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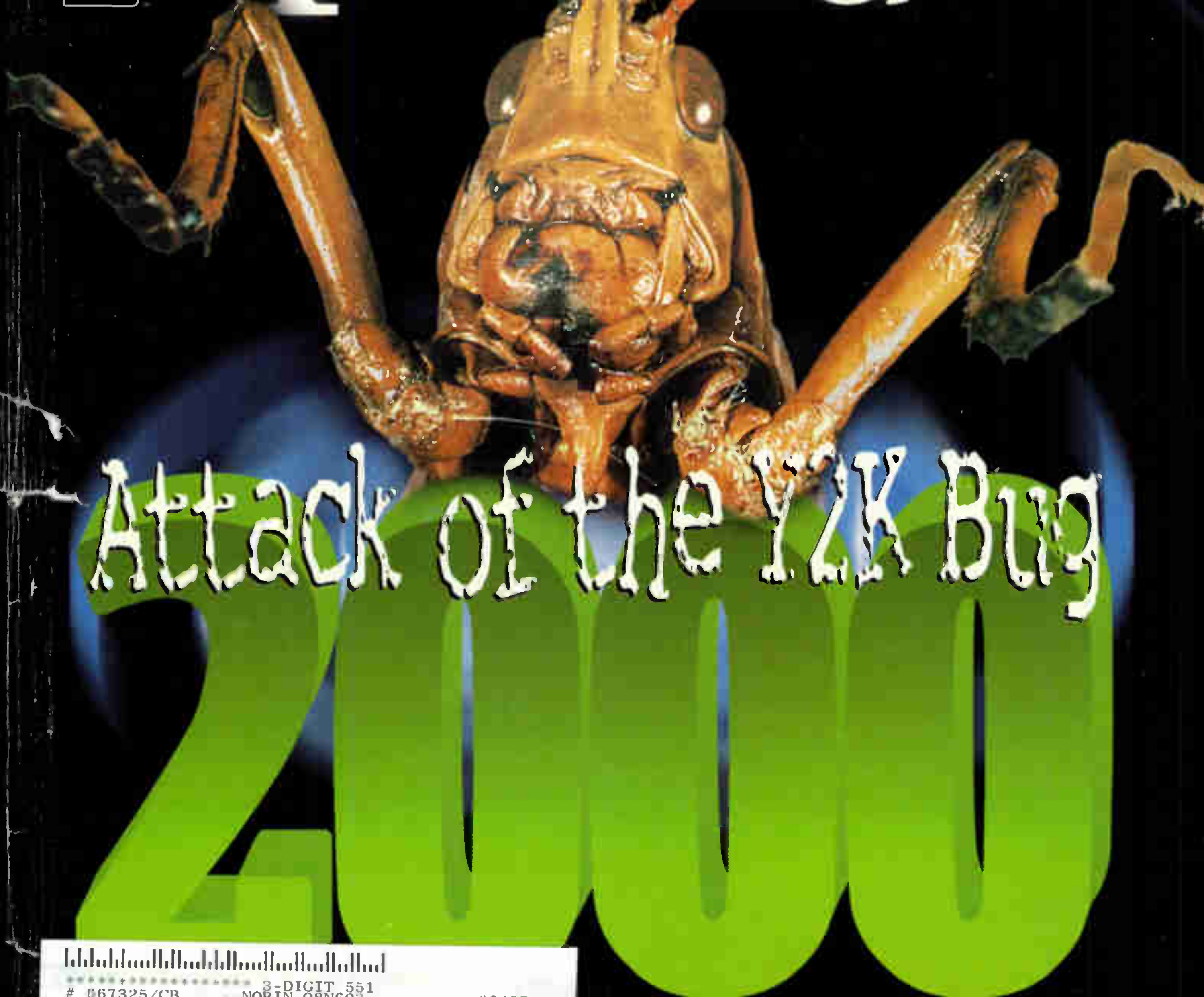
January 1999



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How Cable Engineers are Taking on the Monster

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Design by Maureen Gately
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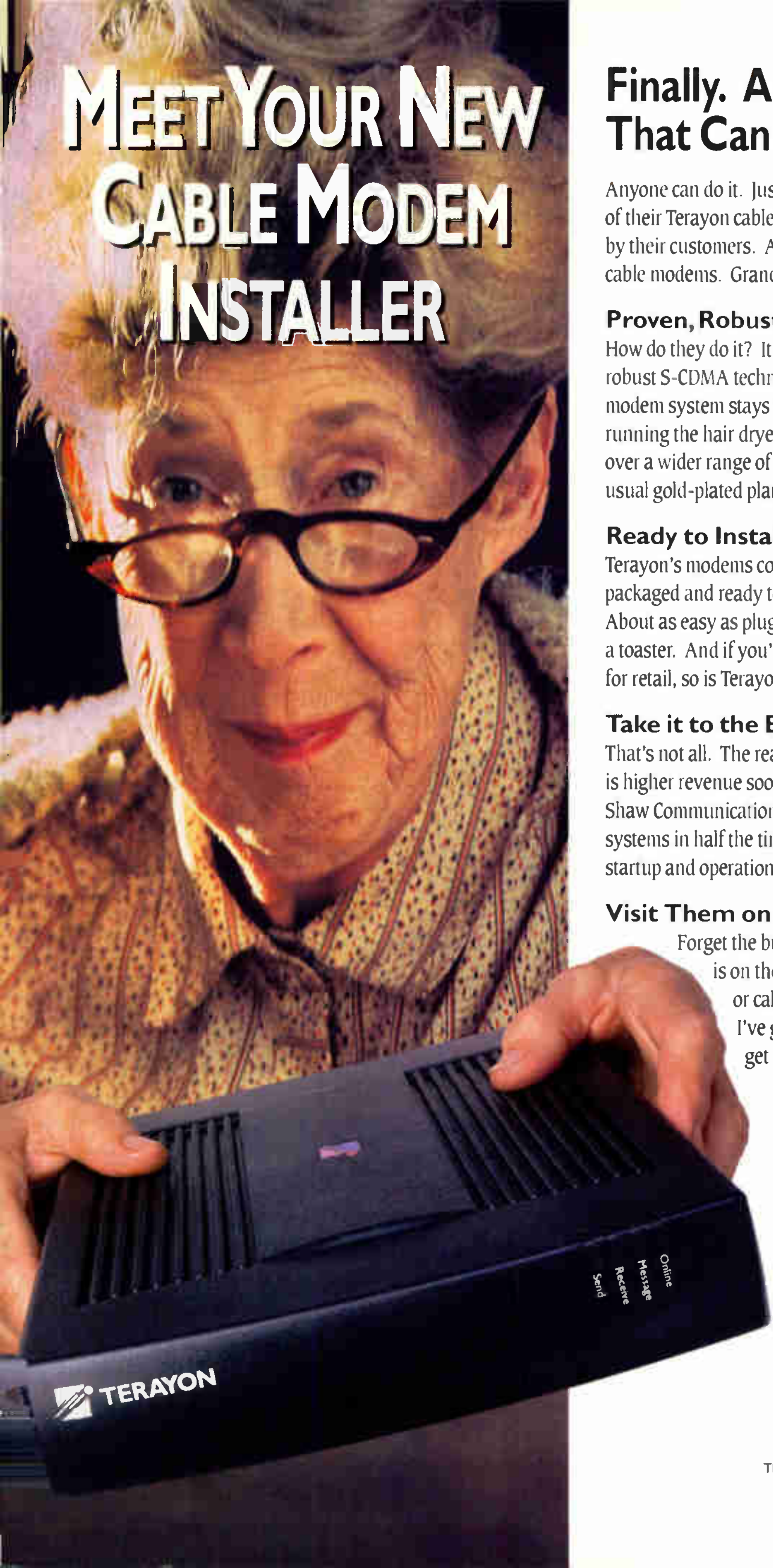

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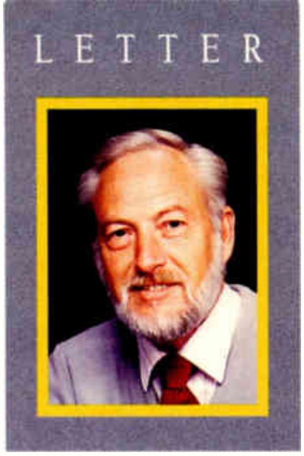
Reader Service Number 4

By Rex Parter



Happy New Year

It's getting closer to the time when we'll say goodbye to this century. It makes even the young feel old. But some good things happened as 1998 ended.

CableLabs and the Society of Cable Telecommunications Engineers moved standards through their association with the American National Standards Institute so that we could begin deployment of high-speed data systems across the nation.

The National Cable Television Center and Museum received donations and sold memberships to begin work here at the University of Denver.

We have a new vice president of science and technology for the National Cable Television Association, William Check.

NCTA always has promoted the efforts of the SCTE. Wendell Bailey served as director at-large, and when he moved on to other work, Andy Scott served selflessly.

We also have a new president of the SCTE, John Clark. I was part of the subcommittee that interviewed scads of quality candidates. I am pleased that the board of directors agreed with us by choosing John. His experience will serve him well in taking the Society to a new level.

Our message about training and certification must be taken to owners, chief executive officers, and general and regional managers. Broadband Cable Technician/Engineer (BCT/E) and Installer certification must be recognized as necessary in planning time and budgets.

Many managers realized the importance of the Federal Communications Commission's second- and first-class licenses as a gauge of electronic education in the past. But I fear most do not realize that BCT/E certification has replaced them for broadband telecommunications. I know we have not emphasized the importance of Installer certification.

Management must help technical workers keep abreast of technology. They must not only allow time for attendance at SCTE chapter meetings, they must demand it. They must not only allow attendance at the Emerging Technologies Conference and Cable-Tec Expo, they must sponsor it.

John Clark knows the operations management side of our business. Those friendships, combined with his background, will open doors to the people who need to understand how SCTE's training, certification and standards programs will impact the future of cable telecommunications.

Rex Porter
Editor

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Reader Service Number 7

SCTE, GI Ante Up for Higher Ed

To encourage academic excellence and personal achievement, General Instrument and the Society of Cable Telecommunications Engineers are offering college-bound students the opportunity to earn a unique scholarship for higher education.

The Milton Jerrold Shapp Memorial Scholarship, sponsored by General Instrument (once known as Jerrold Electronics) and administered by SCTE, was established in 1996 in memory of the company's founder, former Pennsylvania Governor Milton Jerrold Shapp. This $20,000 grant is awarded annually to a deserving high school senior who is the child of a current cable industry employee.

The scholarship recognizes independent thinkers who demonstrate the same ambition, community activism, determination and entrepreneurial spirit exemplified by Shapp's life and accomplishments.

The application deadline for the 1999 Milton Jerrold Shapp Memorial Scholarship Award is Feb. 1. Interested students should contact SCTE headquarters at (610) 363-6888 for application materials. Scholarship information also can be found on the SCTE Website at www.scte.org.

Awards Celebrate Local Partners

In a continuing effort to recognize innovation, commitment and leadership in the broadband telecommunications industry, the SCTE is introducing several awards programs to honor these qualities in members of its chapters, meeting groups and volunteers.

As part of the "SCTE Partnership Program," these awards spotlight the significant contributions local groups make to the industry through training and certification, communication programs, collaborations with other associations and leadership.

"Hundreds of cable telecommunications professionals donate their energy, creativity and expertise to SCTE and the industry on an ongoing basis," said SCTE Director of Communications Steve Townsend. "By honoring its innovative and dedicated volunteers, the Society also encourages the development of tomorrow's cable telecommunications leaders."

The award categories include:

- Chapter of the Year (recognizes chapters that significantly exceed the Society's requirements for its local affiliates)
- Leadership Circle (honors exemplary volunteer leadership)
- Towering Achievement Award—Outstanding Educational Programming
- Towering Achievement Award—Winning Promotions/Communications
- Towering Achievement Award—Effective Partnerships

The deadline for nominations is Jan. 31. Nomination forms are available from SCTE Headquarters. The awards will be presented at Cable-Tec Expo '99, slated for May 25-28 in Orlando, FL.

For more information about this awards program or SCTE volunteer opportunities, contact Steve Townsend via phone (610) 363-6888, ext. 211; Fax (610) 363-5898; or e-mail stownsend@scte.org. Information also is available on the Society's Web site at www.scte.org. CT

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Reader Service Number 9

Partying—"Cable Style"

When we celebrated the 50th anniversary of our industry, we didn't hear much about one of the true pioneers of cable in America. Jim Davidson built his first cable TV system in Tuckerman, AR, as an experiment back in October 1948.

His first customer was Carl Toler, who passed away in 1963 at the age of 52. The coaxial cable drop was connected to an amplifier at the base of the Tuckerman Theater, then to a large cherry tree and finally into the Toler living room.

Louis French, Jim's first system employee, wrote to Jim years later, "We were not sure it would work, running it that distance, but as Carl said, he had the best TV reception and the most company of anyone in town."

Growing up during the Great Depression and orphaned at the age of eight, Jim and his two sisters moved "from pillar to post" with distant relatives and family friends. Self-taught and without any formal education, Jim was drafted by the government to install and supervise a Signal Corps department at a new Army air base that was under construction near Newport, AR.

Leaving the Signal Corps, he joined the Navy and was assigned duties in show business, photography and electronics. His first cable system had only one channel available, **WMCT** in Memphis, TN, about 90 miles distant. He went on to build more than 30 systems and own more than a dozen companies.

I met Jim back in the '60s when I was chief engineer for **United Video Systems** in Kansas City, MO. Back then, his **Davco Electronics** was known as the Supermarket for Cable TV. Not only would he sell you any piece of equipment to build a cable system, but he would give you good technical information about the equipment. If you had a major problem, he would likely fly his private plane to your cable system to solve the problem first-hand.

In October, Janet (Jim's beautiful bride) and some of us in the industry decided to throw a party for Jim and celebrate his "rags to riches" story and his half-century of work at making cable TV what it is today.

More than 150 people arrived at Jim and Janet's Cabot, AR, home to celebrate. In attendance were Audrey Pearcy (former opera singer), Tom Southwick (editor of ***Cable World*** magazine), Harold Wilson and Dwayne Millikin (former Davco Electronics employees), and Jim Keller (representing **The National Cable Center and Museum**).

To begin the party, Jim was given a plaque, on which was written, "50th Anniversary of Cable Television, Tuckerman, Arkansas, October 1948 to 1998, honoring James Yates Davidson, founder of cable television in Arkansas, and possibly first in the world. We are proud of your dedication and expertise in bringing cable television to Arkansas and the world. Your loving and devoted family, friends and former employees."

Jimmy later presented plaques shaped like the state of Arkansas to Naomi Toler and Louis French.

The author of many books on aviation, weather and cable TV, Jim has written another book about this history of cable TV. His home now contains the **James Yates Davidson Museum/Archives**. Jim and Janet have plans for their Museum/Archives to become the southeastern branch of The National Cable Television Center and Museum.

Rex Porter
Editor

John Clark Named SCTE President

Following Bill Riker's summer resignation from his post as president of the Society of Cable Telecommunications Engineers, the organization's board of directors named John Clark as the association's new chief executive in November.

Clark has served the cable industry since 1980 and will oversee all aspects of the Society's Exton, PA-based operation.

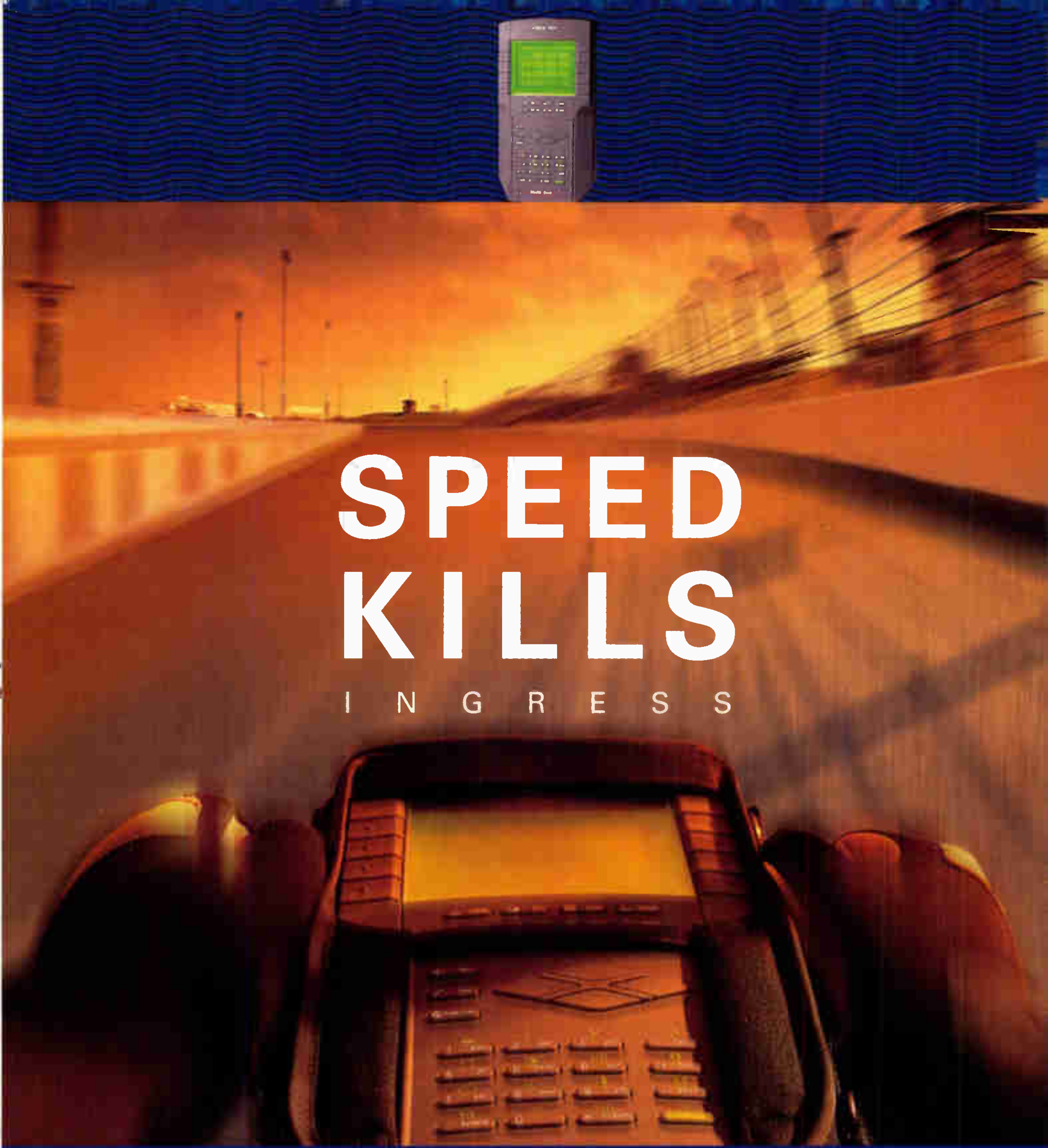
"Since joining the cable industry 19 years ago, my passion has been to participate in bringing the benefits of new technology to the consumer," Clark said. "The engineering and technical professionals of SCTE do this every day. I am proud to be associated with the members."

Clark's background includes extensive experience in executive-level management, marketing, programming, distribution, strategic planning, interactive services and business development. He most recently served as executive vice president for Tele-TV Media.

Prior to this, he was managing director for Telecom New Zealand's First Media cable subsidiary, where he headed this international telephone company's entry into the broadband video business. Clark also served as senior vice president of marketing and programming for Crown Media and Cencom Cable Associates.

Reflecting on the Society's quest for a new leader, SCTE Chairman Hugh McCarley said: "The board and its appointed search committee spent months carefully assessing candidates for the president's position to ensure that we selected the right person. John's background in strategic planning and marketing, coupled with his extensive industry knowledge, provides the core leadership competencies SCTE needs in the next millennium."

Clark has won CTAM's Case Study Award and TAMI award for outstanding contributions to the marketing organization. He also has served as chairman of the CTAM National Pay-Per-View Conference. He graduated magna cum laude from the University of Maryland with a bachelor's degree in business administration. He holds a master's degree from the same school. CT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DEPLOYMENTWATCH

By the CT Editorial Staff

If telephony or Internet services are on the New Year's resolution list for your system, you may find inspiration in some of the players and products we're sure to hear more from in 1999.

MSOs Uncork Motorola Telephony

Motorola recently celebrated its global shipment of more than 100,000 CableComm cable telephony lines as a milestone of the product's success and popularity. According to Motorola, accompanying CableComm headend installations are helping to provide services for more than 400,000 telephony subscribers worldwide.

Convenience for the operator and the subscriber is one of the major advantages to the product, the company said. CableComm allows network operators to provide services that enable subscribers to use their conventional telephones, fax machines, answering machines and other telecommunications devices.

Motorola's cable telephony systems are components for local loop access via hybrid/fiber coax (HFC) cable networks. CableComm supports plain old telephone service (POTS) along with other multimedia services over HFC networks, making it a versatile addition to many operators' networks.

The cable access unit (CAU) subscriber premises equipment includes phones, fax machines and analog modems. The cable telephony system utilizes the HFC network to deliver digital switch functionality such as dial tone and ring cadence to the subscriber premises equipment. Motorola's cable control frame (CCF) serves as the interface between the cable operator's headend and the HFC network.

Motorola says that CableComm deployments are on the rise. Several MSOs have launched the systems with varying degrees of new service offerings in a number of markets. What follows is a list of domestic deployments:

- Time Warner (high-speed data), Akron/Canton, OH
- TCI (high-speed data and telephony), Arlington Heights, IL
- MediaOne (high-speed data), Atlanta
- Comcast (high-speed data), Baltimore
- Time Warner (high-speed data), Elmira, NY
- Time Warner (high-speed data), San Diego
- Cox (high-speed data) Omaha, NE
- Comcast (high-speed data), Sarasota, FL

Subs Gather Under MediaOne Umbrella

A barrage of MediaOne Express deployments coupled with incentives for subscribers are propelling digital telephony and Internet over cable adoption.

In areas where MediaOne services are available, Circuit City customers can buy Bay Networks' Netgear cable modems for $199 and a MediaOne Express installation kit for $49, at a $50 savings over the regular cost of installation. In addition, the monthly MediaOne Express service cost is reduced $10 to $29.95 for customers with MediaOne's standard cable telephony service. Kits include an installation appointment certificate, a MediaOne Express Internet service provider (ISP) user's guide and coupons for MediaOne cable TV products.

This promotion and shift of the technology to the retail market, says MediaOne, are stimulating adoption in the markets where it's available.

A rapid-fire succession of MediaOne digital telephony and MediaOne Express high-speed Internet access deployments have been heating up since the company announced price incentives for subscribers who buy their cable modems retail and opt for the company's local digital telephony service. The following deployments may have helped the MediaOne Group's third-quarter earnings jump 32% to $500 million and to establish MediaOne as a real contender in the local digital telephony and ISP arenas.

- Digital telephony and MediaOne Express to 43,000 subscribers in Lowell, MA
- MediaOne Express to 21,200 subscribers in Revere, MA
- MediaOne Express to 15,850 subscribers in Westfield, MA
- MediaOne Express to more than 13,850 subscribers in West Springfield, MA
- Cablevision Lightpath has the service in its Long Island, NY, system. CT

The "CT" editorial staff can be reached in Denver at (303) 839-1565.

Who's Who in Deployment

- Cox announced successful deployment of **ABL Canada**'s AccessExpress IM-42E inverse multiplexer in Phoenix and New Orleans. Cox is using it as part of the rollout of high-speed Internet access service. The IM-42E is designed to make high-speed Internet access more cost-effective, particularly in multiple dwelling units (MDUs).
- **General Instrument**'s dense wavelength division multiplexing (DWDM) deployment in **OmniStar**'s Chicago and Grand Rapids, MI, systems is among the first and largest of its kind. This rollout is a full eight-wavelength system. Phase 1 passes close to 200,000 homes in those systems.
- **Harmonic Lightwaves** has begun shipping a new high-power optical amplifier that enables cable TV operators to support four times more optical nodes than the lower-powered amplifiers typically used. This is the latest addition to Harmonic's MAXLink family of 1,550 nm transmitters and amplifiers.

"A hundred times faster" refers to
made to 56K analog modem speed. Current upload speed capability is lower.
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Can you imagine an Internet
that runs a hundred times faster?
Your customers can.

By Ron Hranac

Group Delay

Nobody ever said operating a two-way cable system was easy. You've undoubtedly got your hands full with things such as setting levels and managing ingress. Here's another one for your list of stuff that can cause reverse path headaches: group delay.

"Group delay?" you ask incredulously, "I don't have group delay in my system. Err, what is it anyway?" Well, I'm glad you have an inquiring mind.

According to the IEEE (Institute of Electrical and Electronics Engineers) *Standard Dictionary of Electrical and Electronics Terms*, group delay is: "the derivative of radian phase with respect to radian frequency. It is equal to the phase delay for an ideal nondispersive delay device, but may differ greatly in actual devices where there is a ripple in the phase vs. frequency characteristic."

"Now I know I don't have any," you continue. "Radian phase and radian frequency? Never been a problem where I work." Hmmm, I thought you might say something like that. I suspect your system does have group delay, and I'll wager a fresh cup of Starbucks that you've seen it and maybe even measured it, at least in your downstream plant. More on this in a moment.

What it is

About that IEEE group delay definition: It's clearly not all that clear, so let's see if there is a more down-to-earth way to sort it out. I found a pretty good explanation in Roger L. Freeman's *Telecommunication Transmission Handbook*, 2nd Edition, 1981. (By the way, Freeman's book is now up to the fourth edition.) I've paraphrased some of his explanation and adapted it to fit our world of cable TV. Even though I'm emphasizing the reverse path, these concepts also apply to the forward path.

Think about your system's upstream spectrum. It starts at 5 MHz and stops around 40 MHz. That 35 MHz bandwidth can be thought of as a bandpass filter of sorts, at least from the perspective of a signal traveling from a subscriber's cable modem back to the headend.

> "Your next question might be along the lines of, 'What the heck does all of this have to do with causing reverse path headaches?'"

Whether you're looking at the reverse spectrum of a single amplifier or the entire network, a signal within that 35 MHz bandwidth will take a finite amount of time to go from point A to point B because of the velocity of propagation through the amplifier, the cables and all the other parts that make up the system.

The velocity of propagation within a bandpass filter—in this case, the 5 MHz to 40 MHz reverse path—is not uniform across the spectrum. Velocity of propagation usually is a bit higher at the center of the passband than it is at the band edges.

Delay's many forms

A signal takes a finite amount of time to pass through a circuit, an amplifier or the entire system. This is known as propagation delay or transit delay, or just plain delay. Signal delay also can be thought of as the slope of a phase vs. frequency curve. Absolute delay is the delay that occurs at some reference frequency.

Here's where things start to get a little messy. If the propagation time through that circuit, amplifier or system is not the same for all frequencies within a given bandwidth—say, our 5 MHz to 40 MHz reverse path—we have the equivalent of phase shift.

If the phase shift changes uniformly with frequency, no problem. But if the phase shift does not change uniformly with frequency—that is, if the phase-frequency relationship is nonlinear—signals at the affected frequencies will be distorted. The result is called delay distortion or phase distortion and is expressed in units of time, typically nanoseconds, relative to a reference frequency.

Phase distortion commonly is measured by a parameter known as envelope delay distortion, which is the derivative of the phase shift with respect to frequency. Envelope delay distortion expresses the instantaneous slope of the phase shift characteristic and is the difference between the envelope delay at one frequency and the envelope delay at another frequency.

Envelope delay distortion often is called group delay distortion. Another way to think of group delay is the rate of change in the slope of the phase vs. frequency curve.

If a circuit, amplifier or system has zero group delay distortion, that means

the phase-frequency characteristic is linear, and all frequencies within a certain bandwidth are transmitted through the circuit, amplifier or system in the same amount of time.

Is this beginning to sound familiar? A little earlier I said that you've probably seen group delay and maybe even measured it, at least in your downstream plant. It's called chrominance-to-luminance (C-L) delay inequality, which is a type of group delay. When you measure this, you are measuring the time difference between the luminance and chrominance portions of a video signal.

If C-L delay exists, either the luminance or chrominance will arrive at the receiving end before the other one does. In extreme cases, the result is visible as the so-called "funny paper" effect, where the color (chrominance) in a TV picture is offset from the outline of the image (the luminance).

What does it all mean?

Where am I going with all of this? Think back to the earlier statement about the equivalent of phase shift happening when propagation time through a circuit, amplifier or system is not the same for all frequencies within a given bandwidth.

In general, if the frequency response is not flat within that bandwidth—because of any number of causes, including mismatches and reflections—the propagation delay will not be constant, and a phase shift will occur at some frequencies. The result is group delay distortion.

Your next question might be along the lines of, "What the heck does all of this have to do with causing reverse path headaches?" Plenty. The integrity of data can be affected by group delay.

If group delay exceeds a certain amount, data transmission and bit error rate (BER) will be affected. For instance, most cable modem manufacturers recommend that reverse path group delay within the signal passband not exceed a certain value from the subscriber's premises to the headend.

Once group delay falls below that threshold, the cable modem manufacturer will no longer guarantee BER performance as it relates to group delay. Typical maximum allowable group delay figures are in the 70-nanosecond to 200-nanosecond range, depending on the modem manufacturer, modulation scheme, symbol rate and bandwidth. In general, delay distortion should be significantly less than the period of one bit or symbol.

Eradicate delay in the return

OK, group delay can be bad. How is it measured? One way is to use a vector network analyzer, which essentially is a very sophisticated and very expensive bench sweep. Unfortunately, the test leads would have to be pretty long to be able to connect one end in the subscriber's home and the other in the headend.

Another way uses a frequency-modulated signal that is swept through the frequency range of interest. A companion receiver recovers the frequency modulation and determines phase variation as the input signal is swept.

While the latter technique is more practical than the former, there is a more efficient method for cable TV systems. Just over a year ago, I wrote about a rather unique way to test the reverse path. Holtzman, Inc.'s Tom Williams has developed a reverse path measurement technique called burst-mode data capture. It allows one to test the shielding integrity of coaxial cable, as well as measure upstream frequency response, phase response and group delay. Check the December 1997 issue of *Communications Technology* for details on how this technology works, or give Tom a call at (303) 444-6140.

Now for the last question: How can upstream group delay problems be prevented? Easy! Keep the frequency response as flat as possible. This means you need to sweep the reverse path. Note the word "sweep." Alignment with multiple carriers isn't good enough because you can't see what's happening to the frequency response in between the carriers.

If you want to be serious about reliable data performance, then you need to expand your system maintenance efforts to include sweeping the reverse. Do this, and you'll have one less two-way headache to deal with. 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.

Reader Service Number 14

built-in part of a network interface unit (NIU). Motorola's product, according to Marketing Director Gary Grainger, could support circuit-switched data bandwidth on demand, with up to eight 64-kbps slots at the network interface, but has not yet been activated as an offering.

When operators consider these data access products, the services the operator offers are positioned as part of a portfolio that focuses on data rather than voice. As Craft states about his Express/path feature, "(It) is viewed as a tiered data service that is complementary to a dedicated cable modem service." This is true, but such a service also starts to bring the bandwidth needed for IP telephony one step closer to the subscriber's phone.

Circuit-switched or bust

IP network side gateways are another example of a migration building on circuit-switched technology. November's Arris announcement was typical. The Cornerstone IP Access Gateway product will take traffic from the Cornerstone HDT and translate it to an IP protocol for transport to the IP backbone.

"The other part of the truth, however, is that the long run is longer than the competitive local access market, and most cable operators are willing to wait."

Once again, note that IP network access builds upon a circuit switched access product, the HDT. The strategy for the operator is a graceful migration from the public switched telephone network (PSTN) onto an IP backbone. Line cards at the network interface can be replaced and lines provisioned for IP telephony access as it makes sense to do so, and not necessarily all at once.

It is interesting to note how Arris positioned the availability of its announced product. The press release states: "Scheduled availability of the Cornerstone IP Access Gateway is aligned with the emerging PacketCable standards and the development of other standards-compliant, end-to-end IP network components."

You can interpret this in your own way, but my take is that it reinforces the view that IP telephony access without a supporting managed network infrastructure is not a viable option.

As a final example of evolution instead of revolution, consider how even the PSTN side of the telephony switch is beginning to use IP technology. Gateways to IP networks are being installed on the network side of service provider telephony switches. These gateways are not to the public Internet, however. They tie to private, managed IP networks, and all the end user needs to know to use them are the dialup access codes.

So, in the long run, it is true that IP technology will dominate the telephony market, both for access and network applications. The other part of the truth, however, is that the long run is longer than the competitive local access market, and most cable operators are willing to wait.

Perhaps Ken Craft sums it up best: "Most MSOs that plan to deploy telephony are now comfortable with HFC switched-circuit technology and better understand the costs and how to deploy this service. On the other hand, IP telephony solutions, quality of service (QoS), reliability and costs are still in the very early stages of this new technology, and it's premature for any mass roll-out or deployment." CT

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, he can be e-mailed at jjunkus@aol.com.

By David Devereaux-Weber

Fiber: Does Glass Flow?

Odd Theories and Similar Such

This month's selections from the SCTE-List are all about fiber-optic cable. As usual, there were hundreds of messages this past month. These are just a select few, and even they have been edited to fit the available space. I offer my sincere apologies to everyone whose messages I could not include.

From: Leo Boivin
Date: Monday, Oct. 26, 1998
Subject: Definition needed

...has anyone been able to define the useful life of a fiber cable? Did you use average loss in dB/km?

From: Ron Hranac
Date: Tuesday, Oct. 27, 1998
Subject: Re: Definition needed

I'm not aware of any limitation on the useful life of a fiber cable. Assuming it is properly installed and maintained, a fiber cable should outlast the people who put it in.

I'm not sure if you're trying to relate fiber loss to the fiber cable's life. (The two really aren't related.) Fiber loss has to do with the attenuation of optical signals passing through the fiber. Fiber manufactured more recently will tend to have somewhat lower attenuation figures because of manufacturing improvements.

For instance, these days it's not unusual to see contemporary 1,310 nm fiber attenuation for single-mode fiber in the 0.35 dB/km range, compared to 0.4 dB/km (or more) just a few years ago.

When engineering fiber links, some will use an average figure that includes all anticipated splice and connector attenuation, plus overhead for future splice and connector attenuation that may be necessary as a result of repairs and/or system growth. Others will use a published or measured fiber attenuation specification and add published (or measured) splice and connector attenuation figures separately to define a link budget.

From: Douglas A. MacLeod
Date: Tuesday, Oct. 27, 1998
Subject: RE: Definition needed

Although I hate to disagree with Ron, fiber actually does have a finite life. Over time, glass will settle under the force of gravity. While this usually is not significant, in fiber-optic cables it will limit the useful life (at least so the scientists expect) to around 20 years.

After that point, the settling will start to impact the properties of the fiber. Our fiber experts here tell me that the phone industry is starting to see this problem on some of the oldest fiber in their networks, and replacements are starting to be planned. So, who are our fiber experts out there? Steve Wolszczak? Jim Hayes? Any additional comments?

From: Bill Arnold
Date: Wednesday, Oct. 28, 1998
Subject: RE: Definition needed

It sounds a bit crazy, but glass settling is a fact that can be seen in window panes. I have seen this effect demonstrated in the replacement of window panes in a house that is, say, 50 years old. In that period of time, there is a measurable difference in the thickness at the bottom vs. the top of the pane.

From: Ron Hranac
Date: Wednesday, Oct. 28, 1998
Subject: Flowing glass and the life of fiber (was "Definition needed")

When I was in junior high school, I remember a science teacher explaining how solid window glass really was a "liquid" and flowed over time because of the effects of gravity. The proof, he said, was that older glass windows are thicker at the bottom than at the top.

As was mentioned by another List user, this is a myth and has no basis in fact.

Early window glass manufacturing techniques resulted in uneven surfaces and varying pane thickness. In some cases, a thicker portion wound up at the bottom, and in other cases at the top.

Not one to be content with this, I contacted Corning Inc., one of the major optical fiber manufacturers, as well as Siecor, a major fiber-optic cable manufacturer. I also have a call in to a fiber expert at Lucent.

According to both Siecor and Corning (this question went all the way to Corning's senior scientists), optical fiber does

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not "flow" (deform) over long periods of time from the effects of gravity. Uncabled optical fiber has a useful life expectancy of at least 40 years.

Fiber's life expectancy can be reduced by potential damage during the fiber cabling process, which may—depending on the circumstances, the cabling manufacturer, the process and packaging technique—reduce the useful life of the fiber in the cable somewhat, but it still should easily exceed 20 years. Not including "backhoe fade," environmental factors and poor-quality installations are the major factors that will affect the life of cabled fiber.

"Not including 'backhoe fade,' environmental factors and poor-quality installations are the major factors that will affect the life of cabled fiber."

I have requested some of Corning's internal engineering documents plus a trade publication article dealing with optical fiber life expectancy. After the material shows up and I have a chance to digest it, I'll pass along any pertinent comments to the List.

Bottom line—at least at this point—remains that properly installed and maintained fiber cable (assuming no manufacturing defects, of course) should outlast the people who installed it.

From: Jim Hayes
Date: Friday, Oct. 30, 1998
Subject: Glass Legends

The topic of glass being a superviscous liquid that flows over time seems to crop up regularly when fiber optics are discussed. I've heard it many times in the 20 years I've been in fiber optics.

Glass is indeed an amorphous substance (non-crystalline), but I think you'll find most of the commonly heard stuff on this subject are old wives tales.

The evidence usually presented is that old glass is wavy and irregular because it has flowed. In fact, the unevenness is an effect of how it was made. Until the Pilkington process was invented in the middle of the last century, window glass was all uneven. By pouring molten glass on top of molten metal (tin, usually), then cooling it enough to be taken off, a perfectly smooth, flat surface was obtained.

Glass, like other amorphous substances, may anneal over time. Reports of fiber actually having lower loss over time could be attributed to the annealing of stresses in the fiber from pulling, but I've never seen any definitive information related to this.

I suspect it's really an anomaly caused by test equipment. Bellcore published data almost 15 years ago that showed the loss in fibers could change by 0.05 dB/km for only a source change of less than 30 nm (1290-1320), well within the range of variations seen in typical laser transmitters. Figure what happens in 10 km or 100 km!

Thus, measurements have an uncertainty that also could be used (erroneously) as evidence that the fiber loss has changed. I'll try to contact some of my glass manufacturing friends to see what they say, and if anyone has any documented evidence, please let me know.

From: Ron Hranac
Date: Monday, Nov. 2, 1998
Subject: "Flowing" glass and fiber life

OK, gang, I just got off the phone with Lucent's James Refi (former AT&T Bell Labs guy, and one of the fiber industry's top dogs).

He concurs with what scientists at Corning had to say about the question of gravity deforming optical fiber over time due to the glass supposedly flowing.

Bottom line: Bunk! This simply does not happen. This myth has its roots in the false belief that glass windows in old buildings had "flowed" over time because of gravity.

The supposed evidence was that some very old glass windows had been found to be thicker at the bottom than at the top. The real reasons for this were: 1) In early times, glass manufacturing techniques created uneven surfaces and varying thicknesses in the glass panes, and 2) the thicker end of the window often was installed at the bottom.

Corning faxed me a copy of an article that appeared in their publication "Guidelines" that indicates the projected life of fiber is in excess of 40 years.

Here's the quote: "Harsh environments begin to take their toll the moment system components are deployed. Severe weather, moisture ingress, corrosion and fatigue are all known to damage communication infrastructure.

"Given these factors, the typical usable life of most copper systems has been shown to be 15 to 20 years. Conversely, optical fiber's immunity to adverse conditions makes it possible to project its useful life out to 40 years or more. The oldest fiber systems in operation now are more than 20 years old and continue to meet installation performance requirements."

As I mentioned in a previous post on this thread, Corning stated that certain manufacturing-related cabling problems can reduce the useful life of cabled fiber.

Lucent's Refi pointed out one other possibility. In some very early optical fiber designs, the coating material was not well-stabilized and could separate from the glass (primarily near the fiber ends), aggravating microbend-induced losses.

Other than those two potential manufacturing-related problems, quality of installation and maintenance plus environmental factors are the main contributors to reduced fiber life—outside of backhoe fade, of course.

Based on what I've been told by Corning and AT&T/Lucent, we certainly can forget about "gravity-induced glass flow" as a problem. It's not, and there is no evidence to support it. CT

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

many ways to membership societies such as the SCTE.

I, too, work a great number of hours and find it difficult to find time to volunteer. I must say, however, that I am much happier in my life if I make the time to become involved as a volunteer for my church, Boy Scouts, Habitat for Humanity or other organizations. You would think that the added commitments would add stress to my life, but indeed, stress is reduced through volunteer participation. I still even find time to be a couch potato occasionally.

> "Many of the programs that have enticed people to join SCTE have been created or completed by volunteers."

Get involved

SCTE needs your volunteer help. It is easy to be critical or to withhold your participation when you feel an organization isn't meeting your needs or providing the services you desire. It is much harder to look inward at ourselves to find the time and commitment needed to be part of the solution to influence the changes we desire.

We have openings on committees to help with training programs, certification programs, standards development committees, chapter committees and subcommittees and so forth. Contact a member of your local chapter board or your SCTE regional director. Get involved as a volunteer. You will find significant rewards in being an active participant in helping to fulfill the mission of the Society. "The difference is membership." CT

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

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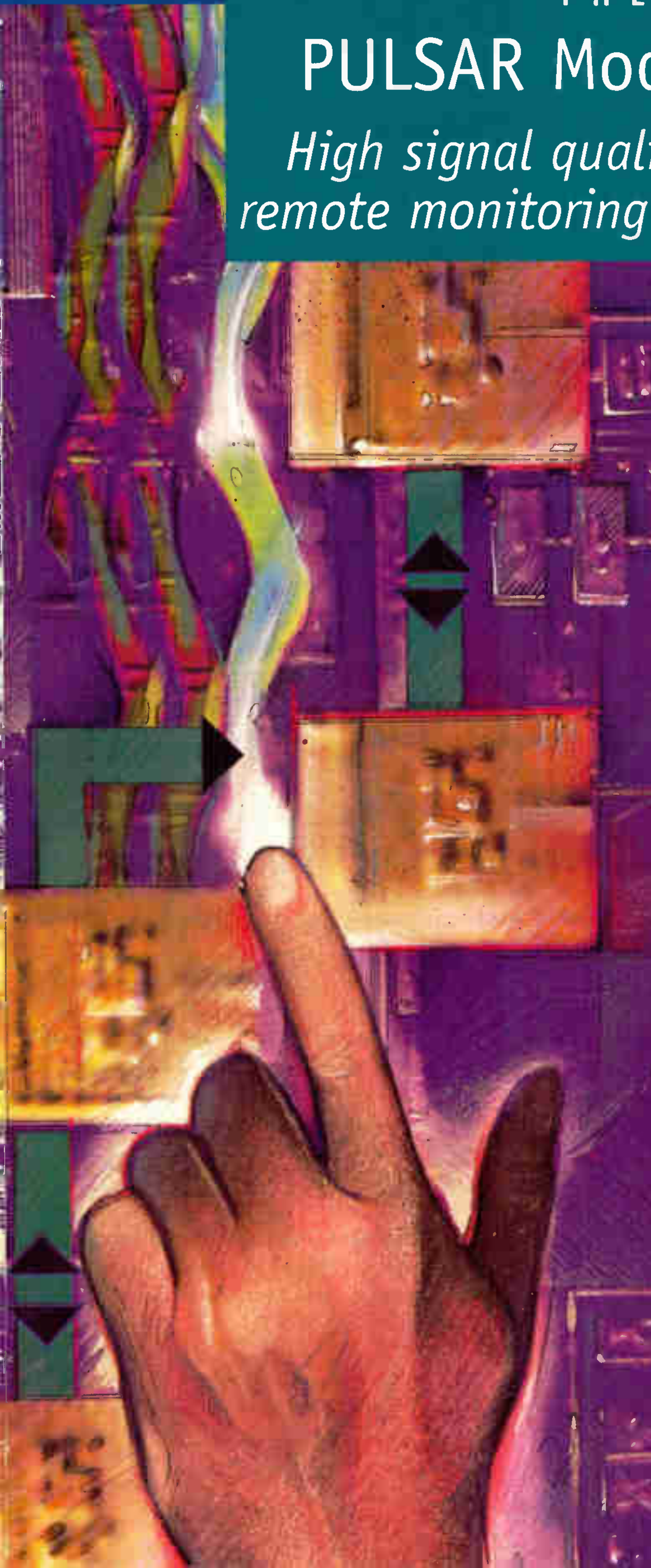

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Reader Service Number 24

Is a Y2K Bomb *Ticking* In Your Cable System?

Prepare for it with a Y2K Contingency Plan

By the *CT* Editorial Staff

It may be impossible to totally squash the Year 2000 bug, but with careful planning, cable engineers and technicians are working together to contain the technical pest as executives work with counsel to stamp out the legal one.

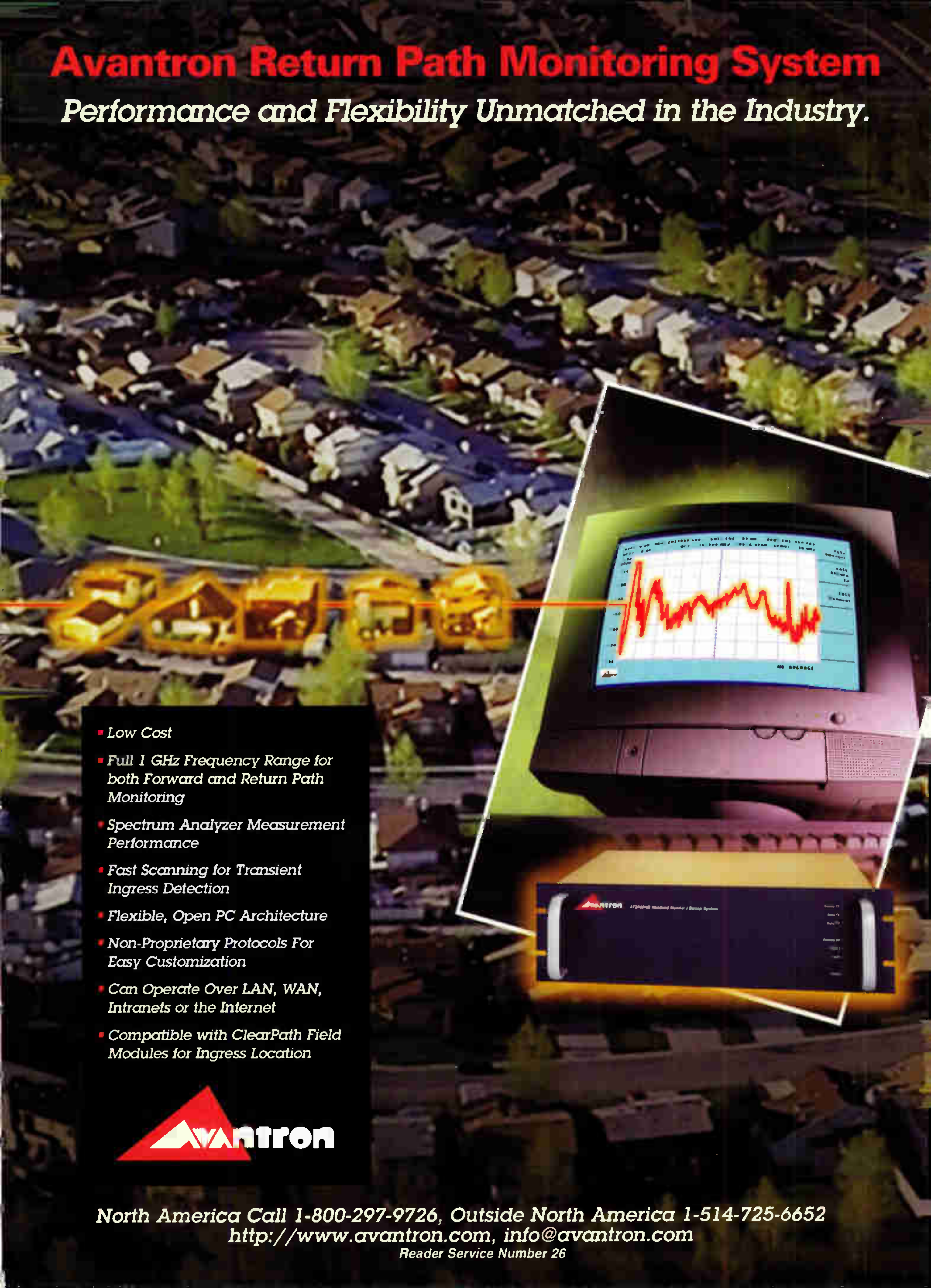
Legal concerns and changes in Securities Exchange Commission rules requiring publicly held companies to disclose their Year 2000 plans, associated costs and status have changed the ways businesses communicate about compliance. Major vendors and MSOs are unable to speak as freely as some would like about how they're handling Y2K. If they're too optimistic, they may be exposing themselves to litigation. Pessimism could alienate shareholders. Since there's no way to know for certain what the future has in store, discussion of Y2K compliance can often take an ambiguous tone.

"I'm sorry, but Time Warner reports on Y2K issues in a formal way at the corporate level only," says Time Warner Cable's Chief Technical Officer Jim Chiddix. All he felt comfortable revealing regarding the MSO's plan is contained in the company's quarterly report.

Legal issues aside, there are substantial technical challenges facing the cable industry. Equipment snafus likely will affect many operations. While lawyers and executives hash it all out in the boardrooms, system engineers and technicians are out there trying to beat the clock and prepare their systems for the unknown.

Identify the enemy

"There are many vague generalities about Y2K for several reasons, says Dave Devereaux-Weber, network engineer at the University of Wisconsin at Madison. "There is no real way to do a 'production' (as opposed to lab) test with all the equipment that needs to interact. There is also a fear of litigation. This appears to be a big opportunity for the legal profession. This problem crosses boundaries among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specialties, like financial programmers, systems programmers, networks, hardware and software issues and legacy equipment." Devereaux-Weber says the latter can define equipment from somewhere between 1970 and 1998.

"Virtually nothing is insulated," says Prime Cable's Senior Vice President of Science and Technology Dan Pike. "Trying to force knowledge where there can be no certain knowledge is futile."

Because Y2K affects virtually every industry and so many types of operations are interdependent, the stealth Y2K bug can even creep through the cracks of a well-prepared system.

"Industries affected include manufacturing, shipping, service, telecommunications, power generation and so on. Our technological sophistication ordinarily requires narrow, deep specialization, but the Y2K problem is a 'systems' type area that requires broad analysis," Devereaux-Weber says. "It is likely that all major cable systems and other communication and financial services companies will have addressed most Y2K problems. The problems that could occur will be those existing on the boundaries between systems." ➤

BOTTOM LINE

Is Your System Y2K Ready?

Contingency planning is key to preparing your system for the Year 2000 according to the Colorado-based CableLabs Y2K Working Group. The group's chairman and leader of Jones Intercable's Y2K program, Patrick Vertovek, and member Doug Semon agree that planning is among the best means of protection. This checklist, compiled by Dave Devereaux-Weber, raises the kinds of issues that need to be addressed before the Y2K clock rolls over. This list is not comprehensive, but a good starting point for a Y2K brainstorm:

- Have a total system inventory on hand.
- Have a way to get into your buildings if electronic systems fail.
- Have a plan for power generation in case of power outages.
- Have a contingency personnel plan in case there are problems with public transportation or New Year's Eve celebrators.
- Have a contingency communications plan (wireline telephone, cellular or PCS telephone, paging, two-way radio). Can you contact your employees? Can your customers contact you?
- Have a contingency plan for vehicle fuel and standby generators, in case your primary provider is down.
- Have a financial contingency plan. Can you pay staff and procure crucial supplies?

Preparation and analysis

"It's like preparing for a natural disaster," says Pike. "You have to think it through. It's a special subset of the plan for dealing with a flood or a hurricane. Make it a priority to protect revenue-critical stuff first, and work your way down the list."

In the final analysis, Devereaux-Weber says, it is important for system operators to understand systems that are under their direct control, determine the times and dates where problems could occur, and plan for contingencies in critical systems during those times. Important Y2K-related dates to remember include the evening of Dec. 31, 1999, to Jan. 1, 2000, and Feb. 28, 2000, to Feb. 29, 2000.

"A cable system is the sum of its parts, and any weak link can bring it down or seriously compromise the efficiency of the operation," says Steve Allen of Jerry Conn Associates. "CableLabs is working to identify the Y2K problems inherent in the cable infrastructure, such as billing systems, headends and commercial insertion. I hope they look farther. At my phone company, we were requiring all of our vendors of products and services to certify their products and their companies as compliant."

Compliance issues

A representative from one major vendor says that legal concerns are too binding for anyone from the company to speak to the press about Y2K compliance, but the company is approaching its customers individually to resolve compliance issues.

Defining what is "Y2K ready" also has posed a pervasive legal issue for many types of equipment vendors and customers. New York state defines it as follows: "We define 'Y2K ready' as being able to continue to operate without service disruptions after a critical date has been passed. There is potential that systems or devices may not report the data properly, but if a device still operates, it is considered Y2K ready. If it also reports properly, it is considered Y2K compliant."

Who's most vulnerable?

"I am concerned for the small systems. There has been so little press at the street level that I am afraid the guys on the street don't know how much they can be affected," Allen says.

Allen posed the question to cable engineer Poge Smit in an e-mail. "In my opinion, the smaller the operator, the smaller the potential for Y2K problems—at least in the areas directly under the control of one's understanding of and capability to prepare for the worst," Smit explains.

"My particular situation doesn't seem all that complicated to consider. Our billing system is in-house and vulnerable. The entire system is 6 years old and in need of a total upgrade, anyway. Compliance was a pretty easy sell to the bean counters when we threw the Y2K scare into them," Smit says. Still, he has more to contend with in preparing for Y2K.

"Regarding the power grid effects: 99.9% of my plant is powered by our municipal generating facility," adds Smit. "I just finished discussing the potential for disaster with the director of technical services there. His department has thoroughly researched the issue as it relates to the local generation and distribution infrastructure. He states without hesitation that our community will have plenty of juice." ➤

Smit points out that in a worst-case scenario, a major disruption of natural gas distribution could force power generation equipment to run on diesel fuel. Without proper contingency planning, a disruption in conventional communications could interfere with dispatching area fuel trucks. These are potential outside hazards to which his system may be vulnerable, but over which he has no control.

> "Trying to force knowledge where there can be no certain knowledge is futile."

"So, see? I don't have anything to worry about," Smit says. His headend accounts for that other 0.1% of his plant. "It's out in rural co-op territory, which is actually an extension of the Ohio Edison system with a nice design. Actually, our municipal generation can produce power for six days with diesel reserves, and my headend can function for five days on our LP reserves. If it gets any worse than that, we're in big trouble, and my concerns will certainly not be cable TV, but rather basic survival for my family. I for one, don't think it'll get that bad."

Reporting from the other side of the cable industry coin is a headend technician and engineer for a larger TCI system who is planning for Y2K on a different scale. "For the past year we have replaced or plan to replace every piece of test equipment, including personal computers, software, remote timers, sweep systems and so on that were not Y2K. Our regional engineers asked for a survey of all equipment and verification of Y2K compliance last year, so it would seem that we have something of a jump on it. However, I know we haven't thought of everything. I am especially concerned with what we cannot see and what is not at first obvious. I am referring to embedded chips in devices that I am sure are being overlooked. It is amazing how virtually everything is related to timing, isn't it?" CT

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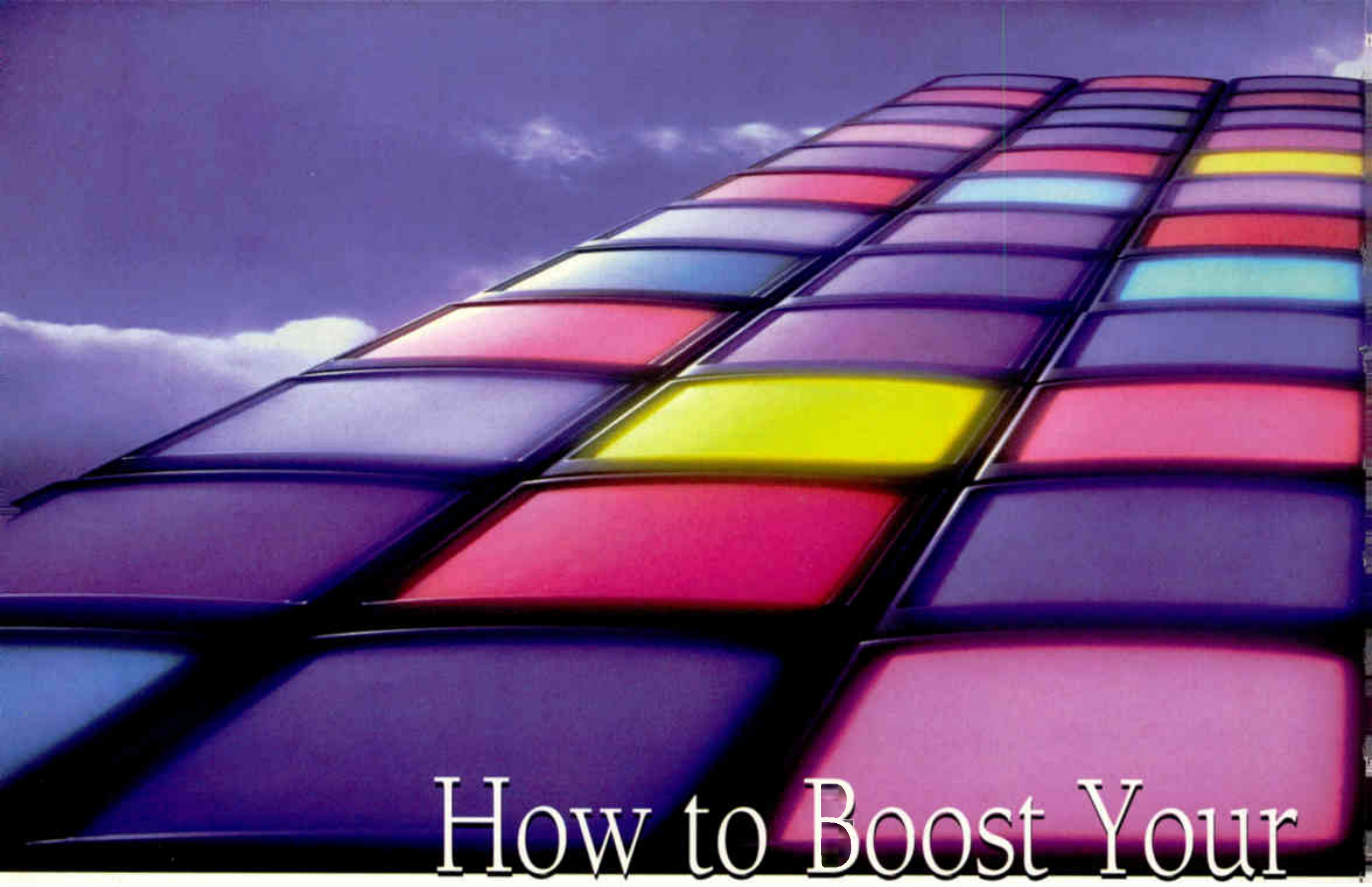


How to Boost Your

Video-on-Demand Network Infrastructures

By Yvette M. Gordon

Cable plants have been upgraded to support digital broadcast. Digital set-tops are being installed, and now we look toward layering interactive services. The logical first service, which is coveted as the new revenue generator for the cable industry, is video-on-demand (VOD).

The cable industry's year of awareness and preparation for VOD was 1998. Technological advancements enabled vendors to reduce equipment costs enough to help make the service a reality. Meanwhile, the industry at large became familiar with the technological requirements. Now both sides are looking forward to deploying the killer competitive application.

More than video servers

Generally, VOD is seen as simply installing video servers. This is far from the truth. Although video and audio Moving Pictures Experts Group (MPEG)-encoded files reside on video servers, the control and management of these files, as well as network integration, are critical to the success of VOD. A complete VOD installation will account for total system automation to ensure that the operational costs won't undermine the business model. When analyzing VOD platforms, it's critical to ensure all of the pieces are planned for because many solutions require an operator to obtain these components from various vendors. So, what are these components?

First, there is the video server. A video server will store many gigabytes (1 billion or 1,000 megabytes) or terabytes (1,000 gigabytes) of MPEG content and stream or output upon request.

In cable broadband architectures there are two standard output types for video servers: digital video broadcast/asynchronous serial interface (DVB/ASI) and asynchronous transfer mode/optical carrier 3 (ATM/OC3).

The number of video servers depends on the number of titles to be stored and the number of streams to be played simultaneously. The goal is to keep server costs at a minimum and, therefore, multiplex as many streams as possible together into one 6 MHz channel or onto one fiber for hub transport. Some servers perform this multiplexing function on their own, eliminating the cost of an external multiplexer.

Another VOD component is the quadrature amplitude modulation (QAM) modulator. For each multiplexed 27 Mbps or 38 Mbps channel, one 64-QAM or 256-QAM is required for modulating content onto a 6 MHz channel.

Subscribers' Choices

The next VOD component is the set-top application, a software program downloaded in-band to a set-top for browsing through the selection of VOD titles. Some VOD set-top applications also are integrated into a program guide application already resident in the set-top. The set-top software allows the customer to browse through and select titles. The content information and graphics are communicated to the set-top either in-band or out-of-band (OOB). Since this information is common to most set-tops, it typically is broadcast to minimize necessary bandwidth.

Movie selections and pause, resume, fast-forward or fast-reverse requests are communicated in real time through the reverse path to another software application at the headend. These typically are called the VOD client and server applications. The selection of the client application is critical to ensuring the look and feel fits what is desired for the area.

Operators may choose to deliver VOD consistent with the program guide or deliver a unique interactive, graphically enhanced experience. Regardless, it is important to keep in mind that the user interface is separate of the video server.

To integrate VOD with the digital network requires interconnect software between the headend application and the digital bandwidth and encryption server..

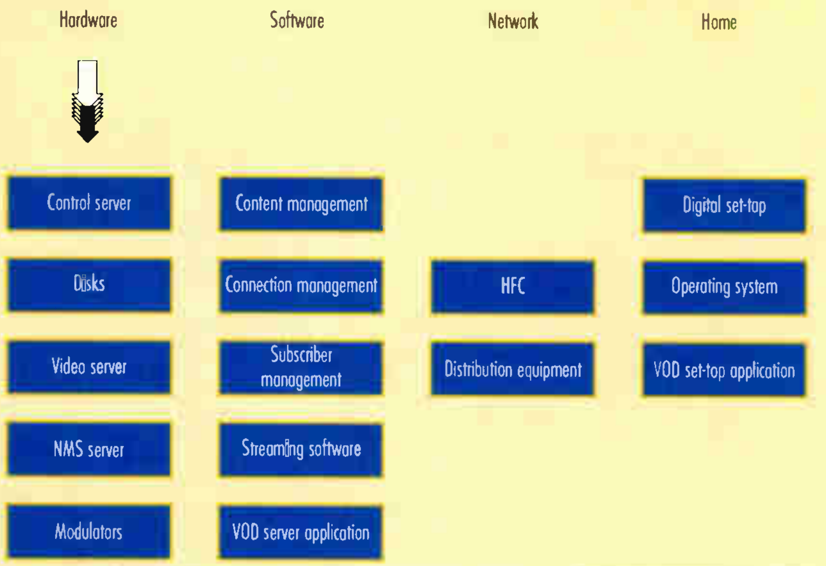
Most digital networks include one or more headend computers, which manage the digital bandwidth, broadcast schedules/billing and digital encryption control. Since bandwidth control and encryption also are required for VOD, it's critical for interactive sessions to employ the same method used for broadcast video. In some cases, the server-side application communicates directly with the encryption server, but for a truly scalable system, this is likely to be a separate software and hardware component.

Some VOD systems also include flexible streaming software as opposed to standard server application programming interfaces (APIs), allowing streams to be controlled by multiple applications in a standard fashion. The streaming software also addresses fault resilience of streams on a software level (re-routing to different QAMs in the event of failure).

Network management is not to be underrated. As technologies advance, having a complete network management system is critical. For VOD, it's necessary to account for hardware and software traps, including run-time diagnostics.

With the logical components of a VOD system defined, we now look at content management—the software component that makes VOD a reality. VOD mandates having video files moving onto and off of

Figure 1: Video-on-demand (VOD) components



servers. If servers reside at hubs, files have to be copied to server complexes all over the city. Performing this manually would introduce extraneous staffing costs and the possibility of frequent errors.

In addition to managing video content, there is the management of the pricing, movie information or metadata (story description, stars, director and so on), and subscriber management. One reason VOD is perceived to be difficult is that until recently no complete and automated content management systems existed.

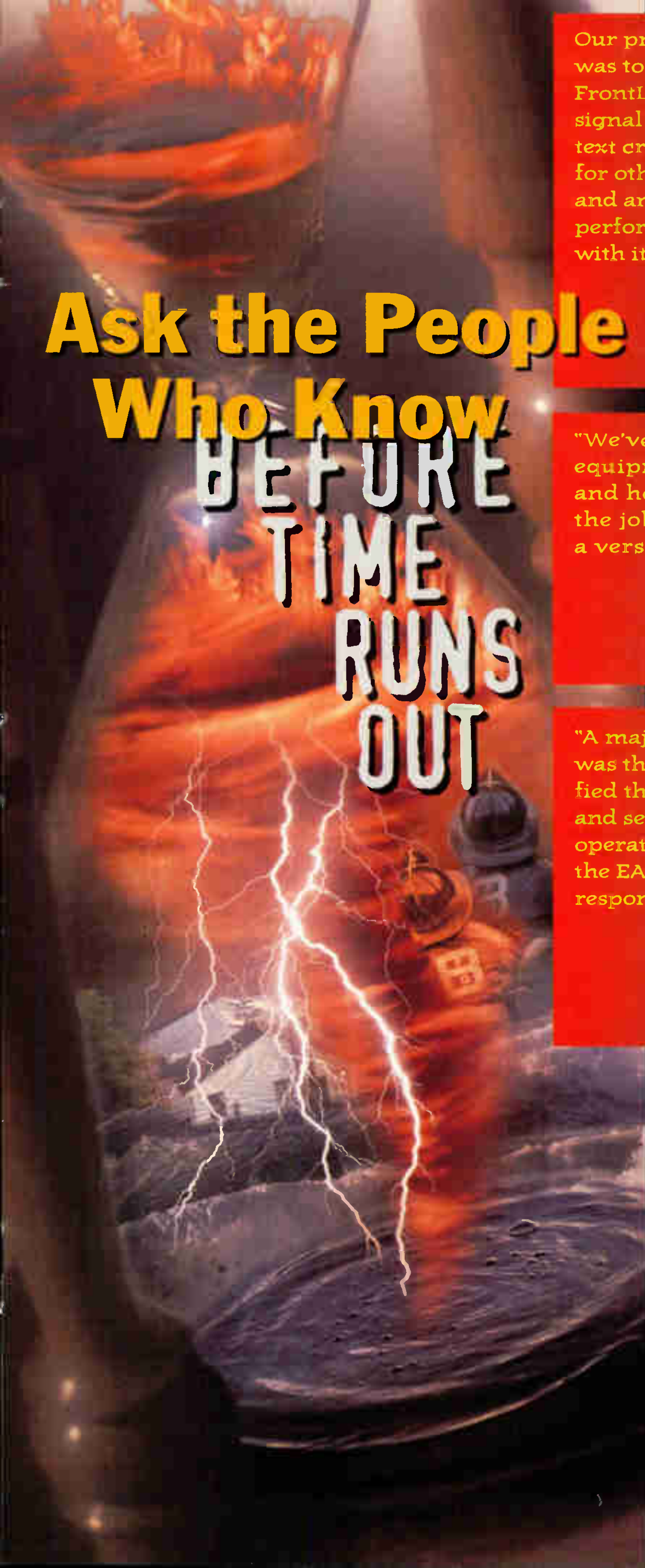
A good content management system that is tied closely to a server solution can reduce operational cost as well as minimize hardware cost by optimizing storage and more.

In addition to its primary task, a good content management system also will propagate content to servers automatically, making actions such as loading, moving, copying and deleting content files hands-off procedures.

Digital network integration

Figure 1 depicts the components described as mandatory for a complete VOD system. (It assumes that a digital network architecture is in place and that VOD will tie into this delivery system.) Depending on which digital set-top box has been selected, the headend architecture can change significantly. Some digital headend equipment includes separate encryption and control servers specific to VOD, whereas others may integrate directly

Ask the People Who Know



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Area Engineer
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Reader Service Number 35

with the same servers that control broadcast bandwidth and encryption.

A generic network architecture for an integrated VOD headend is depicted in Figure 2 (on page 50). Green components represent existing analog broadcast equipment, blue components are existing digital broadcast equipment, and red components are VOD-specific.

Although the concept of every potential VOD subscriber owning his/her own digital channel may seem overwhelming, the amount of bandwidth required for a VOD network is quite reasonable.

Factors for calculating channels required depend on the number of nodes used for combining, size of nodes, encoding rate, VOD penetration rate, simultaneous streams and QAM modulation.

As an example, assume that combining takes place for four 500-home nodes and the VOD penetration rate is 15% of homes passed. Movies are assumed to be encoded at 3 Mbps each. From the many early VOD trials, we have learned that we can support our VOD subscribers by building to 10% simultaneous usage, meaning one stream or bandwidth availability can support 10 VOD subscribers.

So, four 500-home nodes equals 2,000 homes passed. At 15% penetration, we have 300 VOD homes or 30 VOD streams required. Assuming 3 Mbps encoding, this equals 90 Mbps that are required.

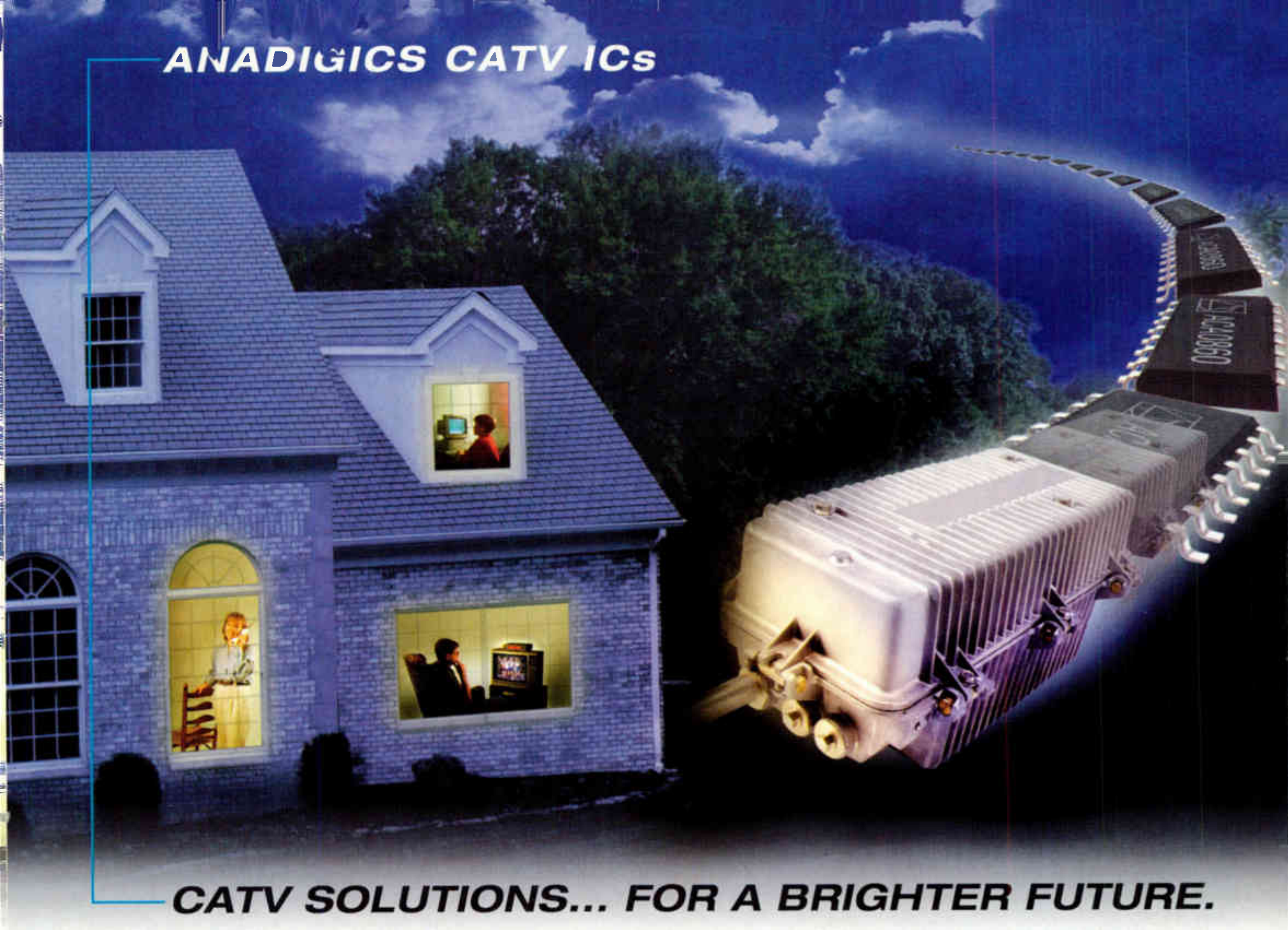
If we use 256-QAM (at 38 Mbps per 6 MHz channel), our system would require just over two 6 MHz channels. Since some broadcast bandwidth is required for data and navigation graphics, we can

BOTTOM LINE

Are You Prepared for VOD?

Several video server providers are building various levels of fault-resilient servers, a critical component to video-on-demand (VOD). Some video server vendors also are addressing the many software requirements for managing VOD deployments. Key partnerships for integration with digital network infrastructures are established, and early deployments using standard digital boxes started in late 1998.

The components that are available today allow this technology to finally become the long-awaited new revenue opportunity for cable operators. Are operators prepared for VOD? If we assume that VOD is an add-on service to digital broadcast, then we can directly link readiness to digital deployments: More than 1 million digital set-tops were deployed in 1998, and several operators announced plans to include VOD as a layered service on digital broadband networks. The year of proof that the technology is ready and can be deployed with ease will be 1999.



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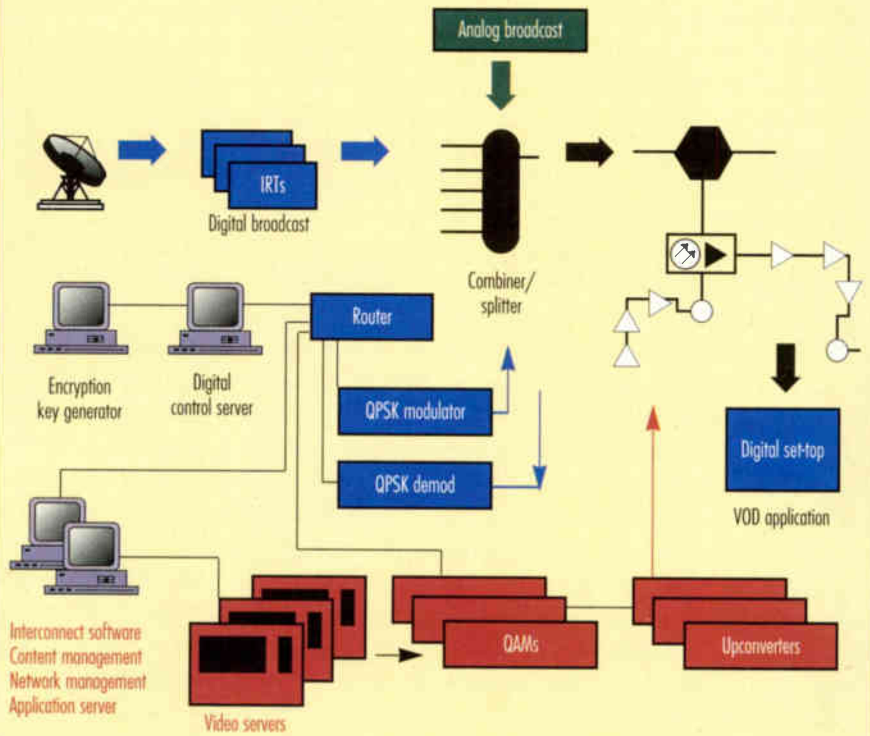
Reader Service Number 37

Figure 2: Integrated video-on-demand (VOD) headend architecture bandwidth



assume three channels are needed in this VOD bandwidth model.

Transport

Transport requirements vary according to the network architecture in place and the amount of available space in hubs.

Some servers are physically small and can be installed in hubs but could introduce operational challenges. Other large systems require locating all server capacity in a central headend, but transporting all bandwidth to hubs can be costly. This trade-off must be justified by the mean time between failure (MTBF) and tools available to help manage the servers.

If all video servers reside in the headend, we must transport all required bandwidth to each hub. If a hub has 20,000 homes passed with a 15% VOD penetration and movies are encoded at 3 Mbps, we must have the fiber and transport capacity to send 900 Mbps to each hub.

This typically can be done using one OC-48 connection. It is important to note that scaling via this distribution method also will incur more transport costs.

If all video servers reside in hubs, there is no transport cost involved, although a high-speed local area network (LAN) connection likely will be required to connect the servers for content management. Scaling does not require add-on transport cost and is a more efficient method of installing VOD when hub space is available and the server platform is fault-resilient and efficient enough to run unmanned.

Fault resilience

Finally, the key component of a successful VOD network is fault resilience. Fault resilience goes far beyond enabling a server to recover from failure.

To fit into the cable TV model, VOD equipment must operate unmanned. This means that content must be moved around servers automatically as needed and that distribution paths must be automatically redirected in the event of a failure. The most successful VOD platforms available today have fault resilience far beyond the server level, including sophisticated software fault resilience methods. CT

Yvette Gordon is director of interactive technologies at SeaChange International in Maynard, MA. She can be reached via e-mail at ygordon@seachange.com.

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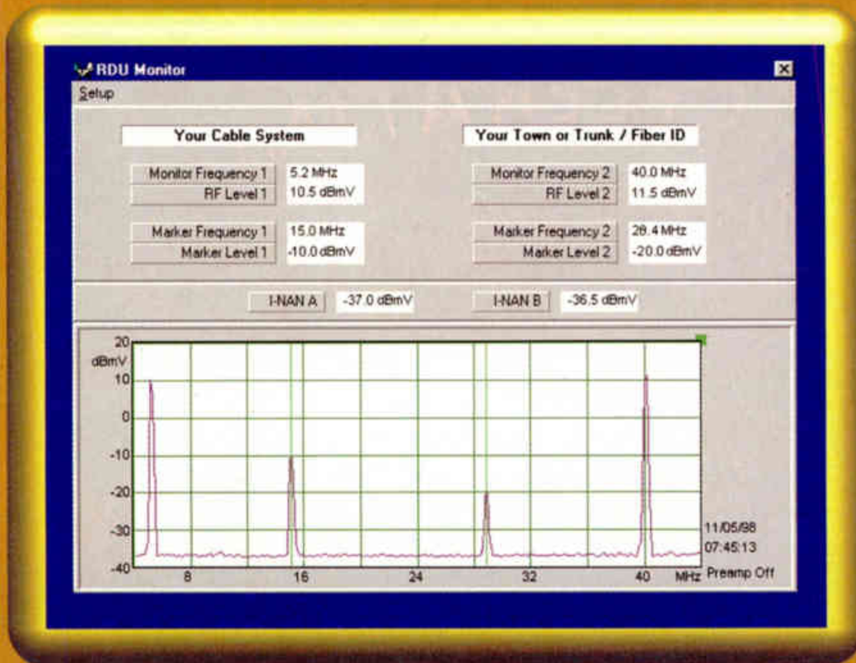

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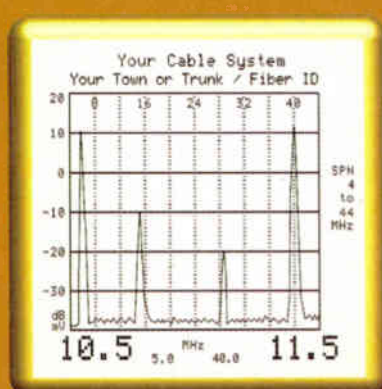

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Reader Service Number 39

MAXIMIZE the Analog Advantage While ACCELERATING the Move to DIGITAL

By Walter S. Ciciora

These days, the most exciting topics in cable involve digital technology, digital set-top boxes and the services enabled by the digital approach. These services include hundreds of digital channels, high-speed Internet access, true video-on-demand (VOD) and Web applications. A good part of the motivation for interest in all of this is the success experienced by digital delivery of programming directly to subscribers via satellite. Direct broadcast satellite (DBS) has become a serious source of competition that requires a response.

Digital technology over cable is that response. But there is more to cable's competitive response to DBS than just a move to digital set-top boxes and transmission. The reality is that the world is still overwhelmingly analog and will be that way for a long time to come.

Old world vs. new world

There are more than 250 million color analog TV receivers in the United States and more than 150 million analog videocassette recorders (VCRs). Consumers buy new

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The new power of broadband requires a new generation of power protection. The type of innovative thinking only a world leader in UPS solutions can provide. To develop it we began with an integrated approach. First marrying our proven line-interactive UPS technology with reliable ferro technology. Then incorporating capabilities that go beyond any CATV powering system available today. Finally, we added batteries, digital monitoring, outdoor enclosures and warranties totally new to the industry. The result is Lectro CPR.™ A total **integrated system solution** for power and bottom line protection.

BEFORE YOU UPGRADE YOUR UPS, CONSIDER WHAT YOU REALLY NEED TO PROTECT.

The **Lectro CPR Solution** protects much more than power. **Its** innovative design and revolutionary technology provide efficiencies that directly translate into lower operating costs.

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- Lectro CPR Outdoor Enclosure—Technician friendly for added safety.
- Lectro CPR Communicator—Digital status-monitoring capability improves reporting and reduces maintenance costs.

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Industry data shows that most MSOs perform field maintenance on batteries four times per year. With Lectro CPR this number can be reduced to one. At an average maintenance visit cost of $35, the annual savings would be $105 per unit, or $52,500 for a 500-unit system. That equals $262,500 in savings over the five-year warranted life of the CPR batteries.

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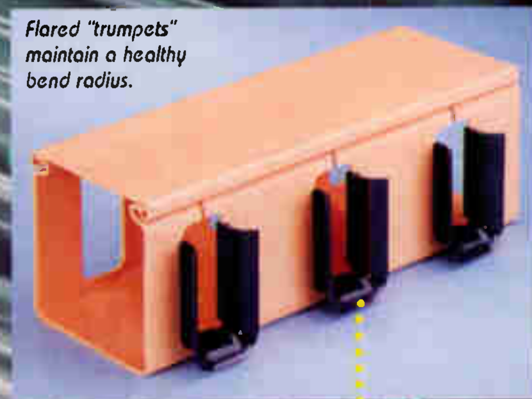
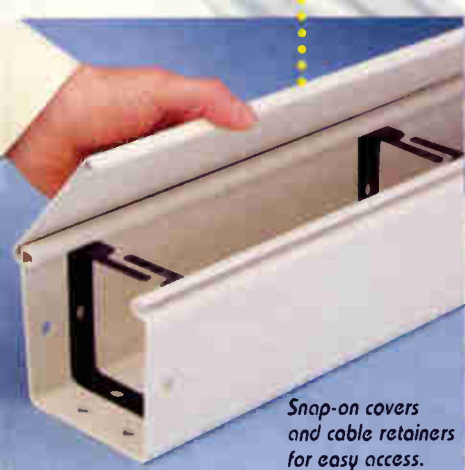


Flared "trumpets" maintain a healthy bend radius.

Carriage bolt/wing nut assemblies for tool-free installation.



Snap-on covers and cable retainers for easy access.

Pre-punched junctions eliminate drilling.

Reader Service Number 40

color TV receivers at the rate of around 25 million per year and 12 million or so new analog VCRs to go with these TV sets. These products have an average useful lifetime of well over fifteen years.

Digital set-top boxes still are relatively expensive—too expensive for all subscribers and especially for all of the receivers in most cable homes. There is a shortage of production capacity to make digital set-top boxes and a shortage of capital to buy them rapidly. Digital set-top boxes will be in the minority for many years to come for reasons of cost, production capacity and capital availability.

There is no such thing as a digital cable-ready TV receiver. And given the difficulty of defining "cable-ready" in the much simpler analog world, there may not be a truly cable-ready digital receiver for a long time to come—if ever. Even so, digital TV receivers (and VCRs) mostly are for the well-to-do. They are too expensive for the average-income cable subscriber. So analog TV will remain "television for the common man" for at least a decade. But even the well-to-do already have multiple analog products in their homes. While they will be the first to get

BOTTOM LINE

Analog Pays the Bills

While the current excitement is over the transition to digital, analog TV will pay the bills and be around for a long time. In fact, one of cable's most important strategic advantages is that it can serve the new digital receiver in the "media room" of the well-to-do while simultaneously serving all of the analog receivers in the rest of its homes.

Analog service will remain the principal form of entertainment. A challenge for cable is to maximize the utility of the spectrum that remains allocated to serving the 250 million analog TV receivers and 150 million videocassette recorders (VCRs) in American homes. There are new techniques for including up to 4.5 Mbps of digital data in analog TV signals. Important applications of such a capability have been described. Included are video-on-demand (VOD), Web applications and interactive enhancements for programming.

The analog spectrum can be used to introduce digital TV service to cable systems that have not yet increased bandwidth. Cable systems with larger capacity can try experimental services in this new capacity while not consuming bandwidth planned for lower-risk digital services. This can be done without reducing the number of analog channels. These approaches maximize cable's analog advantage while accelerating the move to digital. The compatible digital upgrade can accelerate the penetration of digital service.

digital TV receivers for the principal viewing room—in many cases the "media room"—they also will have analog receivers throughout the rest of the residence.

This huge number of analog devices constitutes an important market demanding services. Obviously, only a fool would turn his back on this well-developed analog market just to serve an emerging and currently anemic population of digital receivers. Clearly, analog TV will be with us for a long time to come, even as we aggressively move to digital services.

In fact, this reality is one of cable's major competitive advantages over those who would challenge it. Cable can continue to serve the huge population of analog devices with compelling services while simultaneously promoting the digital TV revolution. Only cable has the capacity to do both.

Analog's legacy

Because it is now possible to put multiple digital TV signals and megabits of data in each 6 MHz channel and, up until now, only one analog TV program in a 6 MHz slot, it is clear that the analog TV technical standard is very inefficient. That is by design. The analog TV standard was designed some 50 years ago when vacuum tubes were the embodiment of "advanced technology." The TV standard was deliberately designed to minimize the number of vacuum tubes required in the construction of a TV receiver. The goal then was to facilitate affordable TV receivers by minimizing the technical burden required of their electronics. There was nothing to be gained by maximizing the efficient utilization of spectrum if there were very few receivers.

An important consequence of the early history of TV standards and receiver design is that now we can find ways of adding digital data in the "holes" deliberately left in the analog signal to facilitate inexpensive TV receivers. This can be done while not impairing the original purposes of analog TV. Several companies have taken advantage of this opportunity.

The WavePhore Corp. uses the vertical blanking interval (VBI) to convey approximately one fourth of the T1 data rate (about 380 kbps). The Digideck Co. slightly modifies the TV signal and adds a data subcarrier to it for carriage of somewhat less than 500 kbps of data. Both have received Federal Communications Commission approval for over-the-air transmission and currently are broadcasting. Such transmissions need no FCC permission on cable.

EnCamera Sciences Corp. adds a quadrature carrier to the visual signal and amplitude modulation (AM) to the aural carrier along with a few additional techniques to include 4.5 Mbps of data in the analog signal without impairing its original analog performance.

These techniques are interesting and important because they increase the value of the spectrum that must continue to provide analog signals to the massive existing population of receivers. Enabling data increases value applications as well. In this way, cable's analog advantage is maximized while accelerating the move to the digital world. ➤

Economies of scale

These techniques save the cable systems that have not yet expanded bandwidth from being shut out of the digital revolution. Using these techniques, those cable systems can introduce digital applications for the subscribers who might otherwise turn to DBS. This is accomplished while at the same time avoiding a reduction in services to those subscribers who are quite happy with their analog programming.

With data capacities of 4.5 Mbps, multiple digitally compressed video programs can be offered. For most movies, current compression affords acceptable results at 1.5 Mbps. Advances in compressor technology will further improve efficiency and quality while not requiring any changes in decompressing receiver designs.

Statistical multiplexing across multiple program data streams further improves efficiency. With this level of compression, a 4.5 Mbps data pipe will support three additional movies. A cable system with 40 analog channels can add 120 digital movies without impairing the analog channels. This yields a total of 160 analog and digital channels.

This technology makes it possible for modest-sized cable systems to enter the digital age and offer such services as VOD. At the same time, the subscribers who were satisfied with their analog service would not suffer any reduction of choice. They would continue as before. When the cable system expands capacity and adds a layer of all-digital channels at some future date, the in-home digital hardware can serve double duty. It can continue to use the existing data paths included in the analog channels while also utilizing the newly added digital bandwidth. In this way, digital technology has been introduced into an analog cable system before expanding the capacity of the plant.

Even larger cable systems can allow experimentation with digital services included in the analog signal while taking less risky approaches with their expanded digital bandwidth. This additional capacity included in the analog channels makes it possible to experiment with more kinds of services.

Since "bits are bits," it is possible to utilize the capacity enabled by including data in the analog signal for other purposes. Web applications, computer publishing, data downloading and high-speed cable modems are included in just a short list of ideas available for business exploitation.

Summary

Serving the huge population of analog receivers and VCRs is one of cable's major competitive advantages. This advantage can be amplified by clever inclusion of digital data in the analog signal in a manner that does not degrade analog reception. New digital services can be added for the more demanding subscriber while not upsetting the existing analog customer. Experimentation with new services can take place without consuming precious bandwidth needed for well-established applications. CT

Walter Ciciora, Ph.D., is a technology consultant based in Southport, CT. He can be reached via e-mail at Wciciora@aol.com.

Digital vs. High-Speed Data

By John Downey

There is a difference between "pure" digital and high-speed data, which is proposed for new killer applications. This article looks at digitizing an analog signal for digital transmissions and the basics behind high-speed data.

Some basics encompass modulation types, multiplexing schemes and making accurate digital measurements. We also will look at time domain measurements such as desired-to-undesired (D/U) ratio and various time domain testing tools.

Digitizing an analog signal

The process of converting an analog signal to a digital signal consists of three steps: sampling, quantizing and encoding.

Sampling: Sampling (see Figure 1) is the act of selecting samples of an analog wave at recurring intervals such that the original wave can later be reconstructed with reasonable fidelity.

During the 1920s, Harry Nyquist theorized that all information contained in a waveform could be captured completely through sampled values if they are gathered at a rate at least as great as twice the bandwidth of the signal. Only the frequency information is preserved by sampling at Nyquist, not necessarily the amplitude. (There probably will be distortions when sampling only at Nyquist.)

Because this sampling typically is about 2.2 times the frequency, this requires much more bandwidth for uncompressed digitized signals than their analog counterparts. This is samples per second not bits per second, which will depend on quantizing precision.

Quantizing essentially is matching the sampled signals to a segmented scale. (See Figure 2.) The number of steps will determine the precision of the digitization. For example, 256 different steps equals eight bits of precision (2^8) that can be used to approximate a signal waveform. Quantizing measures the amplitude of each signal coming from the sampling step and assigns it a number or step.

Encoding: This number or step (see Figure 3 on page 60) has a binary code assigned to it. The final step of digitizing an analog signal is to create a continuous string of 1s and 0s consisting of the sequence of sampled, quantized values with each distinct value represented by a unique combination of bits.

Encoding is the step in which the base 10 number is converted to an 8-bit binary number (transmit end). Decoding is the reverse of encoding (receive end). In the case of 8-bit quantization, there are 256 different combinations, ranging from 000000000 to 111111111. There is an international standard known as CCIR-601 for digital video.

After the analog signal has been converted to a serial stream of digital bits, it must be transmitted with certain coding and received with that same decoding to allow secure and optimum communications. (See Figure 4 on page 60.)

Some transmission techniques are less efficient but eliminate problems such as a build-up of DC voltage and synchronicity. Too many bits being sent in a row could cause a high amount of DC voltage.

Quantizing error (see Figure 5 on page 60), is the small difference between the analog signal and its digital representation. Less precision in the quantizing equals more error that can be created. Quantizing error also is referred to as quantizing noise because it's sometimes heard as "noise" in the signal.

Digital nomenclature

Most digital systems use the binary number system, which can be described by two state levels, typically zero and one. These states can be represented by any of the following "digital nomenclatures:" 1 and 0; mark and space; on and off; -V and +V; and smoke and no smoke.

The -V and +V can be confusing. In Morse code, when the sender engages a "clicker," a circuit is completed that causes current to flow, which causes a voltage drop at the receive end because of the resistance in the wire. This would indicate a 1. When the "clicker" is disengaged, the voltage returns to the original value. Some systems may use +V to indicate a 1 now.

Information and transmission types include analog data on an analog signal, analog data on a digital signal, digital data on a digital signal and digital data on an analog signal.

The last point is the focus of this section of the article. The modulation technologies listed later will transmit digital information through the network by manipulating an analog carrier to represent a

Figure 1: Sampling

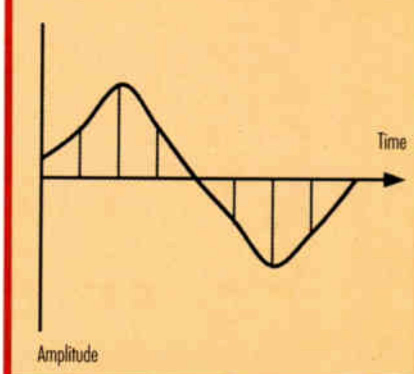
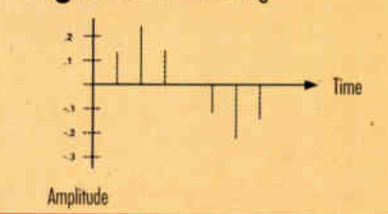


Figure 2: Quantizing



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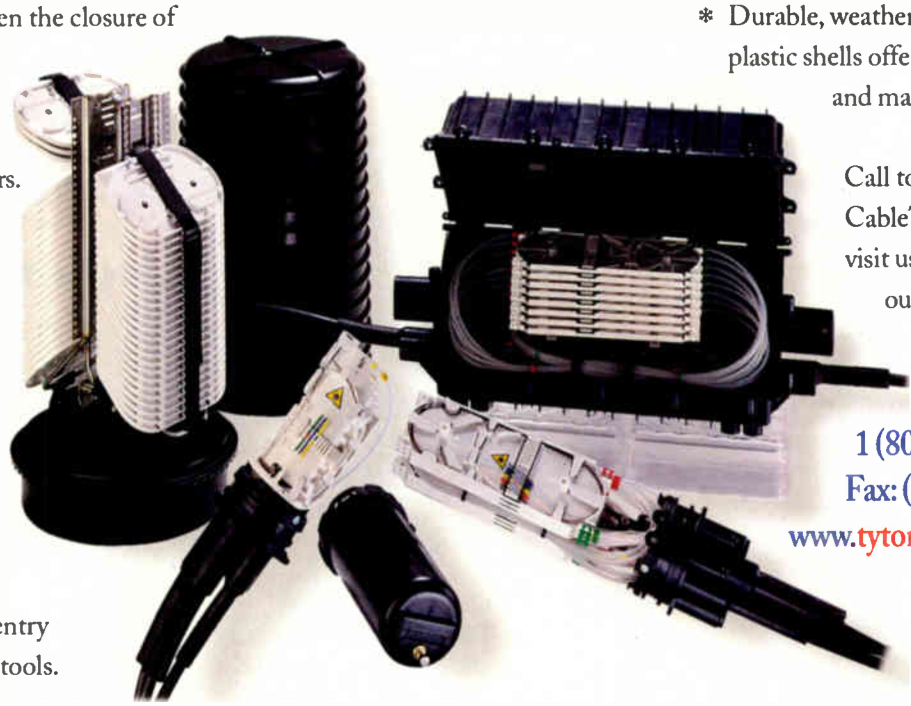

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digital symbol or bit. This will allow operators to transmit digital/high-speed data on their analog systems without the expense of pure digital equipment.

Modulation schemes

Modulation schemes include:

- ASK, FSK, PSK (amplitude, frequency and phase shift keying)
- BPSK (bi-phase shift keying—shifting the phase by 180°)
- QPSK (quadrature phase shift keying—shifting the phase by 90°)
- QAM (quadrature amplitude modulation—shifting the phase and amplitude)
- QPR (quadrature partial response—This is achieved by overfiltering a QAM signal using a filter with a bandwidth less than the Nyquist bandwidth). 9-QPR is made from 4-QAM. 49-QPR is made from 16-QAM. QPR occupying 3 MHz of bandwidth can be placed in regions that NTSC channels cannot, such as the roll-off region below Ch. 2. This may allow new services to be added without affecting the current channel lineup.

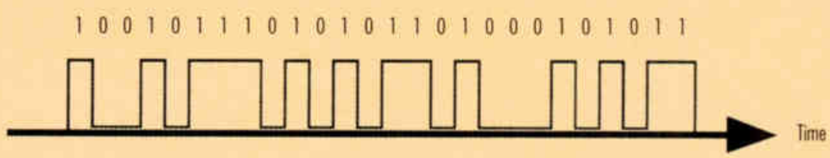
ASK uses a single signal of constant frequency (see Figure 6 on page 62) but varies the strength of the signal according to the state of the digital information to be conveyed.

The higher amplitude signal indicates one digital state; the lower is the other. The carrier can even be turned completely off for the lower amplitude.

FSK uses two frequencies to represent a mark and space. (See Figure 7 on page 62.) The difference between the two frequencies is sufficient for the circuitry of the receiving modem to clearly distinguish them. A signal near either of the two key frequencies could interfere with them. A center frequency (fc) is a reference frequency between the mark (fm) and space (fs) frequencies.

PSK uses a single signal of constant frequency, but shifts the phase of that signal according to the digital information to be sent. (See Figure 8 on page 64.) This diagram indicates BPSK. Every cycle represents a single bit.

Figure 3: Encoding



QPSK in the time domain

In the time domain, you can see the four phase states of the QPSK modulation. (See Figure 9 on page 64.)

Each phase shift is 90°. This also could be interpreted as 45°, 135°, 225° and 315°. Every cycle represents a symbol. In QPSK there are 2 bits per symbol. This would

Figure 4: Transmission coding

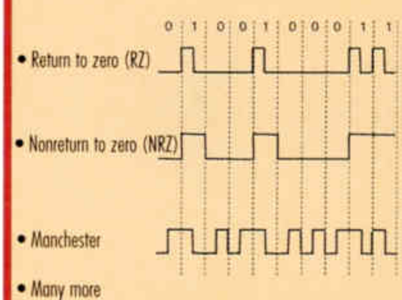


Figure 5: Quantizing error

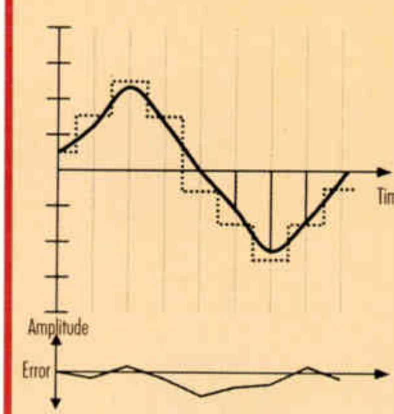


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Figure 6: Amplitude shift keying

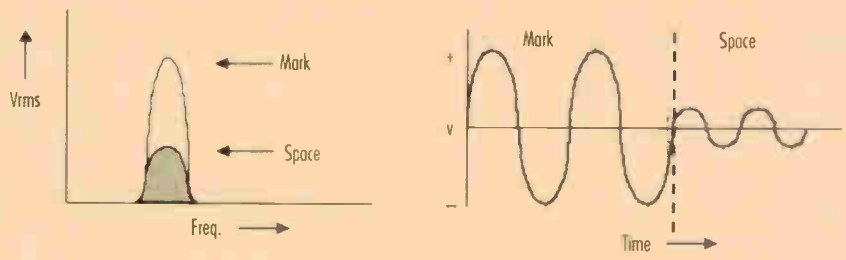
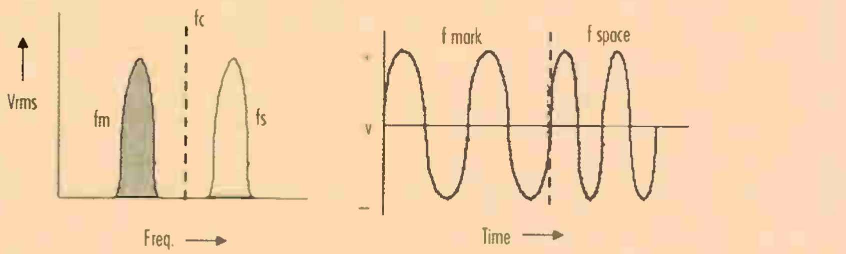


Figure 7: Amplitude shift keying



give a theoretical bits per Hz of 2, but that may be closer to 1.6. Also, some sequence shifts, such as 11 to 10, may not be possible and must be corrected.

Time domain testing techniques include bit error rate (BER), constellation diagrams and eye diagrams.

The formula for BER is:

BER = Number of errored bits received/ Number of total bits transmitted

Corrected BER is used to determine delivered performance. Uncorrected BER is used for monitoring and diagnostic purposes. BER doesn't help isolate the causes of problems but indicates that a problem is occurring or failure is eminent.

For BER and corresponding carrier-to-noise ratio (C/N) for various modulation schemes, see Figure 10 (on page 65). Many services require 10^{-6} or 10^{-8} BER for proper operation. Forward error correction will improve BER. The accompanying table (on page 64), lists more modulation schemes and BER vs. C/N.

Diagrams

A constellation display provides a qualitative analysis. (See Figure 11 on page 66.) It is the two-dimensional display of the baseband amplitude and phase values of the receive symbols taken at a particular time. These points are a summation of plots. The vector from the center of the diagram to a specific constellation point is representative of the amplitude.

An eye diagram shows the I or Q signals vs. time with multiple waveforms overlaid. (See Figure 12 on page 67.) This shows the cumulative effects of noise, ringing, jitter and other impairments.

Consider the following:

- QPSK = 4 phases = 2^2 = 2 bps/Hz
- 16-QAM = 4 phases and 4 amplitudes = 16 = 2^4 = 4 bps/Hz

BOTTOM LINE

Digital 101

Digital data on a digital signal transmission requires an analog signal to be digitized. This entails sampling, quantizing and encoding. When this is achieved, the stream of bits must be coded for transmission synchronicity and other concerns.

Digital data on an analog signal transmission manipulates an analog signal in phase, frequency and/or amplitude to represent digital data. Different modulation schemes have advantages and disadvantages. Gains in efficiency by compressing or sending more bits in a given cycle of a wave usually has a trade-off: that data will be less robust to noise and ingress, thus requiring a higher bit error rate (BER).

These modulation schemes will utilize different multiplexing techniques to transmit the information. These techniques are time or frequency division multiple access (T/FDMA), spread spectrum, or some type of multitone technique. Each has its place and will be a judgement call depending on ingress, thermal noise, impulse noise, intermodulation noise and other factors.

Figure 8: Phase shift keying

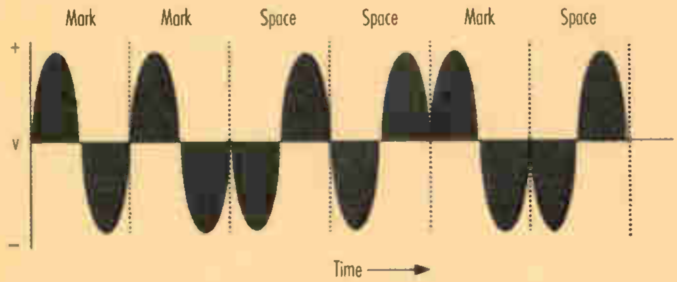


Figure 9: QPSK in the time domain

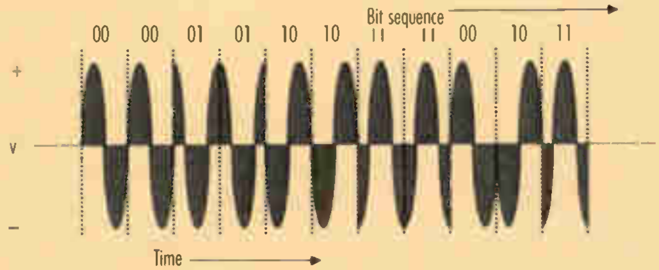


Table 1: BER vs C/N

	BER (10⁻ⁿ)				
	4	6	8	10	12
ASK & FSK	7	9	10	11	12
BPSK	9	11	12	13	14
QPSK	12	14	15	16	17
16-QAM	19	21	22	23	24
32-QAM	21	23	24	25	26
64-QAM	25	27	28	29	30
256-QAM	32	34	35	36	37

- 64-QAM = 8 phases and 8 amplitudes = 64 = 2^6 = 6 bps/Hz
- M-QAM = $\log_2(M)$ bps/Hz

These numbers are theoretical. There will be inefficiency of 15% to 50% depending on filter designs. A typical digital transport capacity for 64-QAM in a 6 MHz bandwidth is 6*6*.85= 30.6 Mbps.

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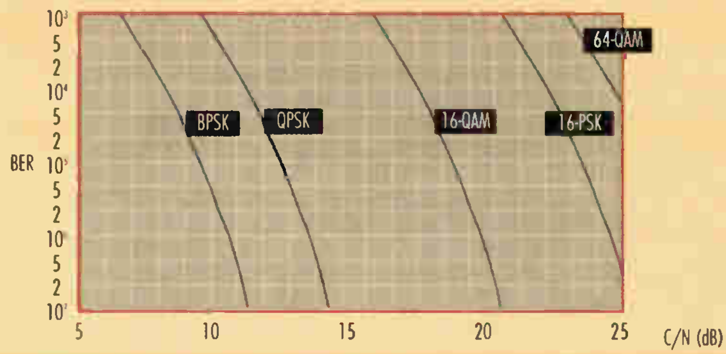
With about 10% allocated to error correction bits, 27 Mbps remains for four to nine digital video signals within a 6 MHz bandwidth. Greater bandwidth efficiency is associated with reduced robustness. The highest telephony modem data transfer rate in common use today is 53,000 bits per second. For image transfer over the Internet, this is very slow. This is what drives the need for RF cable modems with megabit-per-second data rates.

Figure 10: BER vs. C/N waterfall curves



Multiplexing schemes

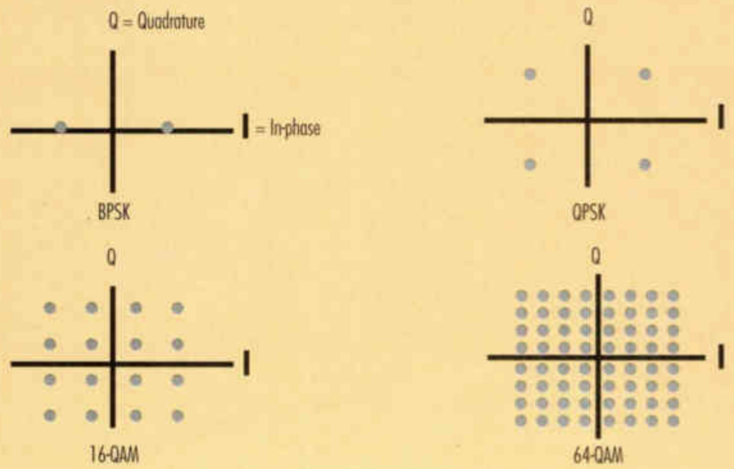
Multiplexing schemes include S-CDMA, TDMA, FDMA, OFDM and DMT.

Synchronous code division multiple access (S-CDMA), otherwise known as spread spectrum, uses codes that are shared between the customer and headend controller to spread a single data transfer over a range of frequencies. The advantage is that it is especially immune to noise impairments and maintains a high level of security. The disadvantage is that it is more sensitive to timing differences between subscribers and there is a peak-to-average ratio of ~9 to 13 dB, which could lead to laser clipping.

Time division multiple access (TDMA) allows multiple users to share a single frequency by allocating "time slices" to each user. Overall transmission rate is dependent on the number of devices sharing the frequency and the types of services being accessed. The advantage is efficient use of bandwidth. The disadvantage is that during high network usage, throughput rate is slower or reduced. Slower throughput may be acceptable for some applications that can resend, but not for telephone conversations and real-time video. These could be delayed, which is not acceptable.

Frequency division multiple access (FDMA) essentially is the dedication of a frequency to an individual service. The advantage is once a network access is established, the dedicated connection is not affected by network usage. The

Figure 11: Typical constellation diagrams



disadvantage is inefficient use of bandwidth, especially for bursty services that do not require full time network usage during a session (modems, set-top boxes).

Orthogonal frequency division multiplexing (OFDM) and discrete multitone (DMT) utilize a multi-tone multiplexing technique.

Here are some basics on bits, bytes and baud:

- Bits are either 1s or 0s.
- A byte is typically 8 bits, but could be more.
- Bit rate = bits per second (bps)
- Baud = symbol rate
- QPSK = 2^2 = 2 bits per symbol. Therefore, if QPSK happens to transmit at 10 Mbps, the symbol rate would be (10Mbps)/(2 bits/symbol) = 5 million symbols/s or 5 Mbaud.

(Editor's note: It's important to understand the difference between modulation symbol rate (baud) and data throughput rate (bit rate), which normally is expressed in bits per second. Bit rate is more commonly used today.)

Measuring digital data levels

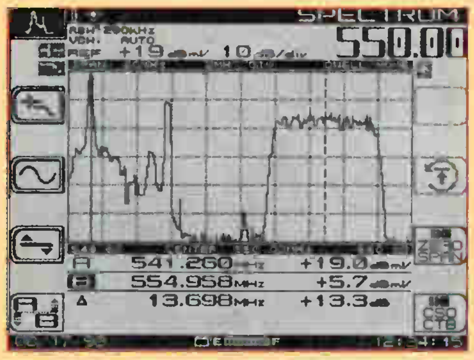
When measuring digital data levels:

- Digital signals appear as noise.
- Spectrum analyzers display noise at different levels when the resolution bandwidth is changed.
- A thermal-coupled power meter is the most accurate device for measuring average digital power levels.

A 10 dB digital-to-analog ratio out of the headend will appear differently on an analyzer depending on the resolution

Figure 12: Eye diagrams

Figure 13: Correction for forward data carriers

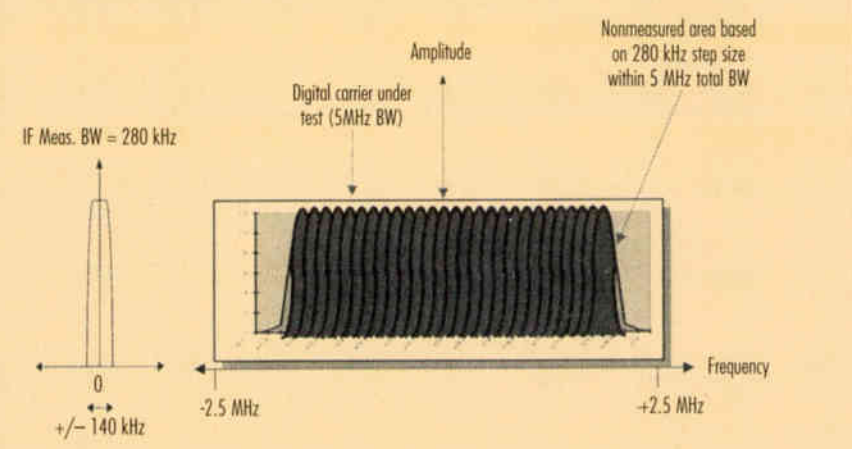


bandwidth settings. This ratio will be set by the system designer and could be 6 dB to 15 dB. This is why it is critical to understand the readings and properly set up the digital signal levels to avoid over-modulating a laser transmitter and increasing composite intermodulation noise (CIN). Many people may not realize that their analog channels could have a worse C/N after digitally compressed channels are added to their line-up because of the carrier-to-composite noise ratio (CC/N).

Consider the following in correction for analyzer measurements:

- L_{RBW} = The level read on the spectrum analyzer.
- C_{TP} = The carrier's recommended total power within the corresponding bandwidth.
- BW_{data} = The bandwidth of the data carrier.
- RBW = The resolution bandwidth of the spectrum analyzer.
- CF = The correction factor associated with the spectrum analyzer. This could be as high as 2.45 dB. Consult the test

Figure 14: Measuring the digital "haystack"



equipment specifications.

For example:

C_{TP} = 6.3 dBmV

BW_{data} = 1.5 MHz

RBW = 100 kHz

CF = 1.8 dB

L_{RBW} = 6.3-[10*log(1.5/0.1)]-1.8 = -7.26 dBmV

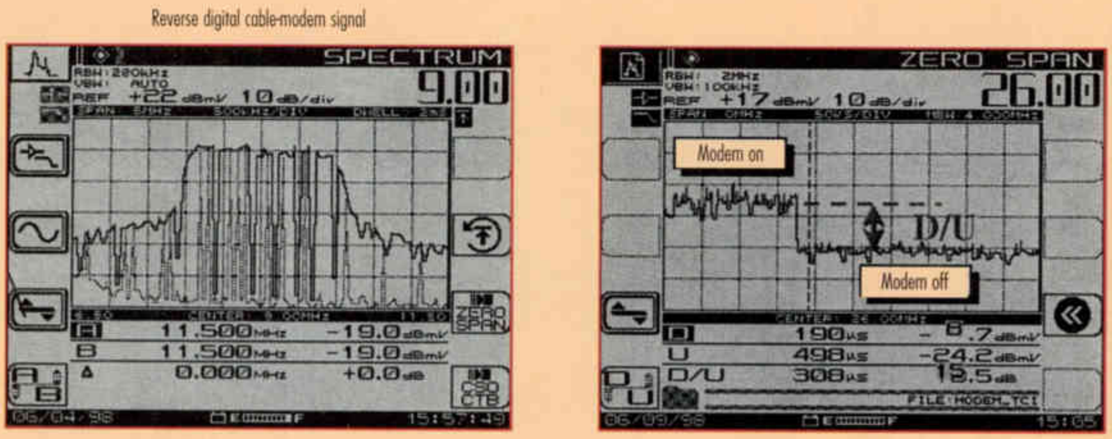
To measure these "noise-like" carriers, a spectrum analyzer can be set to 100 kHz RBW and the power/Hz scenario used. C_{TP} may look like this at the input test point of a node with a 5-40 MHz return passband and a recommended total input power of 20 dBmV: 20 dBmV- derating factor. Derating factor = 10*log(35/1.5) = 13.68, therefore C_{TP} = 20-13.7 = 6.3 dBmV.

For this example the data bandwidth was 1.5 MHz and the spectrum analyzer RBW was set to 100 kHz (0.1 MHz.). Correction factors must be used for the analyzer. This formula will only be accurate for a digital "haystack" that is perfectly square, which usually is not the case.

Something else to keep in mind is that these signals may be bursty, and a peak hold feature will need to be used over a certain sampling time to accumulate the whole "haystack". This is why test gear is desired that can correlate an average digital measurement to a thermal-coupled power meter and possibly a time domain mode to view bursty data. It may not do the derating for you to calculate C_{TP}, but it will eliminate the possible errors associated with misunderstanding the RBW settings and the readings displayed on a spectrum analyzer. This makes life easier.

The same situation occurs for forward digital data. (See Figure 13 on page 67.) The system designer may have run the

Figure 15: TDMA signals in the domain



digital data 8 dB below the analog carriers. This is 8 dB total average power, not peak level.

This 8 dB ratio of digital-to-analog levels was set for a 6 MHz carrier. If that digital "haystack" is less than 6 MHz wide, it must be derated to correspond to the power in a 6 MHz bandwidth.

For this example, the digital signal was located near the 750 MHz high pilot. Another key point for the system designer is the placement of these digital services. Knowing where analog third-order intermodulation beats accumulate will influence the frequency allocation.

This may necessitate an offset so that composite beats fall in the guardband of the digital "haystacks."

$C_{TP} = L_{HighPilot} - 10*\log(6\ MHz/BW_{data}) - D/A$

For example:
$L_{HighPilot}$ = 52 dBmV @ 750 MHz
BW_{data} = 2 MHz
D/A= 8 dB
C_{TP} = 52-4.8-8 = 39.2 dBmV

$L_{HighPilot}$ = The level of an analog carrier at the high system bandedge. D/A= the data-to-analog derating or design ratio. Now, this C_{TP} would need to be inserted into the analyzer measurement formula to see what level would be displayed on the analyzer unless test equipment is used for an average total power.

An average-power method takes small slices of the integrated RF energy, summing them together to one total power reading. (See Figure 14 on page 68.)

This method of measuring the total integrated power under the "haystack" is very accurate, especially for "haystacks" that aren't perfectly square. Using an instrument that uses one slice of the "haystack," or peak hold in spectrum mode, may be less accurate.

Digital signal level measurements should be made with this integrated power technique for QAM, QPR and QPSK (nonbursted) digital signals. User selectable bandwidth is needed for accurate power measurements. Sometimes a quick mode, which measures signals based on bandwidth estimation/normalization, technique aids quick verification.

Looking at TDMA signals in the time domain (See Figure 15 on page 70), the following is possible:

- View one frequency over time
- See noise and signal simultaneously
- Trigger on infrequent events
- Measure D/U average or peak

Select the modem's reverse operating frequency, then switch to zero-span mode to see it in time domain. With this mode, it is easy to measure average power level, carrier-to-interference or D/U ratios and see high traffic periods. All measurements are in-service.

Summary

One inherent problem with digital services is the "cliff effect." Digital channels will work either perfectly or not at all. This could make it more difficult to quantify how a digital channel is performing before it actually "tiles" or freezes.

Forward error correction (FEC) and adaptive equalization will either mask the problems or just delay the inevitable.

On the other hand, analog channels may gradually degrade and allow action to be taken before the picture becomes too snowy for viewing. When a mismatch, such as a test probe, is introduced, the picture could "tile" or freeze if the BER is already close to this "cliff."

Adaptive equalization will adjust and the picture can clear. Once the probe is removed, the adaptive equalizer has to readjust and the picture could freeze again.

Understanding digital data basics, measurements and transmission schemes is the first step to efficiently delivering and troubleshooting this new service. Digital services will require new techniques for testing, measuring and troubleshooting.

A technician or installer who can intelligently explain to subscribers how digital transmissions work will gain their respect and business while becoming more proficient at maintaining these hybrid analog/digital (HAD) networks. CT

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Photo courtesy of MediaOne

MediaOne's Western Regional NOC

Return Path Management Solutions

By Dean Becker

Providing two-way services without the right tools can be formidable. Ingress, thermal noise, common path distortion (CPD) and other impairments present hybrid fiber/coax (HFC) network operators with challenges as they set out to build and maintain a return path that meets the requirements for successful data, telephony and impulse pay-per-view (IPPV) services.

Unfortunately, return path management is a relatively embryonic science with questions outnumbering answers in many network operations. There's a general understanding that the return path requires closer management than the forward path, but this does little to help define an effective strategy.

This dilemma is eased slightly by a growing awareness of the *Upstream Supplement* to the National Cable Television Association's "Recommended Practices for Measurements on Cable Television Systems," a road map for network operators trying to translate their two-way directives into workable plans. Ironically, however, as engineers discover the *Supplement*, they also find a pronounced shortage of tools capable of providing the power and flexibility required to build comprehensive return path management solutions.

Fortunately, a new generation of HFC test, measurement and analysis tools is emerging—integrated (or, more precisely, integratable) systems designed specifically to provide unprecedented understanding of return path signals and impairments.

Signal capture/preprocessing

In test and measurement, speed and resolution specs are made to be broken. Accordingly, the next wave of return path test and measurement tools will provide breakthrough scanning and monitoring.

Network operators may expect the ability to scan the return path from a node in about 20 msecs.

This speed assures users that each node can be "visited" often enough to catch significant events as they occur. Better systems will be separated from node switches. This will let users make price vs. performance decisions that make the best sense for their situations.

A return path system connected to many ports will provide maximum coverage at relatively low investment; the same system dedicated to fewer ports will provide optimal performance at a higher per port cost.

Significant increases in resolution, up to 300% higher than those offered by current off-the-shelf products, will come without increasing scan times. Resolutions of up to 500 spectral data points on each node will give users much finer representations of what's really going on, with less dependence on the accuracy of interpolated results.

Once these faster, higher resolved scans help locate problem areas, users will be able to tune to that specific frequency and have their return path systems trigger and capture data on events that contemporary systems would overlook entirely. Expect detectors fast enough to capture impulse signals as short as a microsecond when monitoring a preselected frequency. While such impulses may or may not create errors in return path signals, they are likely to create difficulty if they occur repetitively.

From the user's perspective, accelerated screen updates—five times per second or more—will make it easier to draw more information from the user interface, spotting trends as they occur.

Systems with built-in AM/FM and single sideband (SSB) demodulators will offer interesting new capabilities. If, for example, an operator suspects that an interfering carrier is a leak into the system from an over-the-air service, the return path analyzer will be able to demodulate the signal. It can then be played aloud through a client workstation outfitted with a standard sound card.

Signal analysis/post-processing

Traditional spectrum analyzers have serious deficiencies as return path monitors. Because the energy content of an impulse-type signal is spread out over many

frequencies, traditional spectral plots yield little usable information.

Moreover, capture of a detected signal allows feature extraction only with respect to its amplitude characteristics. By capturing return signals at the digitized intermediate frequency (IF) prior to detection, all signal information is retained, allowing any analysis to be performed at any time.

This capability will permit users of advanced return path systems to extract various facets of the signal. Numerous statistical methods—incorporating both frequency and time domain analysis—can extract meaningful signal information that is invisible in normal spectral plots. These techniques exploit attributes other than signal frequency, including periodicity and amplitude distribution characteristics.

Post-analysis can identify alternate signal "signatures," which help identify the source and nature of an offending signal.

For instance, impulse noise signals (often periodic) are difficult to see using a scanning spectrum analyzer because of their broadband nature. Ignoring spectral frequency characteristics, certain time domain analysis techniques (auto-correlation) make these offending signals easy to spot by revealing their periodicity.

This provides a clue to the problem's source. Systems with such abilities will have reference libraries, helping users match temporal fingerprints with real-world sources.

Pull it all together

While these techniques answer some tough questions, they are not, in themselves, whole solutions. Users still require tools to integrate and correlate the information they gain from advanced signal capture and analysis, and they still must apply what they've learned to their everyday operations.

Systems that integrate basic services (user interface and alarm display, scheduling, and data management systems) have considerable advantages. Users also gain valuable growth potential, unlocked by mating their test system environment with an advanced network management system (NMS).

Integration with NMS also brings additional technologies to bear on analyzing return alarms. New systems can eliminate "zoning out" from receiving too much raw data, using artificial intelligence (AI) engines to correlate power, optical network and return problems.

The system then can report a root cause alarm, not a few dozen "barking dog" alarms, easing and speeding repair. Similar capabilities, based on the correlation of data from all corners of the HFC network, will boost efficiency, save money and enhance the overall value of users' systems.

Conclusion

By improving scanning and monitoring specifications, by using new technology to deliver new presignal and post-signal capture analysis capabilities and by integrating with network management systems that correlate data across multiple facets of the plant, emerging solutions will redefine return path management. CT

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BOTTOM LINE

Manage the Return

The upcoming generation of return path management tools promises to redefine the state of this still-evolving art. The best of these systems will deliver:

- Faster scans with much higher resolution (500 spectral data points in a 20 msec, 5 MHz to 42 MHz scan)
- The ability to trigger on and capture events that contemporary systems miss entirely
- Improved user interfaces
- Powerful new preprocessing and post-processing capabilities, enabled by capturing return signals at the digitized intermediate frequency (IF)
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Reader Service Number 61

CTA19

Take Off with IVR Technology

Cable's Customer Service Co-Pilot

By Kirk Cameron, Karen Ferraro and Robert Thrasher

Big changes are underway in the cable TV industry. Basic rates have been rolled back as much as 17%. The Federal Communications Commission is imposing higher standards for customer service. Telephone companies are becoming competitors. What's a cable company to do?

With more than 128,000 customers, Paragon Cable in Portland, OR, is one of the top 100 cable systems in the United States. To reduce costs and provide better service, Paragon automated many of its routine customer services using interactive voice response (IVR) technology. Originally, the installed system was used to process the ordering of pay-per-view (PPV) programming.

"We took a total of about 125,000 calls each month," says Sandy Moran, vice president of finance at Paragon. "About 30,000 of these calls were for ordering PPV and were handled by the IVR system. Another 50,000 calls were from people seeking information about their accounts, and these calls were processed by the IVR system. Because so many of our calls could be automated, Paragon's telephone representatives were able to provide better service to subscribers who had detailed inquiries or complex problems."

PPV automation

Initially, Paragon automated PPV orders using a 900 number. Automating this service had mixed results. To maximize PPV revenue, it was important that the service be both reliable and convenient.

Paragon's former system had some limitations. When customers called to order a program, the system always responded with, "Thank you for calling, enjoy the show," and would then hang up. However, some customers were not eligible to order PPV because of problems such as insufficient credit or lack of a set-top box.

Thus, customers neither received the programs they thought they had ordered, nor were they told why their orders were not processed. When Paragon's 900 number provider went out of business, the company needed to find a replacement.

IVR integration

In 1992, in the middle of a major sporting event, Paragon's audio response unit (ARU) crashed.

"We needed someone to fix the problems, so we brought in a telecommunications consulting and software development firm specializing in IVR application development and project management. The consultants suggested ways of streamlining Paragon's systems by integrating voice and data processing. They had worked with various IVR equipment providers before and suggested a system," Moran explains.

"The system fit all of Paragon's design needs. It was a proven product with an open-systems architecture. It was compatible with existing communications lines and host data screens. It also supported integrated services digital network (ISDN), which was needed for automated PPV ordering," Moran adds.

How IVR works

IVR automates dissemination of information to customers via telephone. IVR is a computer application that integrates voice, data and telecommunications.

Most IVR applications connect to some type of host environment (such as an IBM

BOTTOM LINE

IVR Improves Call Automation

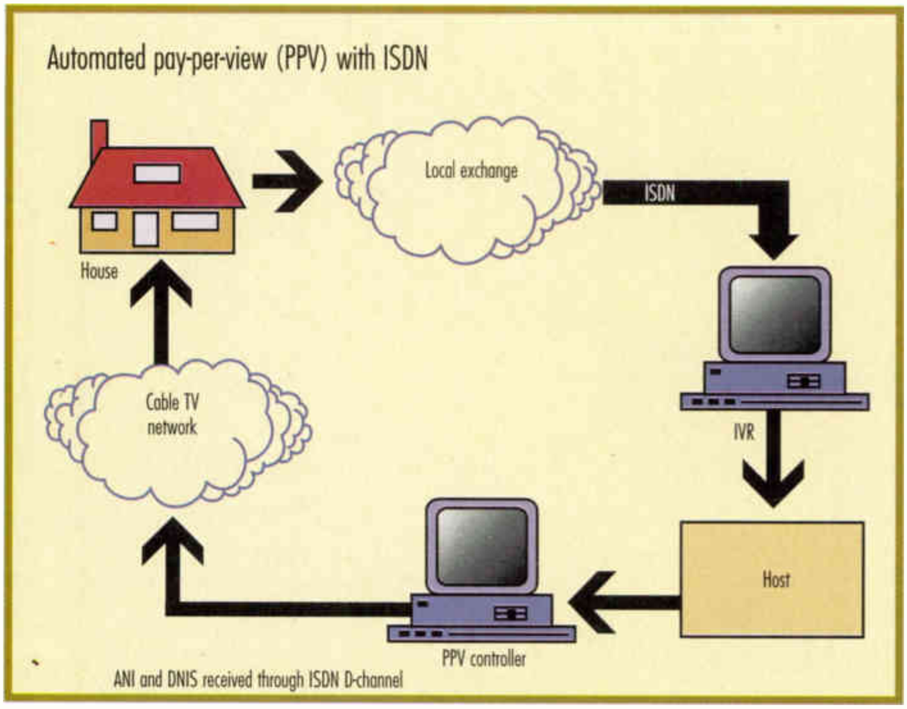
Interactive voice response (IVR) technology is a convenient way to process and automate the dissemination of information to large numbers of customers using the telephone. By integrating voice, data and telecommunications functions, IVR applications help to interpret, route, answer and provide callers with desired information.

Put to use in the cable TV industry, IVR technology is proven to enhance the daily call automation and handling processes via computer and telephony functions. When Portland, OR-based Paragon Cable automated pay-per-view (PPV) programming, the IVR system handled an estimated 60% of monthly customer calls. This greatly improved handling of customer service calls that require detailed information or present complex problems.

In addition, IVR technology will allow this cable company to provide enhanced customer service through applications such as account and billing access, single-channel service additions, work order generation as well as work order access, status and confirmation.

Internally, the addition of enhanced IVR reporting systems will strengthen the IVR manager's ability to monitor system usage and diagnose system problems. Such informed control is essential to ensuring the highest level of customer service and satisfaction.

mainframe or file server) to gather the data the customer wants. This data is accessed through various sources, such as 3720 emulation, transmission control protocol/Internet protocol (TCP/IP) packets and local databases. Most IVRs have a telephone interface/voice processing card that connects to multiple phone lines.



A customer desiring information from Paragon calls the company. The call is routed to the IVR, which guides the caller through a series of pre-recorded prompts to find the information he or she seeks.

IVR determines what a customer wants by interpreting touch-tone digits that the customer enters via the handset. IVR systems also can interface with voice recognition systems and Web-based applications.

ISDN support

Paragon's IVR system is a dual 96-line unit. The system interfaces with two host computers. The first host is a proprietary mainframe system operated by the Cable Services Group in Denver. It performs customer billing and work order scheduling. The second host is a personal computer (PC)-based converter that handles the addressing functions of computerized controllers. A Zenith controller authorizes decoders and certain channels.

Paragon's PPV service relies on ISDN network service ordered from the local exchange carrier (LEC). This was one of the

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LEC's first installations to send automatic number identifications (ANI) over the ISDN D-Channel. The VPS system interfaces with the network and allows the receipt of ANI and direct inward dial numbers (DIDs) in conjunction with the call. An ANI list was established and indexed on the system, which allows callers to immediately order services. If an ANI is not identified or matched via the index, the caller receives a menu option that directs the call to the desired department.

The ISDN network provides several advantages including 7-digit dialing, transmission of ANI information, and intelligent communication between the system and central office. Also, Paragon is not billed for long distance charges.

"We have a different phone number for each PPV channel. Although there are separate numbers, the calls are routed to the same application running on the system, which identifies the desired PPV service based on the number that the caller dialed," Moran explains.

"The system uses the ANI information, which specifies the caller's phone number to determine who is on the line. For security purposes, the caller has to punch in a four-digit PIN (personal identification number). The system then sends a signal to the PC controller, which activates the customer's set-top box," Moran adds. (See accompanying figure on page 78.)

With the consulting firm, Paragon went through system planning, script creation, application flow design and installation. It was tested with employees in July 1994 and launched to customers in August.

"It was exciting to get good results so soon," says Moran. "The system provides detailed call records. The reports show who called, how often, what they ordered, and the reason an order was rejected."

In addition to the customer service application, customers are able to confirm scheduled service and appointment times.

Future directions

Besides PPV, customers will be able to add single-channel services through the IVR system. The IVR will generate the actual work order and send it to the Cable Services Group. Use of voice recognition to perform the functions now requiring a touch-tone phone also is planned.

IVR improves call automation and the way calls are handled by customer service representatives via computer and telephony functions. When the system processes a call and the caller chooses to transfer to a representative, all information acquired by the system will be passed to the operator's monitor. Integrating IVR technology has greatly improved Paragon's efficiency, call quality and general operations. CT

Kirk Cameron is president of Executive Extension. He can be reached via e-mail at kcameron@eei-net.com. Karen Ferraro is director of marketing for Periphonics Corp. She can be e-mailed at karen.ferraro@peri.com. Robert Thrasher is information technology manager for Paragon Cable. He can be e-mailed at bob.thrasher@twcable.com.

Two-Way RF Transceiver Modules

California Eastern Laboratories' Integrated Solutions Group added the ISG3300 Series to its line of two-way RF transceiver modules for cable modems. Multimedia Cable Network System (MCNS)-compliant, the modules are designed to interface directly to Broadcom Corp.'s latest cable modem integrated circuit (IC), the BCM3300.

Like the BCM3300, which combines quadrature amplitude modulation (QAM) modulator, demodulator and media access control (MAC) all on one piece of silicon, the ISG3300 combines all active and passive RF functions in a single shielded drop-in module. The design provides typical signal-to-noise (S/N) performance of 37 for 64-QAM modulation and 35 for 256-QAM, with no post forward error correction (FEC) errors, over an input range of -20 dBmV to +15 dBmV.

Reader Service #312

Pedestal

Reltec's DuraPed pedestal is the company's latest innovation in outside plant security and corrosion protection.

Featuring a mill-galvanized steel top on a corrosion-resistant nonmetallic base, DuraPed provides protection and durability for the outside plant. The polyethylene base serves as a safe and convenient noncorrosive mounting material alternative. It's designed to accept multiple mounting options and a variety of bracketry while affording 360° access. It's intended for tap, directional coupling and splitter applications and comes in an 8-inch by 8-inch model.

Reader Service #310

Digital Support Software

IMAKE Software & Services released its e.merge turnkey digital entertainment business support software. e.merge is a centralized Java-based, Internet-enabled suite of software components with full user capability, authorization and security. The system includes data security to ensure data integrity across various business areas.

The suite of applications offers a complete front-office to back-office solution and supports multiple user types.

Associated products include the EPG (electronic program guide) Analyzer to ensure the accuracy and timeliness of program guides and Problem Tracking, an Internet-enabled database of technical "search and solve" information.

Reader Service #306

Weatherproof Connectors

Phoenix Communication Technologies has introduced a line of weatherproof compression connectors.

The one-piece connectors are bright acid tin-plated, first-generation brass with no plastic parts. Universal design enables the use of one connector for all braid and shielding options. They are designed to be crimped with the existing Ripley compression tool, CAT-SNS.

Reader Service #307

TDR

Riser-Bond has announced its Model 1205CX metallic time domain reflectometer (TDR). This cable fault locator features a sub-nanosecond pulse width for increased sensitivity.

The TDR will enable the user to identify very small, often unsuspected faults that may be within inches of each other. Model 1205CX will troubleshoot and locate faults in all lengths of trunk, distribution and drop cables. Intermittent fault detection (IFD) mode detects and displays intermittent faults and allows the operator to manipulate and reposition the waveform without affecting the IFD function.

Additional product features include noise filters for eliminating unwanted waveform noise, dual independent cursors, and automatic and manual cursor placement.

Reader Service #308

CD Content Via Internet

Arepa released a broadband software platform that enables personal computer (PC) users to instantaneously access compact disk-read only memory (CD-ROM) content via the Internet.

The Arepa system eliminates the need to download software, a slow and unreliable process, then store this data on a PC hard drive. Instead, the system distributes CD-ROM content throughout broadband networks, then delivers the appropriate files as needed in real time from the PC user's local broadband server.

Reader Service #311

UPS

Alpha Technologies has announced its XM Series 2 CableUPS, a 90 V, 20 A uninterruptible power supply (UPS). The unit features dual isolated outputs and 100% front panel access to all connections and test points. Additional product design enhancements include improved modularity, higher output power, a liquid crystal display (LCD) Smart Display, advanced battery charging and N + 1 redundancy capability. The design incorporates complete generator compatibility, flexible system control and advanced status monitoring options. It displays suggested troubleshooting hints under alarm conditions.

Reader Service #309

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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.

- *Broadband Return Systems for Hybrid Fiber/Coax Cable TV Networks*—This guide to designing and deploying two-way cable systems explores the future's most exciting applications. For cable operators, it delivers a complete primer on two-way services, capacity and equipment planning, performance analysis, setup and maintenance. System designers may gain an in-depth understanding of equipment requirements for the headend, distribution system and home. For equipment designers, this book provides in-depth coverage of performance requirements and the technical characteristics of the return path. Order TR-32, $57.
- *The Return Path Package*—These five videotapes span the return path spectrum. Topics covered in the series include: activating, aligning, calculations, management and testing problems and solutions for the broadband return path system. Speakers deal with the real-world problems of the return path and the commitment of time and resources to activate a healthy two-way system. Titles include: *Making Two-Way Work Part One* (T-1204), *Return Path Basics* (T-1210), *Cable Modem Technology* (T-1221), *Return Path Problems and Their Solutions* (T-1222) and *Making Two-Way Work Part Two* (T-1223). For the entire package, order P-111, $170.
- *Broadband Telecommunications Technology, Second Edition*—This book helps readers learn more about various broadband disciplines from the physical transmission medium to high-speed data and video services. The book is a comprehensive guide to an integrated view of new broadband technologies, enabling readers to refine understanding of new concepts and terms in each area. Supported by nearly 300 illustrations, this revision offers updated information on trends in technology development. CT

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CALENDAR

January

8: SCTE Satellite Tele-Seminar Program, Galaxy 1R, Transponder 14, 2:30-3:30 p.m. ET. Topic: "Data Over Cable (Par Two) Managing Your HFC Upgrade." Contact the Society of Cable Telecommunications Engineers national headquarters, Janene Martin, (610) 363-6888, ext. 220.

12: Cascade Range SCTE Chapter technical seminar. Contact Micah Martin, (503) 230-2099, ext. 347.

12: Pocono Mountain SCTE Chapter technical seminar, Ramada Inn, Hazleton, PA. Call Robert Trently, (717) 454-3841.

Planning Ahead

Feb. 24-26: Texas Cable Show '99, San Antonio. Call (512) 474-2082.

March 23–24: Digital Engineering Conference: The Consumer Electronics Future, Crowne Plaza, Hasbrouck Heights, NJ. Call (703) 907-7660.

May 25-28: Society of Cable Telecommunications Engineers Cable-Tec Expo '99, Orlando, FL. Call (610) 363-6888.

June 13-16: 1999 National Show, Chicago. Contact the National Cable Television Association at (202) 775-3669.

June 22- 24: International Conference on Consumer Electronics, Los Angeles Airport Marriott. Contact Diane Williams, (716) 392-3862.

13: Big Sky SCTE Chapter technical seminar, Side Car Restaurant, Laurel, MT. Contact Jim Luttschwager, (406) 628-2100.

14: Penn-Ohio SCTE Chapter technical seminar, Sheraton North Inn, Pittsburgh. Topic: "Competition and CSR Training" with speakers to be announced. Contact Marianne McClain, (412) 531-5710.

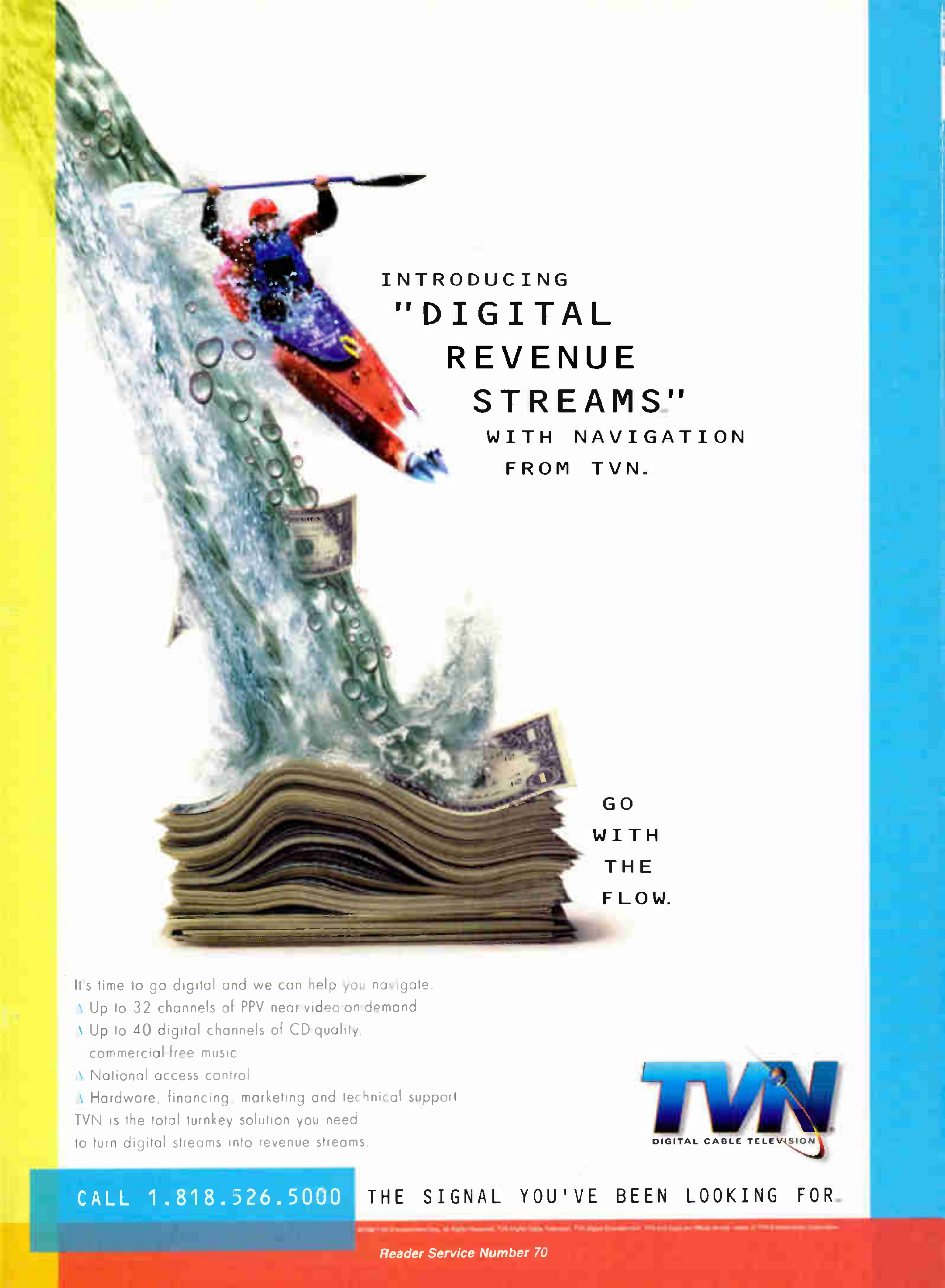
15: International Conference on Consumer Electronics, call for papers submission deadline. Conference scheduled to be held June 22-29 at the Los Angeles Airport Marriott. Contact Diane Williams, (716) 392-3862.

16: Cascade Range SCTE Chapter testing session, Beaverton, OR. BCT/E certification examinations to be administered. Contact Ned Fenimore, (503) 605-4892.

18-20: SCTE Conference on Emerging Technologies, Dallas. Call (610) 363-6888.

21: Dakota Territory SCTE Chapter technical seminar, Aberdeen, SD. Topic: "Category VII Engineering Management and Professionalism" with speakers to be announced. Contact Tony Gauer, (605) 426-6140.

25-27: OSS '99: Operations Support Systems for the 21st Century, Wyndham Palace Resort, Lake Buena Vista, FL. Contact TeleStrategies Inc. at (703) 734-7050. CT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Reader Service #10, 42, 44

Troubleshooting Hum Modulation, Part 4

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 provided two methods (using a TV test set and using the customer's TV set) for checking picture quality at the cable wall plate if you don't have a signal level meter (SLM) that measures hum percentage. This installment covers checking picture quality on the customer's TV set and VCR and the set-top terminal to determine if any of these are the source of the hum.

As emphasized previously, because an electrical shock hazard may exist when troubleshooting a hum modulation problem, always carefully observe all appropriate safety precautions.

- *Checking picture quality on customer's TV set after disconnecting broadband drop cable.* Visible and/or audible hum on a customer's TV set that is connected directly to the broadband cable wall plate indicates either a problem with the customer's electrical wiring, a customer-owned electrical appliance, the TV set, an in-line house amplifier, the drop grounding system, the customer tap, or the feeder system. To determine if the TV set is causing excessive hum, disconnect the broadband drop cable from the set's 75-ohm VHF connector or matching transformer. Next, connect a coaxial jumper from a known good VCR directly to the TV set. Since the VCR is not causing the excessive hum, play a good quality recorded videotape on the TV set. The absence of hum on the TV set indicates the excessive hum is generated prior to the wall plate and not by the TV set. Hum bars on the TV set indicate the excessive hum is generated by the TV set or the customer's electrical wiring system.

  Another way to determine if the TV set is causing the excessive hum is to disconnect the broadband input cable from the customer's TV set and connect rabbit ears or other over-the-air antenna to the customer's TV set to view a strong local signal. Hum bars on the TV set indicate the excessive hum is generated by the TV set or the customer's electrical wiring system. The absence of hum bars indicates the excessive hum is generated prior to the broadband cable wall plate and not by the TV set.
- *Checking picture quality at set-top terminal and/or VCR.* If there was no noticeable hum when the customer's TV set was connected directly to the cable wall plate (Figure 1), check the picture quality at the output of each reconnected active device until noticeable hum modulation is present on the customer's TV set. It is possible that visible and/or audible hum can be produced from one or all of these active devices. Reconnect and turn on one active device at a time to the TV set until the hum bars reappear. Good picture quality at the input to the set-top terminal, but visible and/or audible hum on the TV set at the output of the set-top terminal indicates a defective set-top terminal (Figure 2). Replace the set-top terminal and recheck the picture quality again. Good picture quality at the input of the VCR, but visible hum bars at the output of the VCR, indicates a defective VCR (Figure 3). Explain to the customer that the VCR is causing the interference (as evidenced by good picture quality at the input to the VCR, but visible and/or audible hum at its output), and it requires repair to eliminate the hum on the TV set when the VCR is included in the configuration. CT

The next installment will continue with procedures for systematically isolating the cause of visible hum bars.

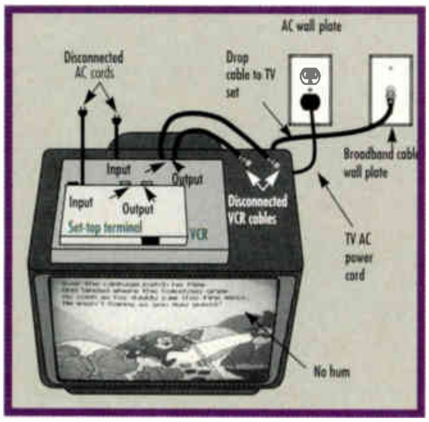

Figure 1: No hum on TV set when connected directly to the wall plate

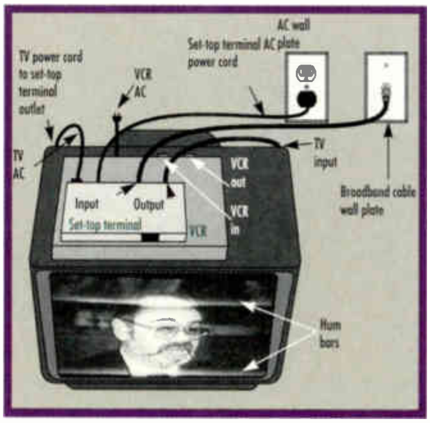

Figure 2: Hum bars present when set-top terminal reconnected indicate a defective set-top

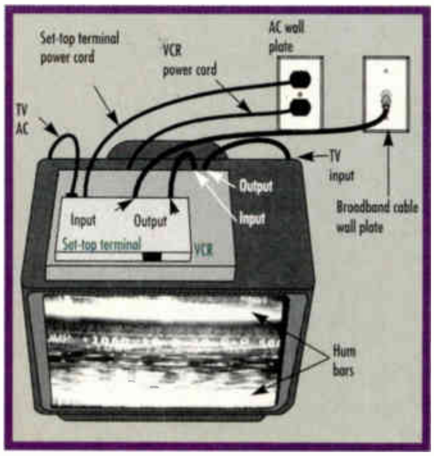

Figure 3: Hum bars present when VCR reconnected using known good set-top terminal indicate a defective VCR

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01. ___ yes
02. ___ no

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

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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
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51. ___ MMDS Transmission Equipment
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54. ___ Cable Modems
55. ___ Subscriber/Addressable Security Equipment/Converters/Remotes
56. ___ Telephone/PCS Equipment
57. ___ Power Suppls. (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 Splices
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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Communications Technology

CT199

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January 1999 Issue

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22	48	74	100	126	152	178	204	230	256	282	308
23	49	75	101	127	153	179	205	231	257	283	309
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 Suppls. (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 Splices
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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By Oleh Sniezko

What's So Hot About ET '99?

Burning issues today often cool down over time and then fade far into the background. For those of us in the cable telecommunications industry, however, the reality is just the opposite. A constant flow of technological innovations and new applications ensure that what's smoldering today is flaming out of control tomorrow.

This year's Conference on Emerging Technologies (January 19-21 in Dallas) will fan the technological flames within our industry to keep those fires burning hot. Our future relies on our ability to provide cutting-edge and seamless services that will keep subscribers looking to us for more. That is why if you are in Dallas for ET, you will be far ahead of the game in dealing with some of the critical issues facing the technical side of our business.

Network services: There appears to be agreement that Internet protocol (IP) will be the standard mode for transmitting information. It also looks certain that hybrid fiber/coax (HFC) networks will be the hardware that people rely on to exchange data.

The challenge for those of us who provide that hardware is in handling large bundles of data and making sure that, regardless of what form of data is being transmitted, it arrives on the other end in proper order and that it appears to be seamless from the customer's perspective.

Common carrier: Imposing regulations on the cable telecommunications industry in the past has caused disastrous effects on our competitive abilities. We again face this challenge in the form of being categorized as a "common carrier."

Common carriers represent entities that supply a network other companies use to funnel services and information to consumers. The common carrier establishes rates for access to the network, but does not control content or access to the services.

As with other entities providing such services, utility and telephone companies, for example, common carriers are subject to a variety of regulations. Beyond the regulatory scheme, however, common-carrier status means giving up or losing control over what our networks carry. This change could completely restructure the nature of the cable telecommunications business.

Interactive services: Our industry still is debating the potential profitability of interactive services such as videocassette recorder (VCR) control over pay-per-view (PPV) services, video games and similar features.

> "Our future relies on our ability to provide cutting-edge and seamless services."

In addition to addressing return path issues, service providers again must ensure that the services appear seamless to the subscriber. Imagine being in the middle of a game, trying to maneuver your controls and having to wait while your actions are processed and the results of those actions appear on the screen.

Even more critical is making sure that when subscribers are ready to order the services, the system is up and running and ready to deliver.

Standards: Because of the number of players involved in the services we provide—our systems, the hardware and software suppliers we use, our subscribers, and the hardware and software suppliers to our subscribers—we have learned the importance of performance and interoperability standards the hard way.

The work spearheaded by the Society of Cable Telecommunications Engineers' Digital Video, Data Standards and other engineering subcommittees represents a critical source that our industry is relying on more and more. The presentations at ET will give you a much better perspective of SCTE's efforts on standards than this article can. (Perhaps the sessions will spur more ongoing involvement in the subcommittees as well.)

ET keynote speaker

I also want to take this opportunity to highlight our keynote speaker for this year's conference, Dr. David C. Nagel, AT&T's chief technology officer and president of AT&T Labs.

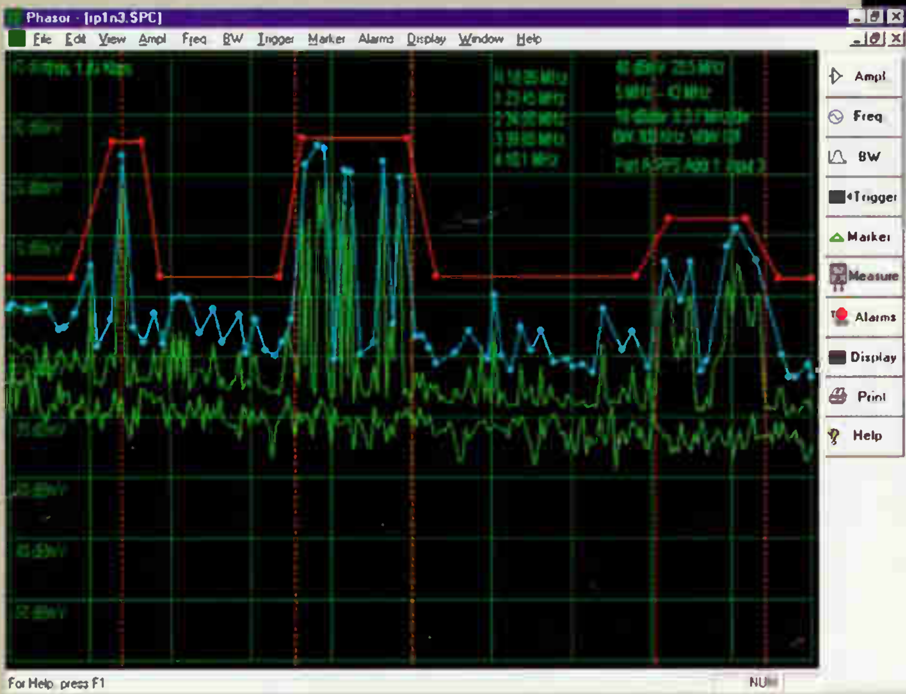
Nagel currently is creating a highly focused and innovative research effort for the "new" AT&T and overseeing the development of a new generation of Internet and other communications and information services. He also advises the AT&T Operations Group and senior management staff on technology issues, and he leads the company-wide Technology Strategy and Development Council. Nagel's address certainly will provide thought-provoking information.

Come prepared to light the torch of your imagination at the 1999 Conference on Emerging Technologies! CT

Oleh Sniezko is vice president of engineering for TCI Communications and chairman of the SCTE's Emerging Technologies program subcommittee. He can be reached at (303) 267-6959.

A MICROSECOND IMPULSE JUST INTERRUPTED YOUR RETURN PATH.

DID YOU CATCH IT?



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The Phasor System can analyze more than 500 spectral data points on a single node – from 5 to 42 MHz – in a 20 millisecond sweep. That's three times the resolution of competing systems, in similar sweep times.

As a result, the Phasor System can scan every node in your network more than three times per second. That's performance that puts Phasor in a class of its own.

This speed, combined with Cheetah's unique new DSP-IF™ technology opens previously unexplored worlds of digital signal processing flexibility. The Phasor System is the finest return path solution available.

For more information, call Cheetah Technologies at 941-756-6000. or e-mail phasor@cheetahtech.com

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