mitsubishi RGB monitors slaved to Honeywell XSM security and HP Openview system
- PCS and Nextel Digital Dispatch two-way communications system
- Superior Satellite Engineers, Columbia Falls, MT, controller, remote steerable 5-meter satellite antenna with Ku band capabilities for recording promos and training videos
- News off-line edit system using Sony 3/4-inch Umatic decks with Sony edit controller, Tektronix test signal generator and Sony eight-channel mixer with microphone and line inputs
- SeaChange compressed digital commercial insertion system running on Windows NT platform: Master video library stores 40 GB of information with insertion units storing 500 MB.
- Dubbing bay supports SVHS, Beta, 3/4-inch and 1-inch tape formats.
- Programming control direct access of Grass Valley Group routing switcher
- Waveform monitoring availability of pre- and post-video and audio
- Addressability control Zenith ZTAC for Music Choice ACC 4000 (Jerrold)
- Public viewing area created behind plexiglass display hall
- Racks braced and anchored to AT&T specs in NOC, headend and distribution hubs
- RoadRunner network monitoring (added in 1997)
- Trilithic 9580 return plant display capability (added in 1998)

Headend equipment

- One primary headend/primary transport hub to service the entire San Diego and Coronado, CA, plant—centrally located adjacent to the 8949 Ware Court operations building
- 128 x 128 SMS 7000 Grass Valley Switcher, switching baseband video and 4.5 MHz audio
- 78-channel Nexus IH-2000 headend—Scientific-Atlanta/Nexus-2000 modulators (78 channel analog headend)
- Headend and hub color-coded cables to aid troubleshooting and identification (blue-Belden 8281 video, red-Belden 8241 4.5 MHz audio and white-Belden RG-59 reverse, in hubs)
- All RG-59 is quad-shield and uses LRC Snap 'n Seal connectors. Video connectors are exclusively Trompeter.
- Cables and equipment are labeled using a Brady LS2000 labelmaker, black lettering on white background.
- General Instrument 70-channel Music Choice headend
- Ipitek optical couplers and attenuators
- All electronics DC powered (with exception of Nexus IH-2000) by AT&T
- -48 VDC lineage power plants at the headend and hubs

Optical transport/ fiber distribution hubs

- 78 analog signals to 15 distribution hubs on a Synchronous 1550 AM fiber supertrunking system, 40 channels each on two fibers, allowing for the future addition of 1,550 nm Erbium-doped fiber amplifiers (EDFAs)
- 80 channel supertrunk backup ring that automatically switches at the DLH receiver upon loss of the primary RF output
- The distribution hubs serve 40 nodes with 20,000 passings, or 500 average passings per node.
- We use Siecor SMF-28 single-mode mini-bundle loose tube, dielectric, armored fiber cable and Preformed Line Products outdoor splicing enclosures.
- ALS/ADC DV6000 and Ipitek CQ8 10-bit digital equipment is used to transport studio broadcast feeds to the headend, and it also provides for a 16-channel interconnect.
- The fiber feeder system uses 20 mW Ipitek/Ortel and ADC HX-7501 distributed feedback (DFB) lasers feeding Augat Miniflex nodes.
- The link budget averages 3 dB to 4 dB with a maximum of 13 dB.
- Our minimum optical link performance is 50 dB carrier-to-noise ratio (C/N), 65 dB composite triple beat (CTB), 65 dB composite second order (CSO) and cross-modulation (XMOD).
- We use a Trilithic 9580 maintenance system transmitter to provide return path ingress monitoring for all node groups at each hub.
- A Wavetek Stealth 3SR transmitter is used for forward and reverse plant setup and sweep at each hub.
- Ipitek 1,310 nm RPRD return path receivers, per node, are -24 VDC backup-powered.
- All distribution hub electronics are -48 VDC powered.
- We use Siecor fiber distribution panels and enclosures.
- We use 84-inch Nexus and Siecor equipment racks.
- ADC Telecommunications fiber management systems are mounted above the racks.

RF distribution

- RF distribution utilizes Augat SDA distribution amplifiers, types 1,2,3 and 4.
- Forward bandwidth is 54 MHz to 750 MHz, reverse 5 MHz to 40 MHz. The maximum cascade is two type 1/4 amps, one type 2 amp and three type 3 amps.
- Minimum end-of-line performance is 47 dB C/N, 53 dB CTB, 53 dB XMOD and 55 dB CSO.
- Alpha XM9015 and Lectro ZTT standby power supplies are used. They can be configured with three or six batteries and tapped for 60 V, 75 V or 90 V. They all can be upgraded with status monitoring capabilities.
- All passives are specified to 1 GHz.

The NOC has proven over three years of operation to identify problems and to ensure that they are repaired, in most cases, before customers even know about them. We sell reliability, and the NOC helps make this a reality. CT

Roger Kramer is vice president of engineering at Time Warner in San Diego. If you want more information on the NOC, contact Patricia Norwood via e-mail at tnorwood@div-mail.san.rr.com.

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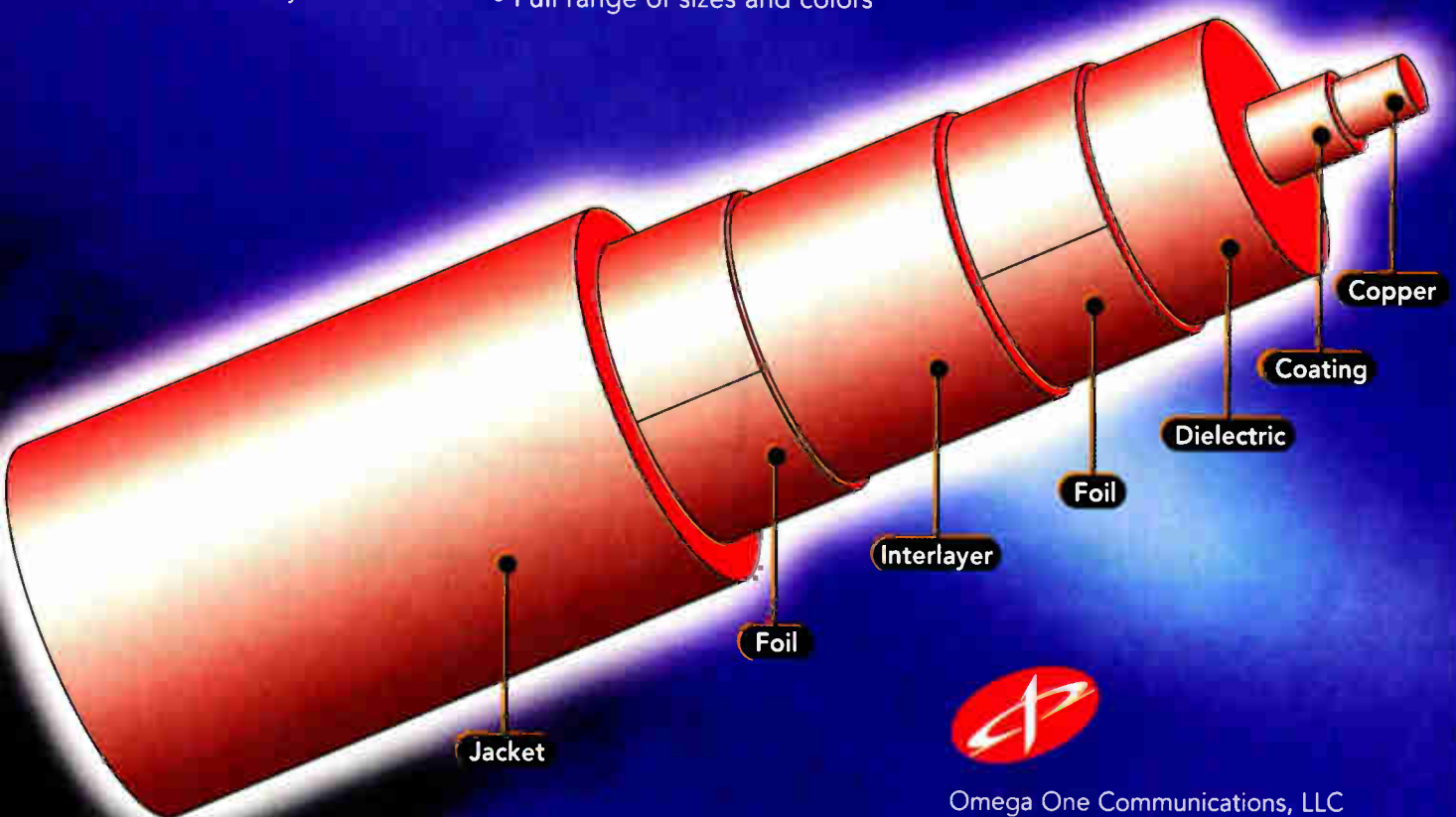

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Combiner

Holland Electronics has upgraded its passive rack-mounted headend combiners. The HCG-12 is a 12-port combiner that uses a directional coupler design to achieve a frequency range of 5 MHz to 1,000 MHz. The unit has +40 dB port-to-port isolation, +16 dB insertion loss and a –20 dB front panel test port for use in larger headends.

Reader Service #309

Cable Tie Tool

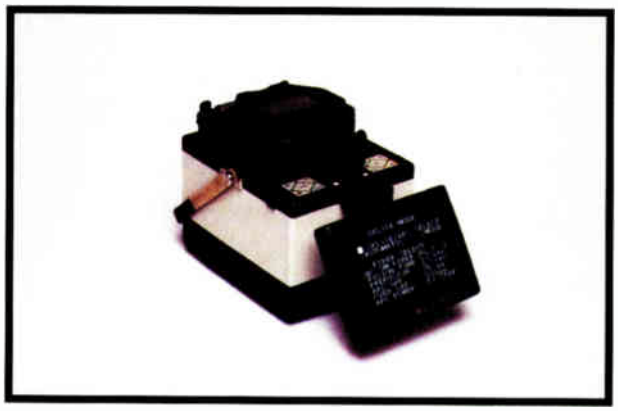
A new cable tie tool from Tyton Hellerman installs cable ties in less than one second, requires no air to operate and is comfortable to use. The Auto Tool 2000 loads easily and requires just one trigger depression for cable tie installation. The system's versatility accommodates a wide range of manufacturing environments. Cable ties are available in strips of 50 or a reel of 5,000. A self-diagnostic light emitting diode (LED) information panel with system status alert guides operation and maintenance functions. The AT2000 also is available as a bench-mount system, powered by either 110 VAC or battery pack.

Reader Service #311

Earthquake-Proof Cabinets

Equipto Electronics has introduced a line of electronic cabinets designed specifically to withstand severe earthquakes. The units are seismic hardened and independently tested to meet standards for Zone 4 earthquakes, the most severe. The line includes both standard enclosures and electromagnetic interference/radio frequency interference (EMI/RFI)-shielded cabinets in various sizes.

Reader Service #308



Fusion Splicer

Sumitomo Electric Lightwave Corp. has introduced a compact mass-fusion splicer with an advanced optical system that simultaneously focuses on 12 fiber images at the same resolution. The Type 63 unit's convenient nine-pound design boasts more accurate loss predictions and speedier splices while sporting a standard battery pack with AC adapter option. The splicer is fully automatic, menu-driven and has real-time image viewing at 40-power magnification through a 6.6-inch liquid crystal display (LCD) monitor. The splicer accommodates single-mode nonshifted, dispersion-shifted and multi-mode silica glass optical fibers. It also splices single fiber pairs including 250-meter and 900-meter pigtails.

Reader Service #310

RF Meter

Surface mount technology and a front-end microprocessor make Boonton's new 4230A series RF power meter fast and accurate. It can sample up to 200 readings per second in stand-alone or in other systems. A sensor data adapter eliminates the need to re-enter calibration data if a sensor is changed, eliminating associated errors and time delays. All major functions are menu-driven from a user-friendly front panel with a liquid crystal display (LCD). Dual channels and built-in mathematical processing provide simultaneous input and output measurement capabilities. Log and linear readouts are presented automatically.

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Reader Service Number 96

BOOKSHELF

The following listing covers several books and videotapes currently available by mail order through the Society of Cable Telecommunications Engineers. The prices listed are for SCTE members only. Nonmembers must add 20% when ordering.

- *Must-See SCTE*—Taped live at Cable-Tec Expo '98, these are eight videos that tackle some of the most pressing challenges currently facing the cable telecommunications industry. *A Vision of the Future: A Discussion with Industry leaders* (order T-1230), *Technology and Operations: Implementing the Vision* (Order T-1231), *Regulatory Update, EAS* (Order T-1232), *Return Path Ingress Mitigation* (Order T-1233), *Excellence Through Customer Service* (Order T-1234), *Return Path Testing* (Order T-1235), *Return Path Design, Components and Alignment* (Order T-1236) and *Digital Video Deployment* (Order T-1237) are available for $45 each, or in a package (Order P-120) that includes a manual for $275.
- *Installer Certification Manual Leader's Guide*—This book was created to present a generic set of installation techniques based on generally accepted engineering practices. It closely follows SCTE's *Installation Certification Manual*. Trainers can use these materials to improve instruction. Tips on organizing skill sessions to help learners to demonstrate their skills and receive constructive feedback make it a worthwhile investment in the future. Order TM-13, $395.
- *The CATV Engineer's Antenna Handbook*—This handbook aims to familiarize the cable TV engineer with antennas and antenna arrays. These tools can improve carrier-to-noise ratio (C/N) on the received over-the-air TV broadcast channels and reduce RF interference and ghosting. It was written for cable engineers to aid in the selection of the best antennas and antenna arrays for particular applications. It provides guidance through antenna specification sheets, installation and orientation processes. Order TR-35, $30. CT

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

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

To order: All orders must be prepaid. Shipping and handling costs are included in the continental U.S. All prices are in U.S. dollars. SCTE accepts MasterCard and Visa. To qualify for SCTE member prices, a valid SCTE identification number is required, or a complete membership application with dues payment must accompany your order. Orders without full and proper payment will be returned. Send orders to: SCTE, 140 Philips Rd., Exton, PA 19341-1318 or fax with credit card information to (610) 363-5898.

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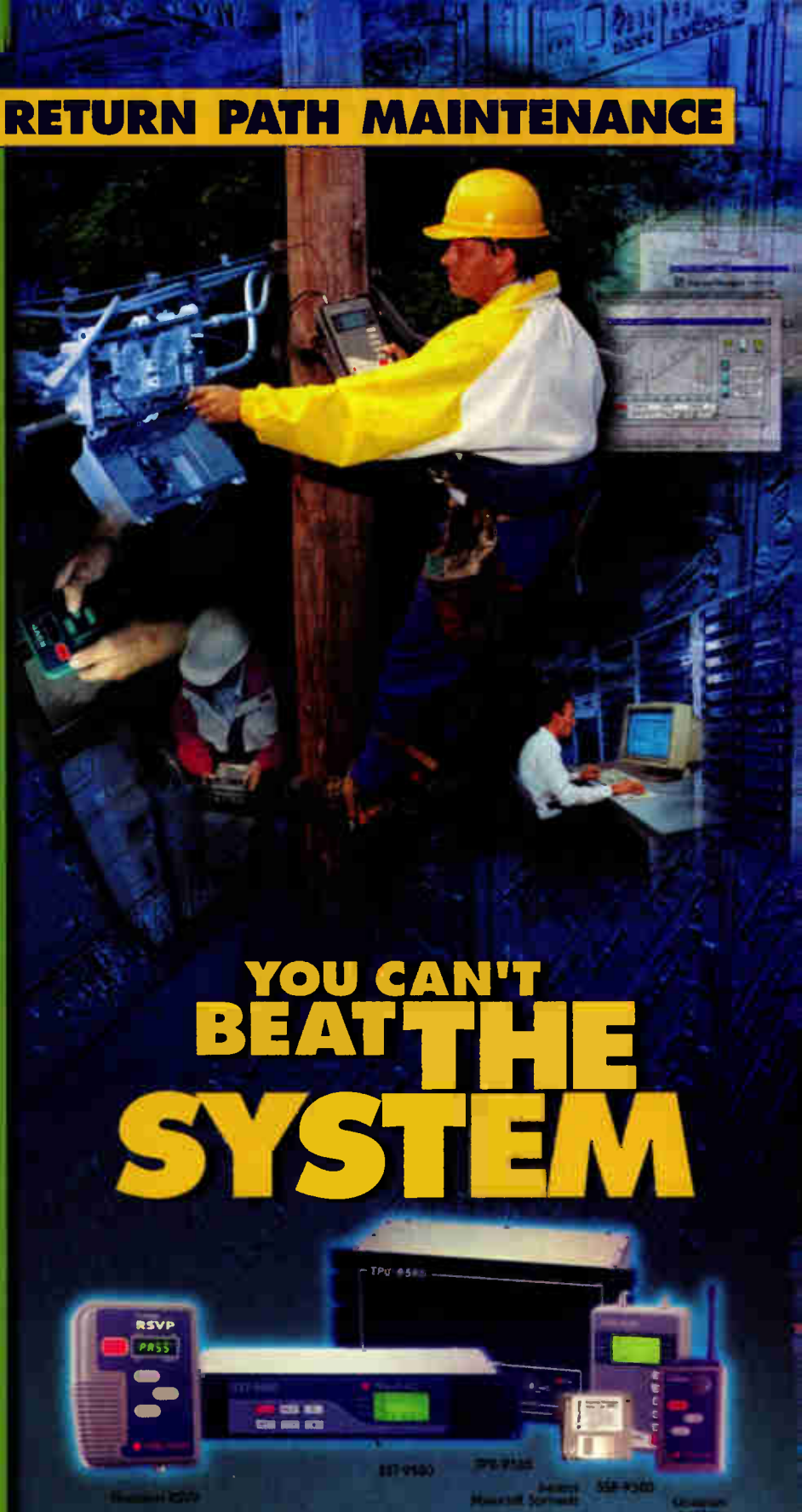

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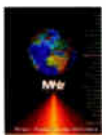

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MONROE ELECTRONICS

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www.sciatl.com

Scientific Atlanta

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Santa Clara, California 95051 • USA
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www.svci.com • email: sales@svci.com

Reader Service No 178

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www.stanfordtelecom.com

STANFORD TELECOM

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Fax: (610)327-9295
www.videotek.com

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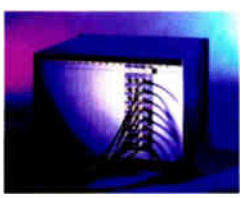
Contact Information:
(317) 788-9351
800-62-5515
www.wavetek.com



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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 1):
Cable TV Systems Operations

03. ___ Independent Cable TV Syst.
04. ___ MSO (two or more Cable TV Systems)
05. ___ Cable TV Contractor
06. ___ Cable TV Program Network
07. ___ SMATV or DBS Operator
08. ___ 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
19. ___ Financial Institution, Broker, Consultant
20. ___ Law Firms or Gov't Agencies
21. ___ Program Producer or Distributor & 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:
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25. ___ Vice President
26. ___ Director
27. ___ Manager
28. ___ Engineer
29. ___ Technician
30. ___ Installer
31. ___ Corporate Management (Chairman, Owners, Presidents, Partners, Executive/Senior Vice Presidents and Treasurers)
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D. In the next 12 months, what cable equipment do you plan to buy?

37. ___ Amplifiers
38. ___ Antennas
39. ___ CATV Passive Equipment including Coaxial Cable
40. ___ Cable Tools
41. ___ CAD Software, Mapping
42. ___ Commercial Insertion/Character Generator
43. ___ Compression/Digital Equip.
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56. ___ Telephone/PCS Equipment
57. ___ Power Supplies. (Batteries, etc.)
58. ___ Video Servers

E. What is your annual cable equipment expenditure?

59. ___ up to $50,000
60. ___ $50,001 to $100,000
61. ___ $100,001 to $250,000+

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

62. ___ Fiber-Optic Amplifiers
63. ___ Fiber-Optic Connectors
64. ___ Fiber-Optic Couplers/Splitters
65. ___ Fiber-Optic Splicers
66. ___ Fiber-Optic Transmitter/Receiver
67. ___ Fiber-Optic Patchcords/Pigtails
68. ___ Fiber-Optic Components
69. ___ Fiber-Optic Cable
70. ___ Fiber-Optic Closures & Cabinets

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

71. ___ up to $50,000
72. ___ $50,001 to $100,000
73. ___ $100,001 to $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. ___ Signal Level Meters
80. ___ Spectrum Analyzers
81. ___ Status Monitoring
82. ___ System Bench Sweep
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?

91. ___ up to $50,000
92. ___ $50,001 to $100,000
93. ___ $100,001 to $250,000
94. ___ over $250,000

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

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

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

97. ___ up to 10 miles
98. ___ 11-30 miles
99. ___ 31 miles or more

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24	50	76	102	128	154	180	206	232	258	284	310
25	51	77	103	129	155	181	207	233	259	285	311
26	52	78	104	130	156	182	208	234	260	286	312

A. Are you a member of the SCTE (Society of Cable Telecommunications Engineers)?

01. ___ yes
02. ___ no

B. Please check the category that best describes your firm's primary business (check only 1):
Cable TV Systems Operations

03. ___ Independent Cable TV Syst.
04. ___ MSO (two or more Cable TV Systems)
05. ___ Cable TV Contractor
06. ___ Cable TV Program Network
07. ___ SMATV or DBS Operator
08. ___ 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
19. ___ Financial Institution, Broker, Consultant
20. ___ Law Firms or Gov't Agencies
21. ___ Program Producer or Distributor & 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:
Technical/Engineering

25. ___ Vice President
26. ___ Director
27. ___ Manager
28. ___ Engineer
29. ___ Technician
30. ___ Installer
31. ___ Corporate Management (Chairman, Owners, Presidents, Partners, Executive/Senior Vice Presidents and Treasurers)
32. ___ Management (Vice Presidents, General Managers, Systems Managers & Directors)
33. ___ Programming (Vice Presidents & Directors and Managers & Producers)
34. ___ Sales (Vice Presidents, Directors & Managers and Sales Representatives)
35. ___ Marketing (Vice Presidents, Directors & Managers and Sales Representatives)
36. ___ Other (Company Copies & Other Titles & Non-Titled Personnel, please specify)

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

37. ___ Amplifiers
38. ___ Antennas
39. ___ CATV Passive Equipment including Coaxial Cable
40. ___ Cable Tools
41. ___ CAD Software, Mapping
42. ___ Commercial Insertion/Character Generator
43. ___ Compression/Digital Equip.
44. ___ Computer Equipment
45. ___ Connectors/Splitters
46. ___ Fleet Management
47. ___ Headend Equipment
48. ___ Transmission/Switching Equipment
49. ___ Networking Equipment
50. ___ Vaults/Pedestals
51. ___ MMDS Transmission Equipment
52. ___ Microwave Equipment
53. ___ Receivers and Modulators
54. ___ Cable Modems
55. ___ Subscriber/Addressable Security Equipment/Converters/Remotes
56. ___ Telephone/PCS Equipment
57. ___ Power Supplies. (Batteries, etc.)
58. ___ Video Servers

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96. ___ more than 2 years

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

97. ___ up to 10 miles
98. ___ 11-30 miles
99. ___ 31 miles or more

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CableAmerica has an opening for an experienced CATV System Designer in the Phoenix, Arizona area. This position is responsible for CATV design, design drafting and may include field work. Experience with Autocad 12 and Signal cable plant design software preferred. Excellent benefits including 401k.

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CableAmerica.

Engineering

MANAGER TECHNOLOGY

Encore Media Group, the nation's largest provider of premium movie networks, has an immediate opening. Individual will provide technical support to both internal and external customers. Qualified candidates will have 5 years of progressive technical experience in satellite and cable television including audio/video, RF, digital system/networking skills. Ability to manage multiple projects and communicate effectively with senior management, field sales and system technicians. BSEE required. Send resume and salary history to: **Encore Media Group, #544, P.O. Box 4917, Englewood, CO 80155.** Successful candidate will be subject to a drug test. EOE.

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RTK One of the nation's leading contractors within the Telecommunications industry is looking for a **TECHNICAL TRAINER** for the West Coast Region. This is an *excellent opportunity* for a highly motivated, team-player with a strong background in CATV, Telephone, and Satellite Installations. The candidate must have strong oral and written skills, good driving record, and be willing to travel. Enthusiasm and people skills a must. Benefits package & company vehicle provided. EOE.

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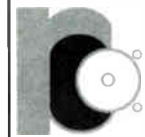

SALES ENGINEER WANTED

Fiberoptic manufacturer looking for technically qualified person for Sales Engineer Position. No sales experience necessary must have CATV background in a technical capacity. Send resume to:

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JM Consulting Group, Inc., a leading contractor in the cable industry has openings for **Sweep and Headend Technicians** for Southern California and the Central Valley. Sweep Techs must have exp in CATV install & pole climbing, electronics testing & ability to read RF signal meters. **Headend Techs** should have FCC test exp, ability to read signal analysis meters & be computer literate. Positions require valid Driver's license, good driving record, and proof of automobile insurance. We offer competitive compensation and benefits and a great work environment. Visit our web site "jmcg.com" to learn more about our company. EOE. If you like to work hard and have fun doing it, fax your resume to:

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CALENDAR

December

Dec. 1-4: Western Cable Show, Anaheim, CA. Call (510) 429-5300.

8: Chattahoochee SCTE Chapter technical seminar and testing session, Holiday Inn, Jonesboro, GA. BCT/E certification examinations to be administered. Contact Guy Lee, (770) 321-0133.

9: Inland Empire SCTE Chapter technical seminar, Ameritel Inn, Coeur d'Alene, ID. Topic: "Cable 101 and Splicing and Construction Techniques" with Adam Foster of Times Fiber and Jack Fullwiler of Century. Contact Laurel Davis, (208) 664-5963.

10: SCTE Satellite Tele-Seminar Program Galaxy 1R, Transponder 14, 2:30-3:30 p.m. ET. Topic: "Inside Wiring Issues (Part Two)." Contact SCTE national headquarters, Janene Martin, (610) 363-6888, ext. 220.

12 Llaño Estacado SCTE Chapter technical seminar, TCA Cable TV Offices, Clovis, NM. Topic: "Hands-on Fiber for the Installer and Technician." Contact Bob Baker, (505) 763-4411.

14-16: C-COR Reverse Path Basics seminar, Columbus, OH. Call (814) 231-5831.

15: New England SCTE Chapter technical seminar and testing session, Holiday Inn, Boxborough, MA. Topic: "Telephony." BCT/E and Installer certification exams to be administered. Contact Brian Bedard, (413) 562-9923, ext. 228.

15-18: Bay Networks' Hub Connectivity Course, Atlanta. Call (919) 461-8600.

16: Inland Empire SCTE Chapter technical seminar, TCI, Spokane, WA. Topic: "Cable 101" with Adam Foster of Times Fiber. Contact Paul Grayhek, (208) 667-6266.

17: Bonneville SCTE Chapter technical seminar, TCI Offices, Salt Lake City. Contact Tom Smith, (801) 466-2922.

18: Oklahoma SCTE Chapter testing session, Edmond, OK. Telephony certification examinations to be administered. Contact Tom Heddlesten, (405) 348-5750, ext. 312.

18: Wheat State SCTE Chapter testing session, Great Bend, KS. BCT/E certification examinations to be administered. Contact Joe Cvetnich, (316) 262-4270. CT

Planning Ahead

Jan. 18-20: SCTE Conference on Emerging Technologies, Dallas. Call (610 363-6888.

Feb. 24-26: Texas Cable Show '99, San Antonio. Call (512) 474-2082.

March 10-12: Northern California Vendor Show and Golf Outing, Hilton Hotel, Concord, CA. Contact Steve Allen, (916) 786-4353.

May 11-12: Kentucky Cable Telecommunications Association Conference '99, Lexington, KY. Call (502) 864-5352.

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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ANTEC Network Technologies, the Atlanta-based manufacturing division of ANTEC Corp., designs, manufacturers, distributes and markets a wide range of active transmission, powering, passives, and interconnection products for fiber optic coaxial and twisted pair networking, worldwide. ANTEC Corp., headquartered in Rolling Meadows, Ill., is an international communications technology company.
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Pamela.girardin@cheetahtech.com
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By the NCTI

Troubleshooting Hum Modulation, Part 3

This month's installment continues a series on troubleshooting hum modulation. The material is adapted from a lesson in NCTI's Installer Technician Course. © NCTI.

Last installment dealt with identifying the possible causes of hum and provided two of the first procedures for systematically isolating a specific cause of visible hum bars. This installment continues with more of these procedures.

As emphasized last time, because an electrical shock hazard may exist when troubleshooting a hum modulation problem, always carefully observe all appropriate safety precautions.

- *Checking picture quality at a cable wall plate with a TV test set.* If you do not have a signal level meter (SLM) that can measure hum percentage or if an unmodulated signal is not available on your system, a TV test set with no known hum problem can be used. As shown in Figure 1, turn off the customer's TV set, disconnect it from the cable wall plate and unplug its AC power cord and any other power cords using that same AC wall outlet. Connect the test set to the output connector of the wall plate, plug its power cord into that AC outlet and turn it on. The test set's picture quality will help indicate whether the unacceptable level of hum modulation is generated by the feeder system, a tap or by a house amplifier between the customer's tap port and the cable wall plate. If no hum bars are present on the TV test set, the source of the abnormal hum modulation is between the cable wall plate and the customer's TV set or the TV set itself. One or two hum bars on the test set indicates that the abnormal hum modulation is upstream, either in the feeder system, between the customer's tap and the wall plate or in the customer's electrical wiring. To further isolate, disconnect the broadband cable from the TV test set, then tune the test set to a known over-the-air channel. A hum bar on the screen indicates the customer's electrical wiring or an electrical appliance may be causing the abnormal hum. No hum bars on the test set indicates the drop or feeder system is causing the abnormal hum.
- *Checking picture quality at a cable wall plate with customer's TV set.* You may not have access to a TV test set or an SLM that measures hum percentage to determine the cause of hum on only one cable-installed TV set. For this scenario, initially disconnect the TV set's broadband input cable and unplug AC power cords of any set-top terminal, VCR, or active RF switch connected to the AC wall outlet. Next, connect the customer's TV set to a set of rabbit ears or other over-the-air antenna and observe pictures for hum bars. If hum also is present in the pictures provided by the antenna, the customer's TV set or electrical wiring is the likely source of the hum. If hum is not present using the antenna, disconnect the antenna and reinstall the broadband cable directly between the cable wall plate and the customer's TV set. Plug the TV set's AC power cord in an active, non-switchable AC wall outlet and turn on the TV set, as shown in Figure 2. The return of visible and/or audible hum on the TV set indicates that the feeder system, the drop system, or the customer's electrical wiring are causing the abnormal hum in the pictures. A lack of hum bars indicates that one of the disconnected devices between the cable wall plate and the TV set is the cause of the hum modulation. Reconnect each of these disconnected devices one at a time until the hum bars reappear to isolate and identify the defective device. CT

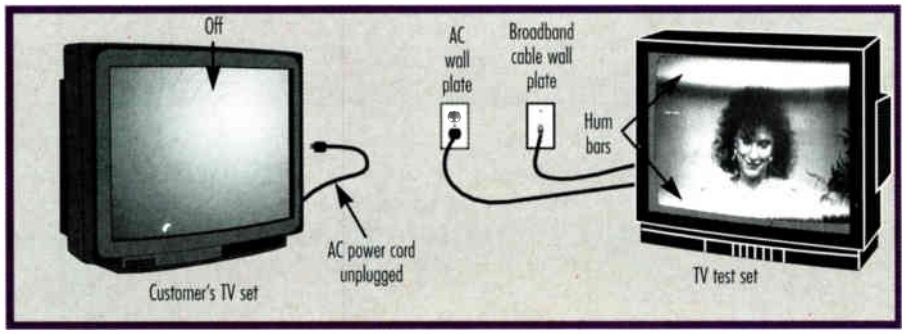

Figure 1: Checking for visible hum bars with a TV test set

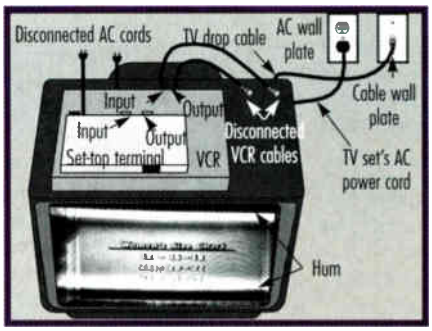

Figure 2: Checking picture quality with only the customer's TV set

The next installment will continue with procedures for systematically isolating a specific cause of visible hum bars.

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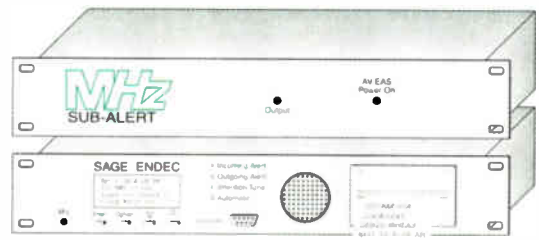

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Reader Service Number 100

By Hugh McCarley

Gear Up for ET '99

The start of the New Year is just weeks away; with that is your chance get a jump on your 1999 training agenda. And what better way to learn the latest information about current technical language than from engineering visionaries at the Conference on Emerging Technologies? It will be held Jan. 19-21, 1999 in Dallas.

For those who have never been to ET, and even for those who have, next year's conference in particular is going to address a lot of critically important issues that we as service providers need to know about.

Rather than use this space to list the session topics (that's what the registration package and program are for), I'd like to talk a little about what makes this conference unique to the trade show circuit.

Celebration, location, education

First: celebration. As you may have heard or read somewhere, 1999 marks the Society of Cable Telecommunications Engineers' 30th anniversary. Over the past three decades, we have earned a reputation as an invaluable resource to our industry. That's because we've made it our mission to keep you at the forefront of technological change through such shows as ET and Cable-Tec Expo.

ET also affords you the opportunity to celebrate the accomplishments of one of your peers in advanced fiber-optics technology with the annual Polaris Award presentation. Although the name of the 1999 honoree still is under wraps, you can be sure that he or she is one of the engineering visionaries with whom you'll become better acquainted when you attend.

Second: location. We'll be heading to the Lone Star State for our eleventh annual winter conference. This locale will give some of you the chance to see a new area of the United States.

Speaking from: experience, Dallas is a great city to visit, with its unique blend of distinctive architecture and rich heritage. Plus, Dallas is home to many technology-related product manufacturers, including representatives from the computer and electronics industries.

For the convenience and comfort of our attendees, ET '99 will be held entirely at the Wyndham Anatole Hotel. The Anatole is the largest hotel in the Southwest, located just two miles from the downtown Dallas business district, 25 minutes from Dallas-Fort Worth International Airport and 10 minutes from Dallas Love Field.

Third: education. To those who still are debating whether to attend ET '99, I have three words: knowledge equals power. While Emerging Technologies doesn't have the hustle and bustle that Cable-Tec Expo offers, it does provide attendees with three intensive days' worth of information and foresight from industry veterans who probably have been where you are today and who can give you some insight into where you'll be tomorrow.

Facing the Challenge

The conference theme is "Facing The Challenge," and that's just what we plan to do. ET '99 will tackle the issues of interactive services, network management and Data Over Cable Service Interface Specification (DOCSIS).

Our five in-depth presentations will answer such questions as, "How do we transition from circuit-switched to packet-switched networks?" and "How well will our network function as a true two-way pipeline for multiple services, especially if we are required to be a common carrier?"

You'll also be able to explore alternative delivery mechanisms for the information age. Digital technology, in particular, undeniably is changing the way we function in the broadband industry. As many of you already know, by April 1999 there will be 40 digital broadcast TV stations in the United States. The future is here.

Keynote speaker

And speaking of that future, who could pick up a newspaper or magazine this past summer without reading about the deal-making between TCI and AT&T? To shed some light on the road ahead for telecommunications, Dr. David C. Nagel, AT&T's chief technology officer and president of AT&T Labs, will deliver a keynote address during the conference.

Nagel currently is creating a highly focused and innovative research effort for the "new" AT&T and overseeing the development of a new generation of Internet and other communications and information services. He also advises the AT&T operations group and senior management staff on technology issues, and he chairs a company-wide technology strategy and development council.

All of the presenters will share their ideas about how technical solutions will emerge to solve known or foreseen challenges in the networks of tomorrow. ET '99 will leave you with greater on-the-job knowledge to build a stronger operation. Not bad for three days in Dallas.

In closing, I would like to thank the members of the Emerging Technologies Subcommittee who, under the direction of Chairman Oleh Sniezko, have planned another exciting SCTE training event.

I hope you will join us in Dallas on Jan. 19 to kick off the future of this exciting business. In the interim, I wish all of you a happy and prosperous New Year.

Hugh McCarley is chairman of the Society of Cable Telecommunications Engineers Board of Directors. He can be reached via e-mail at hugh.mccarley@cox.com.

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