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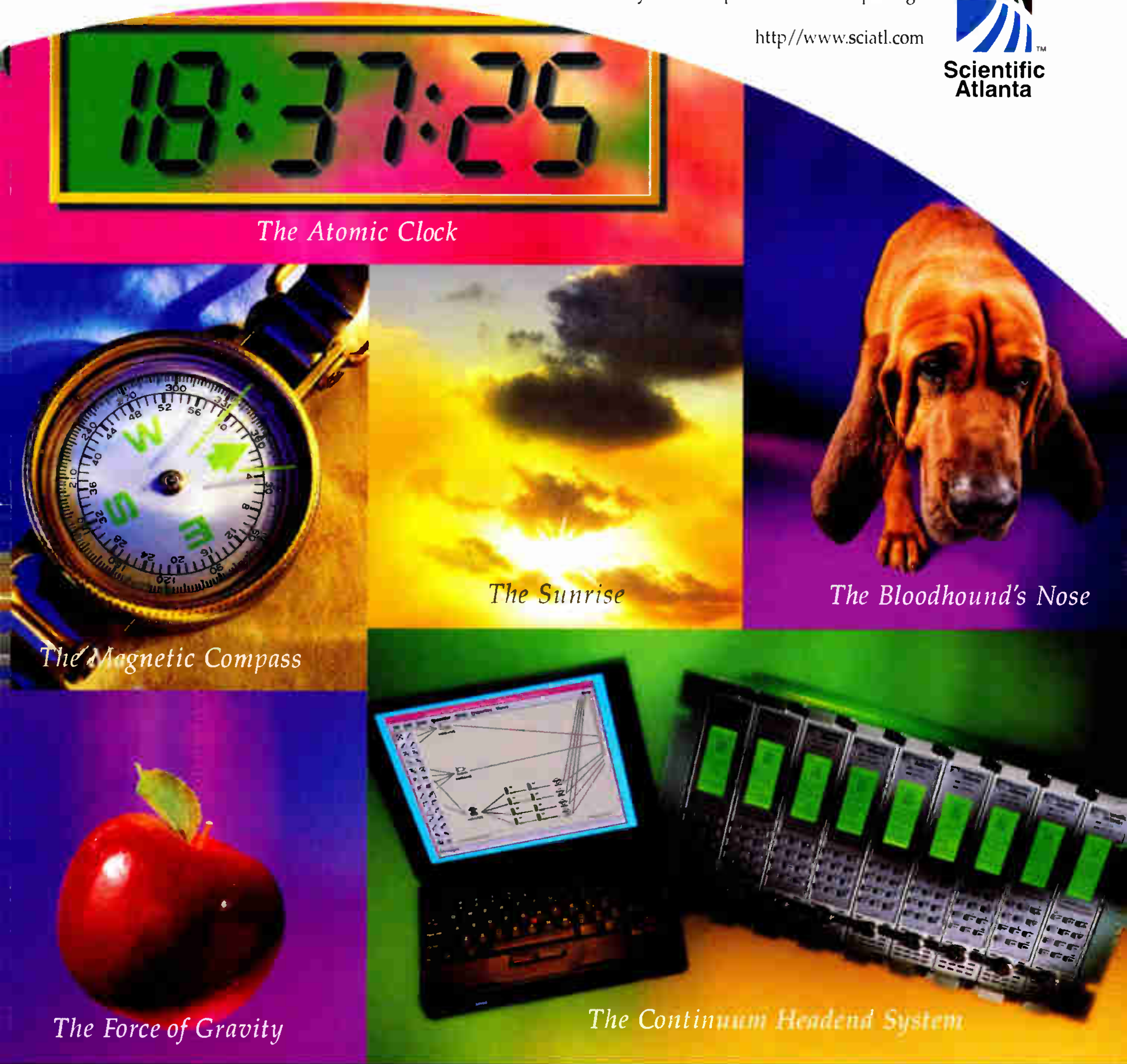

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"The return path is our most potent competitive weapon. We need to tame it and learn to use it."

—Jim Farmer
Chief Technical Officer, ANTEC

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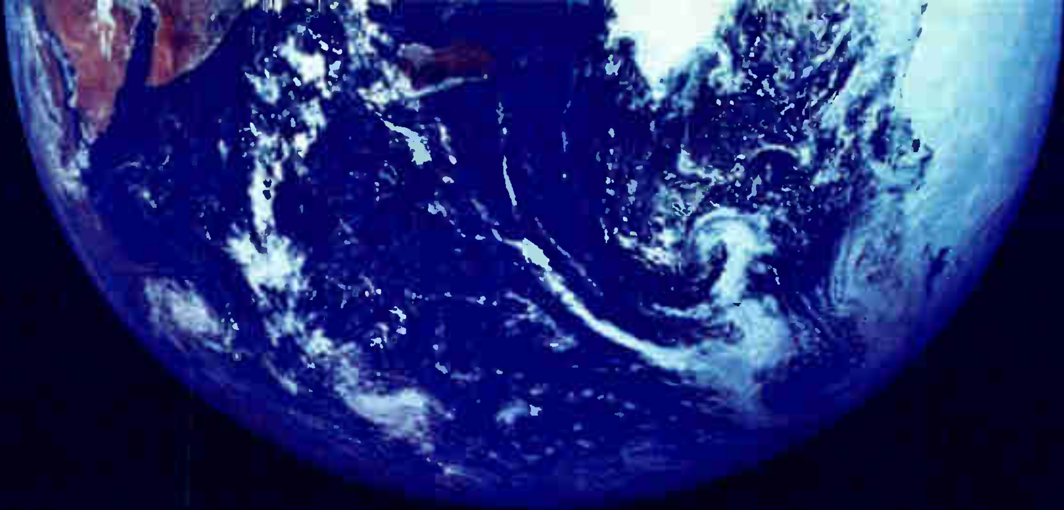

By Rex Porter

Media Madness

Since we last met in Nashville at SCTE's Cable-Tec Expo, cable engineers have been involved in a number of industry developments. Some of the notables:

"CableLabs announces adoption of equipment specifications." "SCTE announces the adoption of industry standards." "Time Warner Cable announces launches of full-service networks across the nation from New York to California." "Continental Cablevision continues its introduction of full-service networks and educational TV throughout its systems." "Tele-Communications Inc., announces the introduction of @Home Network services to five cities—while providing free Internet connection of area schools." "TCI announces a fiber-to-the-node upgrade program." "TCI promises to provide digital service to 75-90% of its homes passed by the end of 1997." "Cox Cable wins prestigious J.D. Powers Award for 1997"—just to name a few.

In the face of these efforts to provide the best service to the consumer, some of the national media seems determined to smear our image and undermine efforts to reach customers with a positive message.

Case in point: An article in the May 5 issue of the *New York Times* accuses us of using digital compression to deliver substandard signals to our customers. The article, by Joel Brinkley, states "major cable companies are placing orders for digital equipment that will allow them to expand their program offerings—and not incidentally, reduce the quality of pictures they transmit." There are numerous jabs such as, "In fact, to squeeze even more channels onto the cable, most of them plan to use compression schemes so extreme that they will produce pictures with lower resolution than the signals they are currently transmitting to their customers." And what's his pull quote right in the middle of the article? It's "Quality for broadcasters; quantity for cable." Perhaps you wonder why I think this should concern the technical side of cable...

My message is that the engineers and technicians know the true story of compressed video services. Since we are the ones who understand analog and digital systems, we have an obligation to help ensure the message to the consumer is factual and true. And so the engineering departments may have to take a more active (but careful) role in passing the message to the media. Even with our best efforts, there will always be writers who don't want the truth or facts—they want sensationalism!

Contrary to the message of the *New York Times*, we plan to compress digital video because 1) it does not impair the quality of signals; 2) it provides bandwidth for traditional cable TV distribution services, 3) it provides bandwidth for video-on-demand with instant access; 4) it provides bandwidth for I-TV service; 5) it provides bandwidth for interactive games; 6) it provides bandwidth for access to telephone services (both long-distance and local); and 7) it provides bandwidth for personal communications service (PCS).

We are not diminishing the quality of service—we are providing full service networks for America and the world...

On another note, I want to call attention to *CT's* new look and to ask readers to write and tell us how you like it. *CT* Executive Editor Alex Zavistovich tells you more about the details that went into the redesign on page 35.

Rex Porter
Editor

Communications Technology

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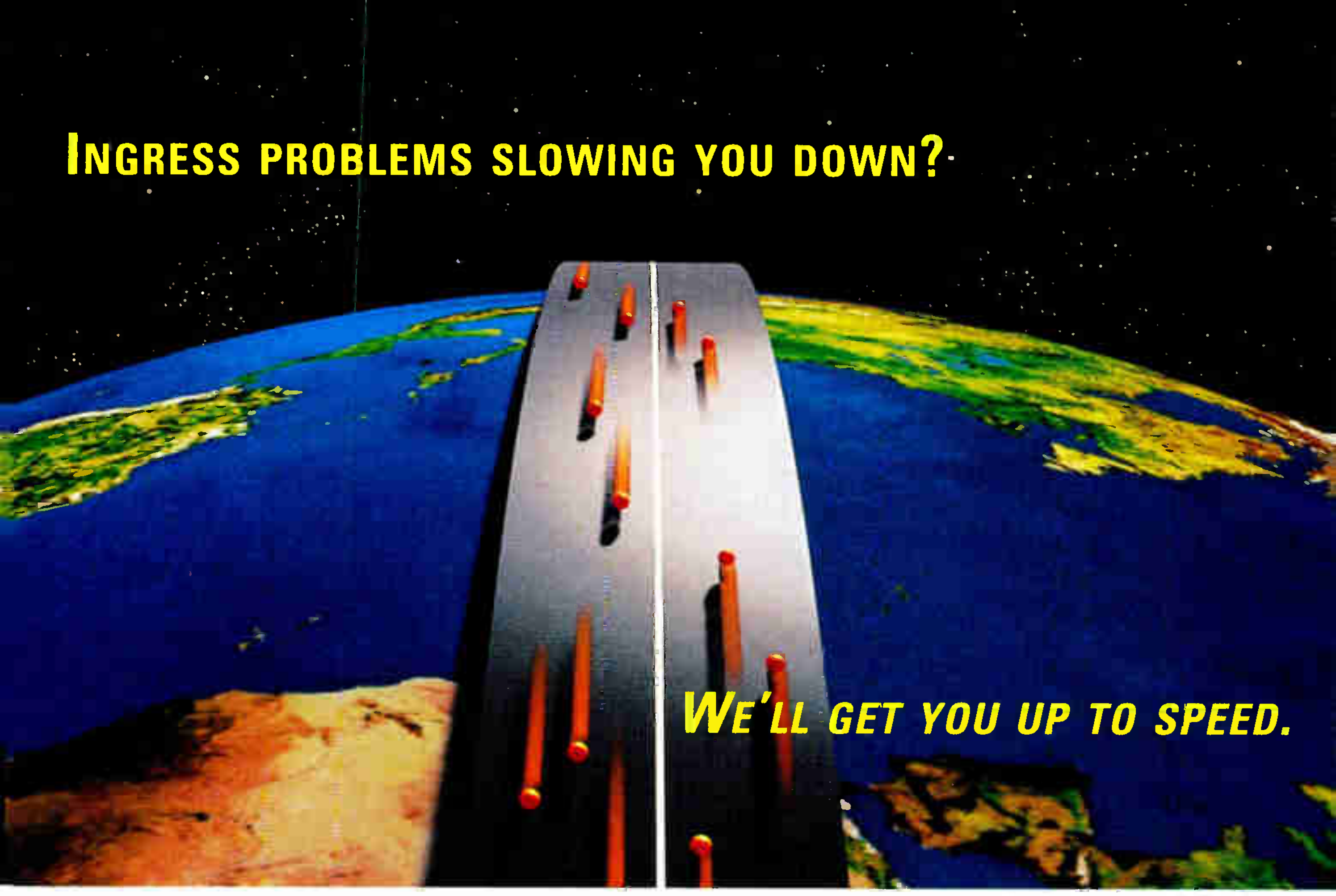

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Reader Service Number 10

HEWLETT PACKARD

A Cable Modem User, Really!

I'm amazed at the number of articles about cable modems written by vendors of the modems or system operators, but surprised by lack of articles written by users. Well, I'm a real live cable modem user, and I'd be glad to tell you about my experiences so far. I'm no stranger to the technology. I was the co-chairman of my kids' school system's technical committee when we did a field trial about three years ago. That involved the Winchester, MA, school system, DEC sourcing LANCity modems and Continental Cablevision, who provided our school I-Net. It worked like a charm and we expanded it to network the whole school system. I'm no stranger to computers or the Internet either, having programmed computers since they had tubes. And finally, I'm not a disinterested party. My company, Fotec, sells fiber-optic test equipment to many of the system operators, including Continental Cablevision, who serves my community.

As a consequence of all of the above, I was anxious to try out cable modem service. I found out the availability of Highway-1 service through the "grapevine" before it was formally announced. They gladly took my order and set an installation date for about a week in advance. It took about three hours to install the cable, including a new drop to the house. The computer setup took about an hour, with an experienced computer service type (ex-DEC) doing the work. I don't see why I couldn't do it myself. No software or hardware glitches have surfaced. None! Once it was in, I began exploring its use. It's the speed that impresses the most. Web pages that used to take 3 to 5 minutes load in so many seconds! It's like loading files into Netscape from your hard drive. You notice server latency, but loading so fast makes up for the short connection wait. "Surfing" is no longer frustrating. It's "instant gratification."

The most interesting change in my use of the Internet is the use of Netscape mail. Many of us put our Web site URLs in our signatures or reference them in text. With my cable modem, I usually click on them and explore the site right then. I really haven't had time to get CU-seeme or Internet Phone set up but I will soon. And my family (with two teenage computer geeks and an in-house 10base T-network) wants the upgrade to a four-port hub so they can use it too. *Bottom line: it's hard to deal with dial-up access anymore; it's soooooo slow!*

- Recommendation #1: Operators should follow PC practice by selling us the cable modem and cutting service costs. We're all used to paying $300 for state of the art modems and prefer the flexibility of upgrades when we want them. This assumes some cable modem standards and interoperability.
- Recommendation #2: System operators should gear up to get this service to commercial users ASAP. If I had it at the office, we'd be using it for e-mail, our Web server and videoconferencing for our fiber-optic training programs. (And phone service, when available!) *Warning:* In case they haven't figured it out yet, the backbone suppliers for the Internet better get ready for a lot more traffic as cable modem use grows. And servers will need upgrading to handle the volume of requests also.

Jim Hayes, Winchester, MA—E-mail: hayes@highway1.com; Web site: http://www.fotec.com/jim.htm; jeh@fotec.com; http://www.fotec.com/.

Editor's response: I hope more of our readers will take the time to comment on their experiences with cable modems. We report on launches in cable systems but it's great when we hear from customers in those systems. Feedback like yours can help guide the system operators and the manufacturers of the full-service components.—RP

Ask the cable guy

Just thought I would drop you a note about my Web site. I work as a field technician for a local cable company. About six months ago, I got the idea to construct a site that would be used to educate anyone, and everyone, about cable TV. It took some work but I got some good content up and running. People loved it; cable guys loved it. In the March issue of *YAHOO! Internet Life* (and in the on-line version) "Ben's Cable Box" was picked as one of the "25 Most Incredibly Useful Sites" on the Internet! I guess I accomplished what I set out to do. I hope my work dispels the Jim Carrey Cable Guy image and create a kinder, gentler and more helpful one. *Ben's Cable Box, PO Box 152, Wind Gap, PA 18091. Web site: http://www.geocities.com/SiliconValley/Park/3254/cabletv.htm; e-mail: cablebox@ptd.net.*

Editor's response: Hey, I'll have to visit your Web site. I don't care for Jim Carrey (you'd certainly realize that if you read last year's editor's response to the movie) and I couldn't see wasting money to see the movie, "The Cable Guy." The writers and directors of that movie used so much false information that they should have named that movie "Liar, Liar," instead. Anyhow, innovative technicians and engineers like yourself who work hard to improve the image of cable TV are the true "cable guys" and our industry should continue to highlight and reward your efforts. Write us anytime and especially when your have interesting news like this.—RP

A loyal pain!

I am writing you concerning some difficulty I am having with Ted Hartson about being inducted into your "Loyal Order of the 704" group. I have asked for a gold pin and some literature on the group because "if anyone is qualified to belong to an engineers' Pioneers Club, it's me." My dad, George "Slats" Spelvin, Sr. was actually inducted into the Cable TV Pioneers club at the Boston show in 1968, only to be thrown out by a bunch of cable cronies, following that show. I am attaching a certified list of CATV Pioneers, dated April 15, 1968, signed by Benjamin J. Conroy, Jr. I am also sending a copy of a letter to Mr. Conroy, from Bill Adler, which led to my father's expulsion. ➤

When I was just a little tyke, I helped my father with his system he built in 1943. My background as a system tech and engineer in this system is unique. For example, in 1950, in our Northern Ohio system, we were the first company to lash-up cable in place of using hog-rings. In 1954, we were investigated by the Federal Communications Commission for radiation. Later we were told we were responsible of the FCC's rules on permissible radiation (10 microvolts per meter at 10 feet, etc.) This caused the founding of our Spurious Emissions Division.

- In 1954, the first CATV unionized (by the United Mine Workers, District 50).
- In 1959, the first system to discover water in strip-braid cable.
- In 1966, the first company to bid as much as 90% of gross receipts payment to the city for a franchise (in Harrisburg, VA).
- In 1965, we were the first company to sign a new Ohio Bell contract for a pole rental raise from $2.50 to $4.
- In 1967 we were the last system in Ohio to reduce our installation fee from $125 to $19.95. Saturation then was at 93%.
- In 1961, our chief technician was the first man to fall out of the bucket in a hydraulic ladder truck.
- In 1951, we were the first system to convert a VHF signal to UHF for system distribution.
- In 1952, we were the first CATV system to delete network commercials and insert our own.
- In 1964, we were sending e-mail over a two-channel cable system. Computers were so slow that we invented a different version of Web-TV. We cut off The Weather Channel but it was worth it.
- In 1996, we demonstrated a low-band system that allowed digital TV (superior to high definition TV), six international telephone calls, Webbrowsing, multiple e-mail use, HITS activation without a dish, and direct banking simultaneously.

I think this Hartson is probably scared to have me join with my long background. Someone told me he is like a hermit working out his garage and no one seems to be able to contact him anymore. Anyhow, I know people in the industry like Ron Hranac, Jim Chiddix and Rex Porter will support me as a member. My dad, "Slats" Senior, is now retired to Gilbert, AZ, and I know he would be proud to see me following in his footsteps. If you print this perhaps some other members will remember me or my dad and tell Hartson to stop pushing an old industry veteran around.

George "Slats" Spelvin, Jr.
Manager, Spelco Corp.

Editor's response: Sounds like an industry veteran suffering like his dad, "Slats, Sr."! I'll speak to Hartson! —RP

Write to us

Write to the *Communications Technology* editorial staff at 1900 Grant St., Suite 720, Denver, CO 80203 or fax (303) 839-1564. Editor Rex Porter may be reached via e-mail at tvrex@earthlink.net.

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

H-P Folds QuickBurst

Before even getting QuickBurst out of the starting gate, Hewlett-Packard has folded the cable modem product line.

The news came in a tersely-phrased press advisory in early May, and also affects the Kayak digital set-top box products. According to H-P, the company is "refocusing its strategy," and "will not pursue further the ends of a two-way plant in the form of cable routers in the headend and cable modems in the consumer premises."

Bill Hahn, H-P's operations manager for interactive broadband products, was succinct in his reasoning. "We're not in the HFC pipe business," he said. Hahn maintained that the company will, however, continue to sell test equipment, servers, printers and other items that support that segment of their business.

H-P is waiting for a interoperability standard to emerge for cable modems, and then will partner with other firms for cards to install into its computer products. Hahn suggested a standard might be a year or two down the road. At that point, he said, H-P will decide on its partner for cable modem chips or cards, "just like we're teaming with leading telco modem providers for that technology."

According to its official statement, "H-P will work with those customers that had planned to implement...QuickBurst modems to transition them to alternative solutions." At the Western Show in December 1996, H-P had announced that the QuickBurst modem would be rolling out to 20 different sites in 10 different countries. Hahn noted that the trials had not quite reached those projections, so it should be a "smooth transition" from H-P products to suitable replacements for those test sites.

Hahn would not disclose the number of units involved in the trials, nor the dollar value represented. He declined to speak about the number of people that may be affected externally as well as internally by H-P's decision.

The Kayak set-top was included in the press advisory, Hahn said, because the same H-P team worked on that product as on QuickBurst. Essentially a GI DigiCipher clone, work on the Kayak project actually was suspended a year ago last fall, Hahn explained.

While surprising, the news is not expected to dampen enthusiasm for data over cable. Jim Chiddix, chief technical officer for Time Warner Cable said that having H-P discontinue its QuickBurst line will have "no real impact" on the market. "Lots of companies want to build modems," he said, adding that Time Warner has seen "strong results" in the marketplace from offering data services over cable.

"H-P has been tentative about set-top box business," said Chiddix, speculating about the company's phase-out of Kayak and QuickBurst. He suggested that "the competitive market for this consumer-type of electronics may not be what the company wants to get into."—*Alex Zavistovich*

Coming to a Neighborhood Near You

Customer satisfaction is the key behind the cable industry's coordinated *On-Time Customer Service Guarantee (OTG)* effort called, *In the Trenches Week*. The event brings CEO and general managers to local cable systems nationwide.

Participants will visit customers' homes with service and installation technicians; take neighborhood walks to survey customers about service satisfaction levels; personally deliver a refund to customers who recently had a late appointment; meet with state and local officials; and field customer calls.

In the Trenches Week will include Advance/Newhouse Communications President and National Cable Television Association Board Chairman Bob Miron, Time Warner Chairman and CEO Joe

Collins, Marcus Cable Chairman and CEO Jeff Marcus, CTAM President and CEO Char Beales, and NCTA President Decker Anstrom.

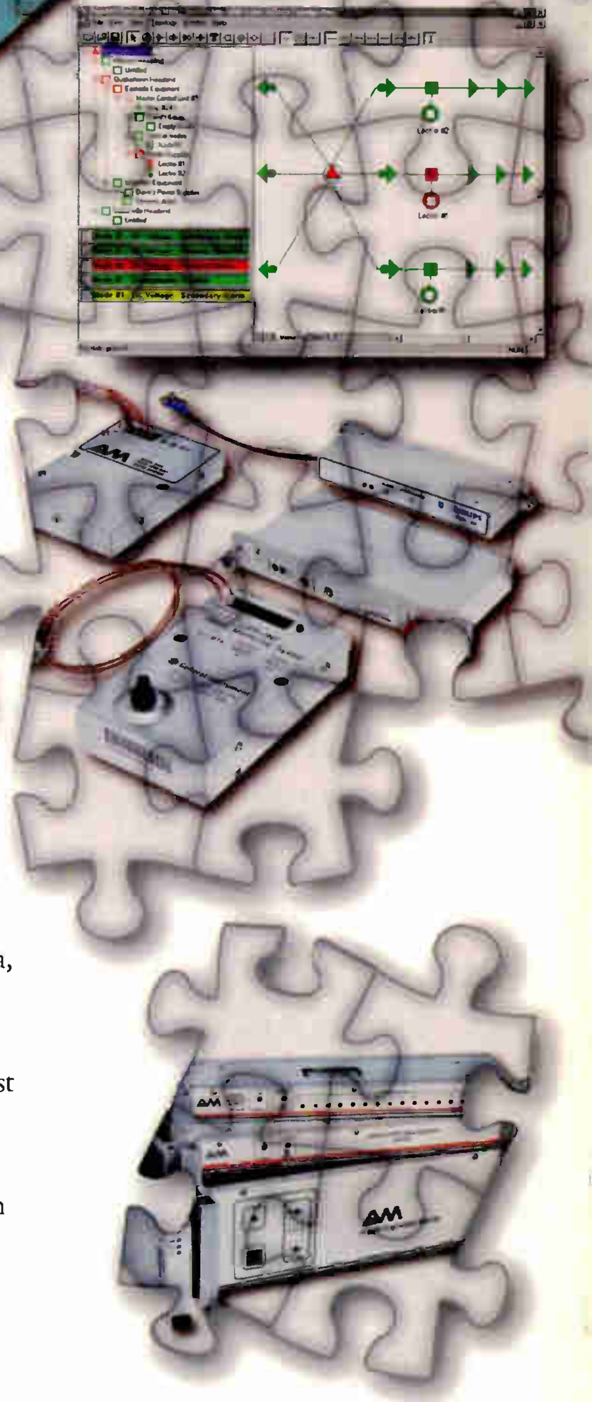
The OTG program was launched in March 1995 and guarantees on-time installation or the service is free, and on-time service appointments or the customer receives $20.

No Fair! Coalition Battles Telco Charges

The Internet Access Coalition is fighting attempts by some telephone companies to impose "access charges" against Internet access providers. The coalition has been joined by the Consumer Electronics Manufacturers Association. CEMA shares the coalition's concern that additional charges would be passed on to consumers and as a direct result, limit customer Internet use.

NEWS BITES

- Marcus Cable signed an agreement with CableData to consolidate all of its customers onto CableData's DDP/SQL customer management and billing system.
- A distributor of video and audio commercials, **Vyvx Advertising Distribution** Services, converted its satellite network to the digital format. The digital conversion package includes a General Instrument DSR 4500 digital satellite receiver.
- SpotMagic Inc., a San Francisco-based communications technology company, and En Technology Corp., a New Hampshire-based high-speed data broadcasting firm, have signed a letter of intent to debut an over-the-air trial broadcast of interactive multimedia TV on the PC, using a TV station's vertical blanking interval (VBI).
- A long-term alliance was formed between **ADC Communications** and **Carrier Access Corp.** An original equipment manufacturers' (OEM) agreement allows ADC to market CAC's Access Bank I and Access Bank II T-1 voice and data multiplexers, as well as CAC's Wide Bank 28 DS3 access multiplexer.
- **Prime Cable of Las Vegas** has purchased a 24-channel MPEG-2 (Motion Pictures Experts Group) digital ad insertion system consisting of Channelmatic's MVP (managed video playback) products and Sony's VideoStore multichannel video file server system.
- A partnership and joint marketing agreement was formed between **Integration Technologies** and **Superior Electronics Group** to support an integrated operational support system (OSS) infrastructure for hybrid fiber/coax (HFC) broadband networks.
- **Cox Communications** announced that it is offering bundled applications to an Orange County, CA, community. The service includes telephone service, traditional cable and high-speed data services using **Nortel (Northern Telecom)** access, transport and switching equipment.
- **Jones Intercable of Augusta, GA, selected Philips Broadband Networks** to provide various fiber-optic transport equipment and systems, including Philips' Diamond Transport transmitters, Diamond Net nodes and Diamond Diagnostics element management systems. CT



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Membership Elects 1997-99 Board

March 28 marked the official closing of the Society of Cable Telecommunications Engineers' annual election to fill seven empty seats on its board of directors for the 1997-1999 term. The results of this year's Board election areas follows:

At-Large Director: Andy Scott, NCTA, representing the entire United States.

At-Large Director: Wendell Woody (incumbent), Sprint, representing the entire United States.

Region 1 Director: Ralph Patterson, Patterson Communications, representing California, Hawaii and Nevada.

Region 2 Director: Steve Johnson (incumbent), Time Warner Cable, representing Arizona, Colorado, New Mexico, Utah and Wyoming.

Region 6 Director: Robert Schaeffer (incumbent), Technology Planners, representing Minnesota, North Dakota, South Dakota and Wisconsin.

Region 9 Director: Hugh McCarley (incumbent), Cox Communications, representing Florida, Georgia, South Carolina and the Caribbean.

Region 11 Director: Dennis Quinter (incumbent),Time Warner Cable, representing Delaware, Maryland, New Jersey and Pennsylvania.

They will join the eight SCTE Board members currently serving their 1996-1998 terms:

At-Large Director: Ron Hranac, Coaxial International, representing the entire United States.

Region 3 Director: Norrie Bush, TCI of Southern Washington, representing Alaska, Idaho, Montana, Oregon and Washington.

Region 4 Director: M.J. Jackson, Gilbert Engineering, representing Oklahoma and Texas.

Region 5 Director: Larry Stiffelman, CommScope, representing Illinois, Iowa, Kansas, Missouri and Nebraska.

Region 7 Director: James Kuhns, Comcast Cablevision, representing Indiana, Michigan and Ohio.

Region 8 Director: Steve Christopher, Augat Communication Products, representing Alabama, Arkansas, Louisiana, Mississippi and Tennessee.

Region 10 Director: Maggie Fitzgerald, DAVI Communications, representing Kentucky, North Carolina, Virginia and West Virginia.

Region 12 Director:John Vartanian, Viewer's Choice, representing Connecticut, Massachusetts, Maine, New Hampshire, New York, Rhode Island and Vermont.

Newly elected directors will officially take their seats, beginning their two-year terms, at the next SCTE Board meeting on Tuesday, June 3, prior to Cable-Tec Expo '97 in Orlando, FL.

Society Welcomes New Staff Members

As the broadband industry expands and changes, so does SCTE. Recently the Society welcomed several new staff members to our national headquarters staff in an effort to better serve both our growing membership and this dynamic trade called cable telecommunications.

Alan Babcock and Steve Townsend joined SCTE's professional staff in March as part of our campaign to keep members better informed and on the cutting-edge of technology.

Alan Babcock will serve as in the newly created position of Director of Training Development. An SCTE member 1985, he had been the chairman of the Training Committee for more than two years. He will be working out of his home near Denver, CO.

"I'm really excited to be associated with SCTE," Babcock said. "Now I can put my money where my mouth was and help influence the direction of the Society." Babcock's new role will be to

develop leader guides and tools to support existing SCTE training materials, and to help local Chapters to not only gain more training, but to better utilize what they already have.

"The training that the Society offers is good, but I think we can take it to a new level," said Babcock, who has been involved with training for most of his 15 years in cable TV. "We're facing new challenges. For example, how will we maintain a balance between training and certification?"

One way Babcock will strengthen SCTE's existing program is by helping to implement two new certification programs, "Telephony" and "Service Technician," which will be available for chapter testing dates this fall. His long-range goals include aggressively pursuing new SCTE training tools. He would like to see the creation of new programs for members that will build and reinforce their skills and also address new technology, i.e. digital and telephony. Together, he and Townsend, newly appointed manager of chapter development, will be beneficial contributors to the growth of local chapters.

Townsend is new to broadband communications, but he became very familiar with the issues facing local chapter support, having worked with over 100 chapters during the past eight years. "I am really looking forward to learning the industry, with its challenges and opportunities, and being on the forefront of a major evolution," said Townsend. Townsend said his key first goal will be to get settled into his new position by building good relationships with chapter and meeting group leaders to address challenges on the horizon. When asked what his job with the Society will be, Townsend smiled. "This isn't my job," he said. "This is my opportunity to better serve the chapters. They will tell me what my job is."

Call for Scholarship Fund Applications

The SCTE Scholarship Committee is accepting applications for the 1998 Milton Jerrold Shapp Memorial Scholarship Fund that honors the memory of one of the pioneers of the cable telecommunications industry, Milton Jerrold Shapp.

Applicants must be sons or daughters of current cable telecommunications industry employers. Their parents must have been employed in the industry for a minimum of three consecutive years and must not be currently employed full-time in any other field.

Those applying must have maintained a "B" average in high school. They must also be recommended by at least two teachers, administrators or coaches.

The winner will be announced at the Society's Cable-Tec Expo held in the spring of every year. The total scholarship is $20,000 per individual.

For further information contact the SCTE, Attention: Milton Jerrold Shapp Memorial Scholarship; 140 Phillips Road, Exton, PA 19341-1318; phone (610) 363-6888; fax (610) 363-5898. CT

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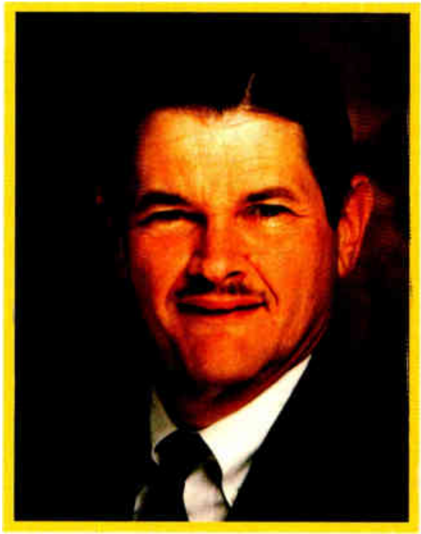

Jim Farmer

Jim Farmer has more than 26 years of experience in cable TV engineering and was recently recognized for his outstanding contributions with the 1996 Vanguard Award for Science and Technology. As chief technical officer, Farmer is responsible for the overall technical direction of ESP and ANTEC engineering efforts. He oversees technology developments and monitors emerging standards. He holds a number of patents in converter systems and file servers.

He joined ANTEC's ESP division in 1992 as vice president of linear systems, handling the selling and performance of engineering contracts. Farmer began his career in cable TV communications with Scientific-Atlanta, where he was involved in the development of headend and set-top converter products. He was principal engineer during his last seven years with S-A.

He is active in the National Cable Television Association, Society of Cable Telecommunications Engineers, Institute of Electrical and Electronic Engineers, Society of Motion Picture and Television Engineers and American Radio Relay League. He serves on the joint NCTA-EIA Engineering Committee and was the chief architect of the IS132 recommended standards. He holds bachelor of science and master of science degrees in electrical engineering from the University of South Florida.

Farmer spoke with *Communications Technology* about ANTEC's recent ventures, plans for using new technology breakthroughs successfully and his drive to increase customer satisfaction.

Communications Technology: *In 1995, the SCTE honored you with the SCTE Personal Achievement award and, in 1996, you received the prestigious NCTA Vanguard Award for Engineering. It seems that your service to our industry and the various engineering societies is perpetual. Could you list some of the committees and boards you have either chaired or on which you have served?*

Jim Farmer: I have spoken at a number of industry events, some of which award plaques, which look impressive on the wall and cheer me up when I feel down. I presently serve on the joint NCTA/EIA engineering committee. With this committee, I was the primary architect of the IS132 channelization standard and the IS105.1 decoder interface, physical layer. I am a past member of the SCTE Board of Directors (secretary) and vice president of IEEE's Consumer Electronics Society's administrative committee, as well as a member of the NCTA's upstream practices committee. I was a member of the committee that rewrote the NCTA's measurements procedure manual to bring it into conformance with 1992 Federal Communications Commission rules. I also chaired the committee that wrote the original SCTE certification tests on subscriber devices.

I'm starting to exercise another long-term interest now, in writing. Besides some monthly stuff, I've gotten involved with a major book project. It's taking a lot of time but I'm having a ball with it.

CT: *Jim, along with all of those projects, you are involved with the activities and planning for so many different departments and divisions within the ANTEC family. Could you discuss these company departments and how you manage activities on a daily basis?*

Farmer: Fortunately, we have strong engineers in all of our divisions. Because of this, I don't have to be as involved on a day-to-day basis as I might have to be otherwise. I am trying to work more through the organizations we have in place, setting overall technical objectives and developing the culture necessary to be a world-class technology company. ANTEC manufacturing is a collection of smaller companies that ANTEC has purchased.

As a company grows from a small, independent organization to an arm of a larger body, several things have to change. We have to be more sensitive to the market direction, but at the same time we must take a leadership position, which requires that we understand our customers' business as well as they understand it. This is why I like to spend so much time in industry activities: It lets me get to know our customers better, and to understand the pressures they are facing.

A small company tends to respond to the last guy who walks through the door holding a check in his hand. While there is nothing intrinsically wrong with responding to him, a larger organization needs to play a role in working with

The Juarez, Mexico, location of Texscan (Active Electronics Manufacturing Facility), a new member of the ANTEC family.

customers to decide the direction in which we should all go. As a manufacturer, our future is intimately tied to that of our customers. Their success, or the lack thereof, will be our fate.

CT: *How will the recent acquisition of Texscan figure into ANTEC's plans for future growth?*

Farmer: I am looking forward to spending more time with Texscan (Active Electronics Manufacturing Facility) to work on the culture issues discussed above. There was some duplication of effort between work going on here in Atlanta with the engineering group we set up for ANTEC, and the Texscan group in Juarez. However, thanks to the good efforts of people on both sides of the fence, we have pretty well-defined areas in which each group will work. We expect to keep and grow both groups, but we need to get to know each other better, and we need to establish close liaison between the groups.

Texscan offers ANTEC the ability to expand into another product area, RF amplifiers, where ANTEC has only acted as a distributor previously. In addition, Texscan brings into the family a factory that has been rebuilt, in the last year, to a very high standard of manufacturing technology and efficiency. This will allow other products to be brought into that facility.

Admittedly, the Texscan factory had not been operating too effectively until last year or so, and we still have issues related to those past conditions that we

have to deal with. We are methodically working through those and will get on top of all of them. As we leave them behind, we feel that facility will play a key role in product manufacturing for the industry.

CT: *Could you comment on your, and others', involvement with Texscan becoming a part of the ANTEC family?*

Farmer: Of course we have the cultural issues to overcome. In fact, the cultural issues with ANTEC, namely the differences between a distributor culture and a manufacturer culture. are significant. We have agreement as to who is going to work on what projects. We also have an agreement that Texscan's factory will be the primary electronics manufacturing facility for ANTEC. We are working to get a common set of CAD (computer-aided design) tools and practices between the different groups, and to understand the capabilities and documentation needs of the factory.

The bad news is that we have several groups of people to pull together in a short period. The good news is that they are all good people, and we are in agreement about the common goal.

CT: *Will this added engineering task allow you much free time to continue your involvement in SCTE, IEEE and NCTA activities?*

Farmer: I surely hope so. As I mentioned, I believe it is the place of a responsible manufacturer to understand his customers' business as well as his customers understand it, and to find new ways of applying technology to solve problems. Getting out and mixing with customers is one of the best ways to do this, short of actually working as an operator for a while.

CT: *What new innovative engineering breakthroughs do you foresee before the new century?*

Farmer: I love breakthroughs, but frankly, at this time, we need to concentrate on turning the breakthroughs of the last few years into useful services that somehow make the quality of life better for real people (a.k.a., customers) and, incidentally, improve our industry's ability to make money. The first half of the '90s were the years of hype. Now we have to sort out what is real and what is not, and make the "real" work.

I am expecting a gradual improvement in what we do, driven both by the needs of the marketplace and by technology. If we are going to compete with other broadband delivery media, we must improve customer service. We also need high-quality analog signals delivered to the home, we need to develop the market for digital video services in such a way that it makes economic sense, and, most importantly, we need to develop the return path. That return path is our most potent competitive weapon; we need to tame it and learn to use. ➤

ANTEC's headquarters building in Chicago.

CT: *With all the new technology being introduced, how should technical personnel (especially those crossing over into cable from telephony, computer and other fields) plan their future?*

> "We have to sort out what is real and what is not, and make the 'real' work."

Farmer: A broad-based technology education is always helpful. I don't generally like to see people specialize too much in one area. The technology changes so fast that no one can expect to finish their career doing the same things they start out doing. We have to be ready to adapt to new technologies. A sound education in the fundamentals of the technology is imperative, as is some sort of continuing education. Anyone who isn't spending several hours each week (outside of work hours) improving themselves is just kidding about their career.

A technique I sometimes use when interviewing job applicants who have been working for a while, is to quiz them on their present job until I learn where their responsibilities end. I then ask them about what lies just beyond their responsibilities. If an applicant answers that he knows nothing about that, because it is not his job, then I feel he is just doing a job and doesn't have a burning desire to understand the technology and where his part fits in. I much prefer an applicant who is interested enough to go beyond what he has to know, and tries to comprehend the bigger picture.

Yet another important thing, for the future, is to understand the larger picture of how your job fits in with the organization, and to understand the ultimate payer of the bills, commonly known as the subscriber.

Engineers make their money by dealing with technology but you cannot be totally effective unless you understand the overall business and the customer. Taking course work or self study in other disciplines, from accounting to marketing to psychology, also will improve your ability to work with others and that is really what any job is about. CT

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

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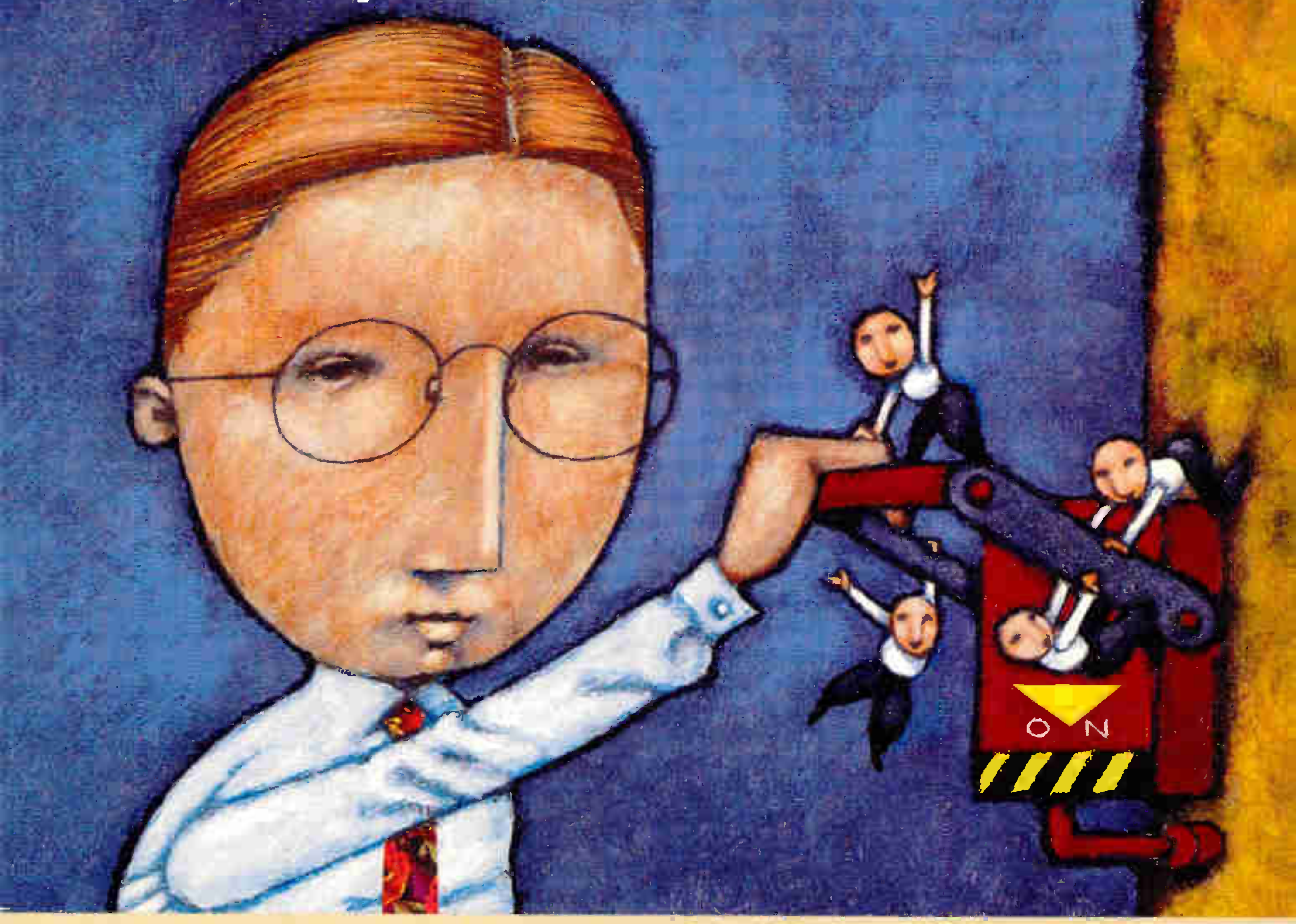

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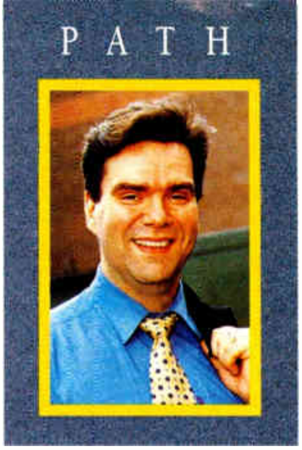

By Alex Zavistovich

Don't Think Advanced, Think *Enhanced*

I've seen the future of television, and it's a pretty scary thing.

Scary, that is, if you're waiting until your cable system's return path is completely shored :fore offering two-way interactive services. Your competition is already courting the comput- dustry to put a new spin on the idea of "advanced TV." If cable isn't careful, it will be caught its guard down by an increasingly threatening nemesis: direct broadcast satellite (DBS).

the computer industry wants to drive lirection of digital TV, and key play- -most notably Microsoft—already a plan. Their point is that if your of advanced TV stops at high defini- digital transmission, you're less than vay there. Generating consumer inter- n digital TV, they say, is not only it picture quality, it's about how con- ers *interact* with the programming.

The concept is called "enhanced TV," ch combines video and data. It's al- ly possible over some satellite ser- s. At the recent National Association Broadcasters convention, Microsoft a satellite dish set up on the roof of Las Vegas Convention Center, receiv- an enhanced broadcast of the UPN edy *Moesha* on an ordinary PC.

This is the gist: Some satellite compa- are reserving a portion of their ca- :tiy for "multicast Internet Protocol " applications like enhanced TV.

en a customer accesses the enhanced *esha*, for example, they're actually on a ne page that includes both data and o. The customer can enlarge the to full-screen size for the traditional ve TV viewing experience, or they an the program in one corner of the while related data frames the pic- Viewers then can tap into actor bi- aphies, the moral or historical context of the episode, and more.

There's even a built-in incentive to watch a program from beginning to end. If you receive an uninterrupted data stream from the home page, you get a "goody" like low-resolution out-takes from the episode, or a CD-quality song. If you inter- rupt the stream, you don't get the goody. Reduced channel surfing. Would advertis- ers like that? You bet they would.

The computer industry has an answer for improved picture quality, too. They've tossed out most of the Advanced Televi- sion Systems Committee's proposed video formats (based on interlaced scan lines) in favor of progressive scanning formats. Because of psychovisual perceptive cues, a 720-line, 24 frame-per-second progres- sive format played over a VGA computer monitor is the effective viewing equiva- lent of 1,080 lines, 24 frames-per-second interlaced. That alone lowers the estimat- ed cost of a digital TV receiver from four figures to three.

Computer people don't care about return path capacity, even though we in the cable industry know it's important. Telco return is enough for most users, they say.

As far as they're concerned, if you have downstream bandwidth for multicast IP ap- plications, you could be playing in the digi- tal fast lane right now. Your competition is. Wait much longer and you risk being just one road to the enhanced TV of the future— and not a major thoroughfare, either. CT

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

Notice Anything Different?

In these rapidly changing days of cable technology, everyone is working on the return path. Same with us.

Communications Technology is essentially the return path for the cable telecommunications engineering industry. We gather information, process it and send it back out to the industry where others can make use of it.

Like many of you, lately we've been wondering whether we've done all we can for our return path. Thus, the new-and-improved, redesigned *Communications Technology*, just in time for the SCTE Cable-Tec Expo.

Throughout the magazine, you'll notice not only a new look, but improved performance overall. From the retooled logo through each separate department, we've made the magazine tighter and cleaner, with a more efficient use of available bandwidth.

An important addition to *Communications Technology* is "Bottom Line," which provides a summary of the salient points from each feature. It's a good way to hit the high points of each article—a great time-saver for managers and a quick technical update for the engineer in the field.

We hope you find *Communications Technology* more useful and enjoyable than ever before. Just like you, we know how important an optimized return path can be. This is the result of our own labors. Best of luck on yours.

By Ron Hranac

Two-Way Education

I just finished attending a two-day seminar called "The Reverse Path: An Executive Forum." It was sponsored by Scientific-Atlanta, and was held in Denver. Bottom line: A tip of the hat to S-A for a job well done. I personally think this seminar should be made more widely available to the industry, and attendance should be mandatory for anyone contemplating two-way operation, regardless of the brand of equipment being used. There are several points from the seminar that I'd like to review.

Reverse lasers

We all know that the weakest link in the upstream path is the reverse laser. Its dynamic range is considerably less than the coaxial plant that precedes it. The laser's lower dynamic range limit is defined by a combination of system and optical path noise (the noise floor will be degraded by impairments such as RF ingress and impulse noise), and the modulation type and data rate. The laser's upper dynamic range limit is the onset of clipping, and varies with total composite power and modulation type. It's between the two limits that we have to set a laser's input operating levels, and this is much easier said than done.

Lamar West, senior staff engineer at S-A, discussed laser loading theory. He emphasized concepts introduced during a similar presentation at this year's SCTE Conference on Emerging Technologies. That is, setting laser input levels on a constant power-per-Hz basis probably is not as good as using techniques based on probability density functions.

Case-in-point: Clipping can still occur when levels are set using constant power-per-Hz and the total composite power of multiple carriers is kept below a laser's clipping threshold. One reason is that the phases of multiple carriers generally will be random, but if the carrier phases should happen to reach peak power simultaneously, clipping may be the result. This can be avoided using PDFs, which are like histograms. I suggest you read West's Emerging Technologies paper, available in the conference proceedings manual. Copies of the manual are available from SCTE by calling (610) 363-6888.

Simulation software

Graham Mobley, S-A staff vice president and technical director, discussed the company's reverse path performance simulation software in his presentation "Simulating the Performance of a Hybrid Fiber/Coax Reverse Path." One key to using the simulation software as well as operation in the real world is understanding a laser's optical modulation index. I won't go into the mathematics that define OMI, but you can consider the 100% point to be the power input level that causes laser clipping. It should be used as the primary reference when determining the RMS %OMI that is to be assigned to each reverse path carrier in normal operation. Unfortunately, a laser's 100% OMI level is not a specification you're likely to find on a manufacturer's spec sheet.

There were comments by several seminar attendees suggesting that manufacturers should start providing this figure to users. I agree, and encourage all laser vendors to add this number to their published specifications. To determine 100% OMI for existing equipment, S-A's Mark Lucas suggested the following procedure: Inject an 8 MHz CW signal at the laser input, and increase its level until harmonics at the optical receiver reach -20 to -30 dBc, as observed on a spectrum analyzer. Note laser input level when that happens. That's the laser's 100% OMI level. The son for a relatively low frequency for a test is so that the carrier's harmonics w fall in the reverse path passband.

Back to the simulation software. It's Windows-based, and works in Window 3.1, 95 and NT. The software simulates effects of laser clipping and nonlinear tortion on signal performance. It was signed to simulate reverse path performance from 5 MHz up to 65 MH and predicts bit error rate for different modulation types at various drive levels. The user can specify different combinati of orthogonal frequency division multipl ing (OFDM), quadrature phase shift key (QPSK), 16-QAM (quadrature amplitud modulation), 32-QAM, and 64-QAM, as well as CW carriers. As well, different re verse path impairments can be added to allow determination of their overall impa

Once the user has defined the softw input parameters, including the laser characteristics, some very complicated gorithms will calculate the overall "lin" performance, including providing soft ware-generated spectrum analyzer plot either an I-Q eye diagram or a data con stellation, a composite signal histogram and link performance statistics. The so ware has been extensively correlated w real-world measurements.

During one of the seminar worksh we had a chance to play with the software. It's interesting to see the effects o strong 27 MHz CB carrier, or general across-the-band ingress. All of this can done without affecting an operating link while still allowing the user to produce some reasonably accurate test results. For the time being, S-A will be training its internal staff to use this software to assist customers with link performance

analysis. Frankly, I think this is a tool that should be made available to the whole industry. (I asked about this during the seminar, and was told that there are still a few software instability problems on the Windows platform. When these are worked out, I think S-A would have a real winner if they made the software available, say, through SCTE.)

Close-loop level control

Luis Rovira, S-A's principal engineer discussed the idea of closed-loop level control in the reverse path. I've heard others refer to this as "long-loop AGC." Whatever you want to call it, the concept is the basis for maintaining correct levels throughout the system. Closed loop level control compensates for system gain variations by changing subscriber terminal reverse output levels to keep laser drive levels constant. But for it to work, there can be no variable gains or losses, that is, AGC, between the laser and upstream receiver.

Rovira suggested an idea to provide system operators with a useful reverse path signal level reference. Generate a low-level pilot signal at each node so that it will be easier to quantify signal levels relative to 100% OMI. For example, the pilot could be set to a level 35 dB down from 100% OMI. All other levels, including measurements of ingress, could be referenced to the pilot. Attendee reaction was generally positive about this idea.

Upstream design

Bob Loveless, S-A's director, strategic planning and technology, taught the session "Optimizing the Reverse Path." He presented some very good ideas about upstream design considerations. In particular, Loveless commented on the need to consider the various reverse path signal level operating windows, and the importance of minimizing reverse level variance.

This can be done by using input pads at reverse amplifier locations (most manufacturers now have a place in their reverse amplifiers to install an input pad); set the unity gain point at the reverse amplifier input port (the downstream amplifier output port) rather than at the reverse module input; use in-line equalizers with a plug-in for a reverse pad (these will be available later this year); and standardize subscriber drop configurations to have approximately the same total loss in all drops as much as is practical. Try to keep subscriber reverse terminal levels as high as possible (be sure to leave sufficient headroom for normal system level variations), and do so consistently throughout the system.

There was a lot of very good material presented in the two-day seminar. S-A is planning to offer reverse path training based in part on this seminar, which will be available through S-A Institute, the company's training arm. It's a super idea, because the more we know about reverse path operation, the more successful we'll be providing two-way services. CT

Ron Hranac is senior vice president, engineering, for Denver-based consulting firm Coaxial International. He also is senior technical editor for "Communications Technology."

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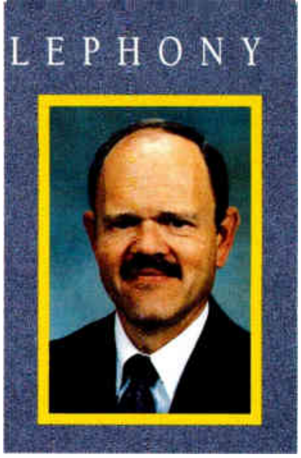
By Justin J. Junkus



New SCTE Telephony Certification Carries Benefits

If professional knowledge and proficiency in your field is gold in your career portfolio, then recognized proficiency is platinum or better. That is why I am proud to have been part of the Society of Cable Telecommunications Engineers' group that created the telephony certification program, which is being announced at Cable-Tec Expo this month. In this column, I want to make you aware of what this new SCTE program now includes, the direction it will be taking, and the benefits of becoming SCTE telephony certified.

Program overview

The SCTE telephony certification program will ultimately consist of two levels: associate and master. Associate level certification is being introduced at this time. Per the SCTE Telephony Certification Program rules, the associate level "consists of demonstrating proficiency with and the comprehension of a broad body of telephony related technical knowledge." The "broad body of knowledge" included in the associate category encompasses the history of the telephone, the components of the telephone instrument, signaling, switching, transmission, and the public switched telephone network. There is associate level telephony certification recognition for both technicians and engineers. The associate level test will be the same for both.

Master level certification will follow at a later date. It consists of passing the associate level certification and demonstrating a higher level of proficiency in each of the following six specialty areas.

- Customer premises equipment: This is equipment owned by the user. Certification requirements in this area will include knowledge of the demarcation point, station sets, key systems, private branch exchanges, inside wiring for residential and business service, testing and diagnostics, standards and regulations.
- Access: The interface between the end user and the service node (location of the telecommunications switch) is defined as access. Required knowledge includes the North American numbering plan, the switching hierarchy of the public switched telephone network (PSTN), telephone loop electricity, telephone signaling, the characteristics of twisted-pair, other transmission mediums, craftsperson tools, bonding, safety and troubleshooting.
- Network: These are the interconnections between telephony network elements, such as switching offices and remote terminals. Included are ring architectures, operation systems and facilities grooming.
- Transmission: Conversion, coding, formatting, and bandwidth maximization are all part of transmission. Certified professionals in this area will be expected to know the representation of digital information, analog-to-digital conversion, digital telephony, companding, multiplexing, the North American Digital Hierarchy, T-1 through T-3 carrier systems, and digital cross connect systems. They also will demonstrate proficiency in the synchronous optical network (SONET), radio and satellite telecommunications, and testing and diagnosis of multiple transmission systems.
- Switching: The switch is the heart of the telecommunications network. Areas of proficiency include switch evolution, the components of a digital switch, network hierarchies, the functions of a telecommunications switch, features, engineering a switch, interswitch signaling, and operations and maintenance.
- Powering: Telephony power is unique and multidimensional. In addition to the obvious safety considerations, the certified professional will be expected to know AC and DC power systems used in both the network and the switch, backup systems including battery and diesel, network protection, tests and maintenance.

Be prepared

Anyone who has gone through the other SCTE certification programs knows that preparation is a lot of work. Since most people like to put their efforts into projects that yield the optimal reward, I want to answer in advance a potential objection that some might raise regarding the apparently diminishing role of telephony in cable systems.

While it is true that many companies have decreased their enthusiasm for competition with the local telephone company, very few are not upgrading for two-way service. Although today's motivation may be high-speed data, once the system is two-way capable, telephony becomes an easy addition—if the company has trained personnel. When your system is ready to offer telephony, your SCTE telephony certification will put you in the vanguard of trained personnel.

Now, let's also think about the relationship of telephony to data communications and digital data in general. Most of what you need to understand just to start learning data comes with an understanding of telephony. Remember, data communications has its roots in telephony.

Above and beyond the close ties of telephony and data, note that cable systems

connect to telephone networks. To quote Marv Nelson, SCTE vice president of technical programs, "Even if your system is not immediately implementing telephony, you need to be able to communicate as a telecommunications professional with other telecommunications professionals. Some of your interfaces will be with people who have several years of experience in telephony, perhaps with a telephone company. By pursuing SCTE telephony certification, you will be equipped to gain their respect and cooperation as a professional on equal standing."

> "When your system is ready to offer telephony, your SCTE telephony certification will put you in the vanguard of trained personnel."

If you buy into the need for telephony knowledge, the SCTE certification process is one of the best tools to get it. Certification establishes a formal structure for an individual who wants to become proficient in a particular area. Each category is defined by a list of topics where the certified individual is expected to demonstrate competence. It therefore becomes easy to know exactly what is required to become a recognized expert. Certification also provides a way to document that the individual has completed an educational process that brought him or her to that proficiency. In this respect, it is similar to academic programs leading to a degree in a particular field.

Unlike a degree program, however, certification provides greater individual freedom by not constraining a candidate to a fixed curriculum. Certification takes into account knowledge gained on-the-job, through self-study and independent reading, as well as through formal training. To remain certified, an individual must demonstrate continued education in the certified discipline. A certified individual is therefore an individual whose expertise is based on today's required knowledge as well as the knowledge he or she demonstrated some time in the past.

Like categories I-VII of SCTE's Broadband Communications Technician/Engineer (BCT/E) certification, telephony certification will be awarded after a candidate passes a written examination. The certification committee has ruled that the associate level exam is closed book, because it is a test of basic knowledge. For those of you who have some trouble with this concept, consider how you pass the exam for a driver's license. As an experienced driver, you still may occasionally refer to the owner's manual and state rule book. In your day-to-day operation of your vehicle, however, you need to have memorized its basic operating features and the traffic laws before you hit the road. In a similar manner, telephony professionals need to have a basic knowledge before they can even begin to work in this field. A closed book test ensures that you have captured that basic knowledge and made it part of your professional mind.

Preparation will be crucial to achieving telephony certification. To assist in this area, SCTE will be publishing a list of recommended resources, and is planning to inventory key training aids at headquarters, for member purchase.

Of course, practical experience as well as theory is needed for full proficiency in telephony. Like BCT/E certification, telephony certification assumes the professional requiring hands-on knowledge will acquire it. For example, there are new wiring practices and network interfaces with the telephone company. That type of experience comes from on-the-job training or by attending courses with lab exercises, just as it does in other SCTE certification programs.

Be prepared for both data and telephony as cable enters the next millennium. Take the next step by committing to SCTE telephony certification as one of your career goals. CT

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

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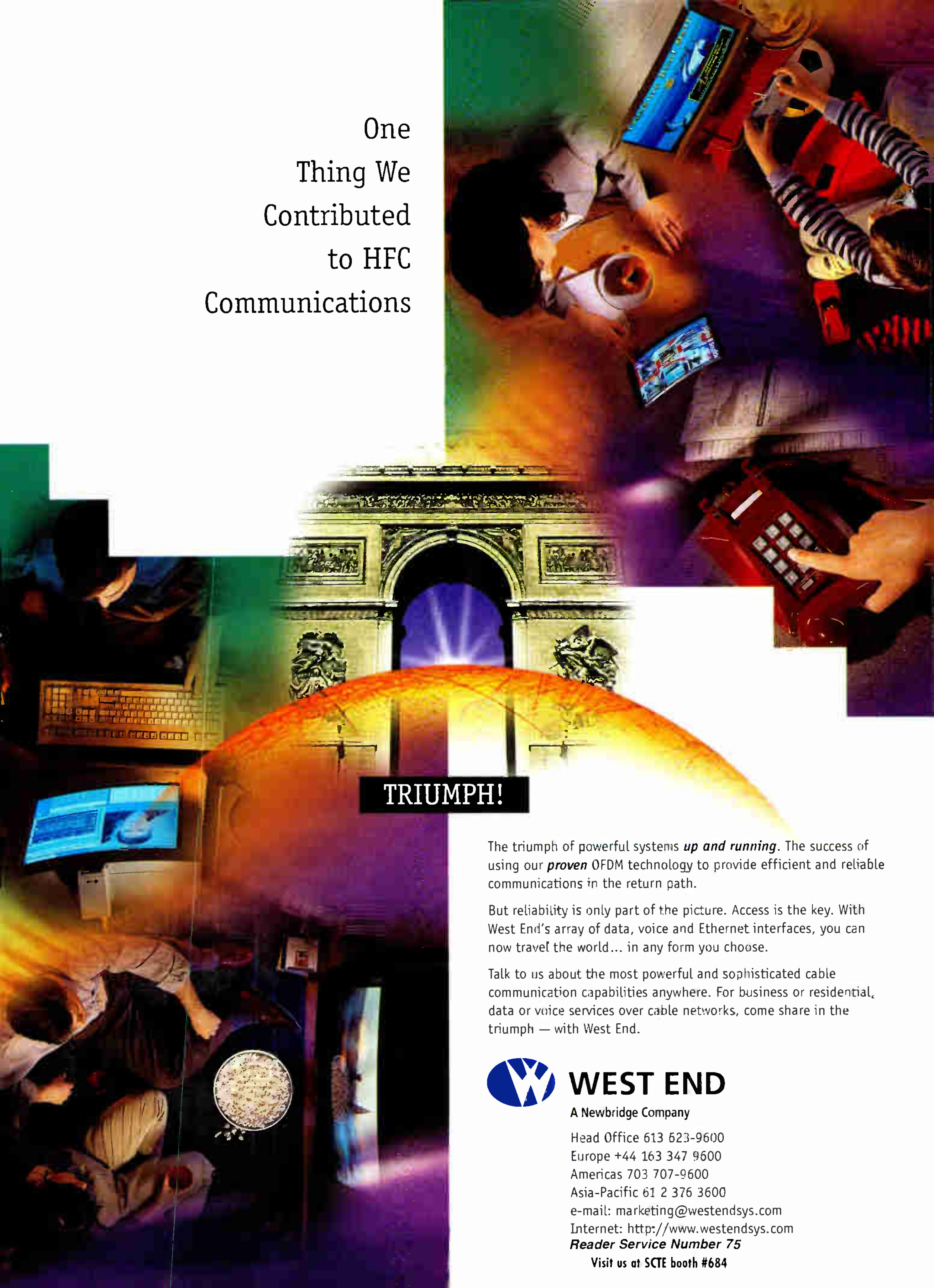

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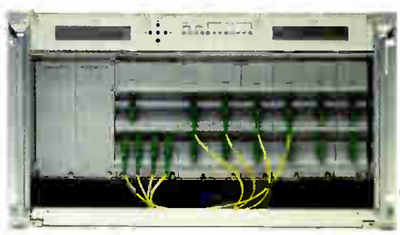

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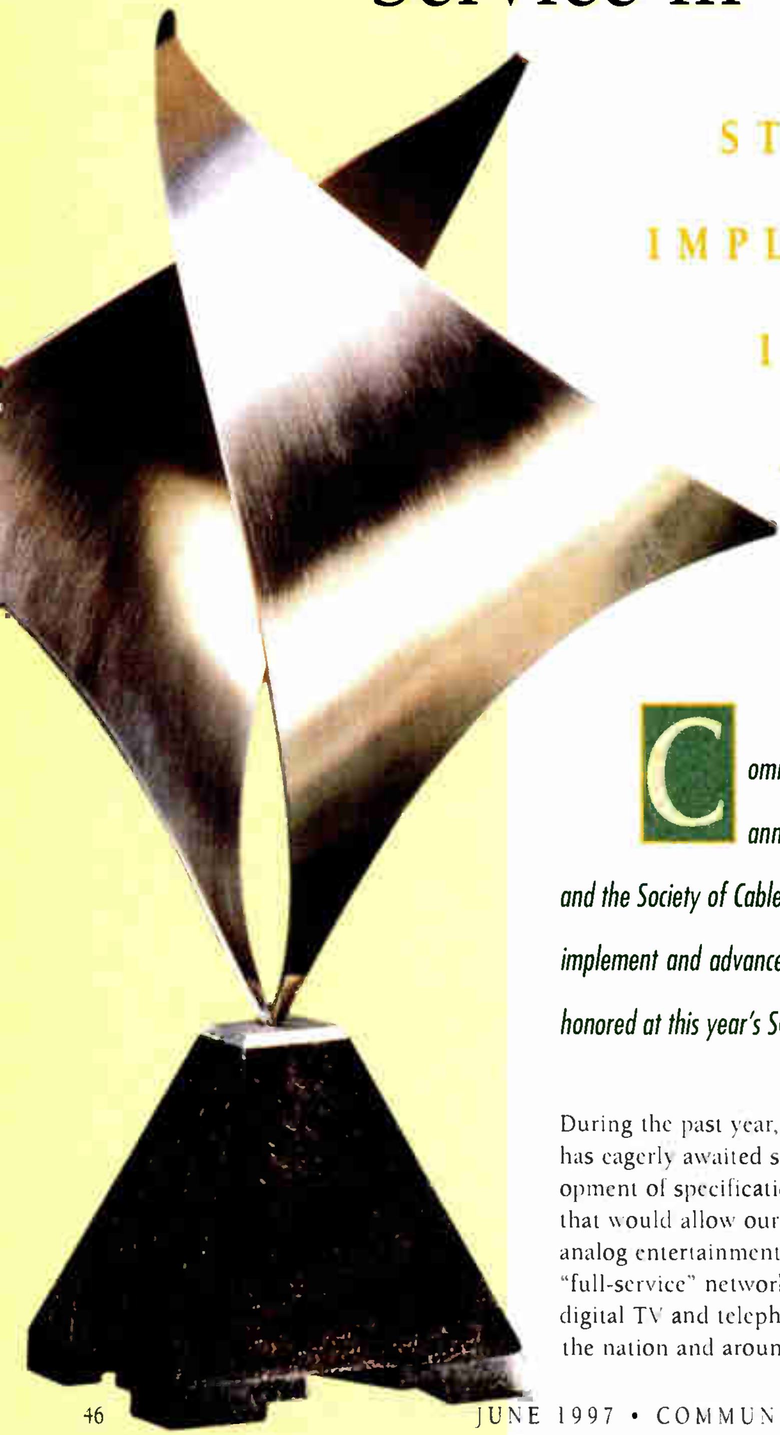
CableLabs and SCTE: Winners of the 1997 Service in Technology Award

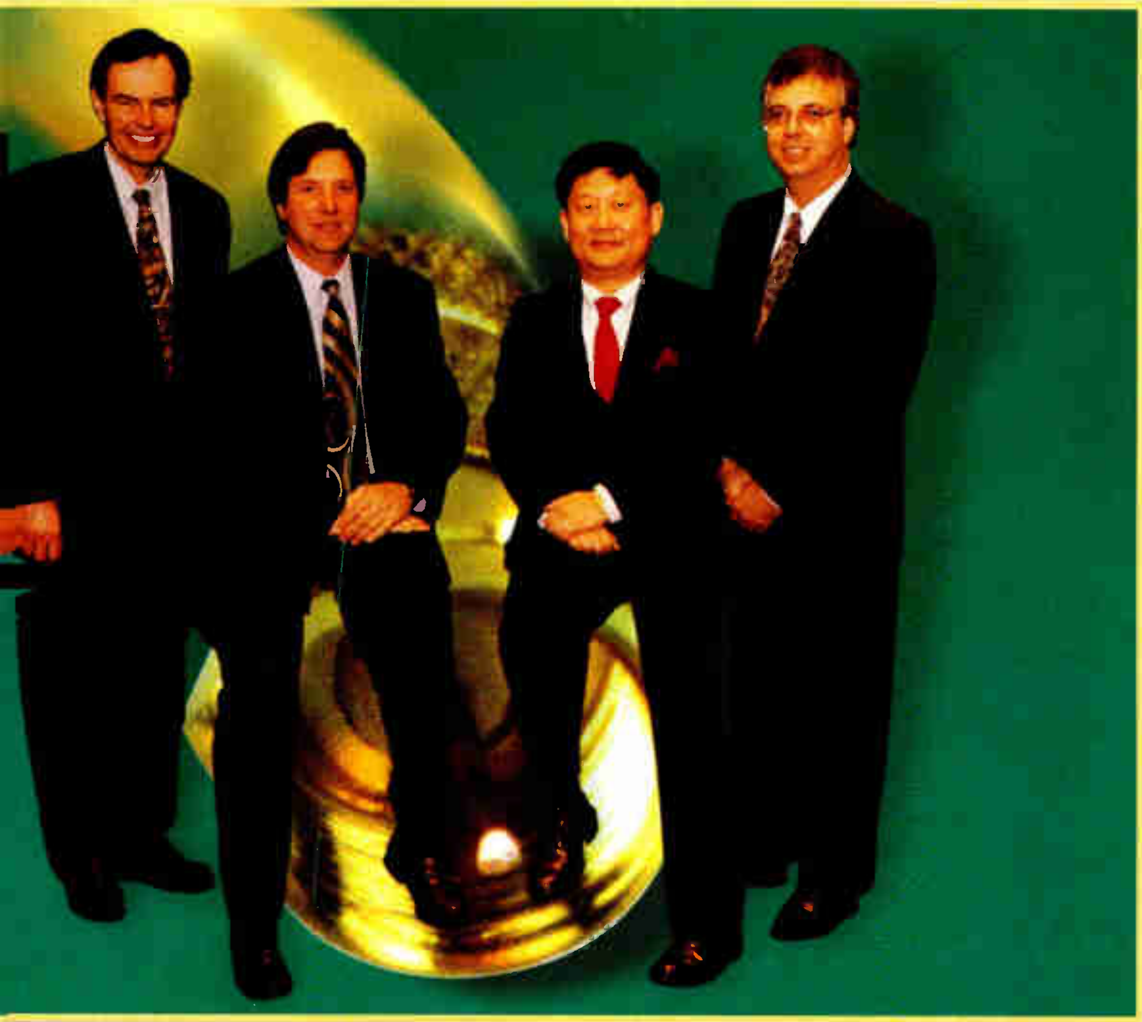


STRIVING TO DEVELOP, IMPLEMENT AND DELIVER INDUSTRY STANDARDS AND SPECIFICATIONS

By Rex Porter

Communications Technology and Phillips Publishing International are proud to announce the winners of the 1997 Service in Technology Award: CableLabs and the Society of Cable Telecommunications Engineers. An overview of their committed efforts to implement and advance telecommunications technology follows. CableLabs and the SCTE will be honored at this year's SCTE Cable-Tec Expo Annual Awards Luncheon in Orlando, FL.

During the past year, the cable industry has eagerly awaited selection and development of specifications and standards that would allow our transition from analog entertainment TV systems to "full-service" networks, providing data, digital TV and telephony services across the nation and around the world. Two groups have worked exhaustively to deliver these specifications and standards, many of that have been adopted by others as well as the cable TV industry. We are proud to honor these two groups, CableLabs, working under the direction of Dr. Richard Green and Dr. Richard Prodan, and the SCTE's



Riding the cable standard wave are (left to right): CableLabs' Dr. Richard Green and Dr. Richard Prodan and SCTE's Dr. Ted Woo and President William Riker.

standards efforts working under the direction of William Riker and Dr. Ted Woo, as winners of the 1997 Service In Technology Award.

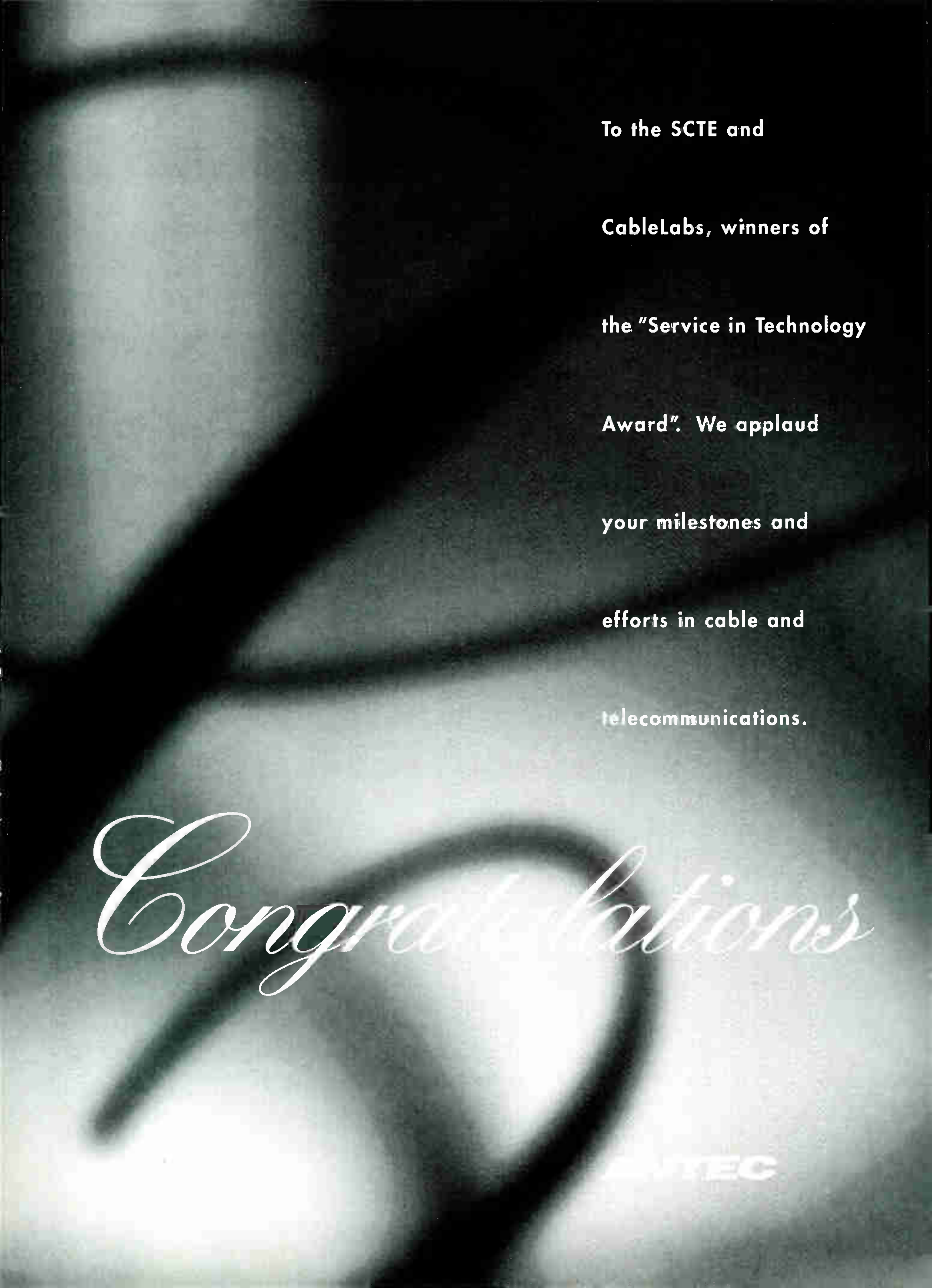
Quest for interoperability

In 1996, CableLabs developed a set of specifications aimed at gaining interoperable high-speed cable modems. In praising the success of CableLabs, Dr. John C. Malone, chairman of CableLabs' board of directors, said. "This is a major accomplishment for the cable TV industry. We said last year at the (1995) Western Show we would do this as quickly as we could and here we are one year later at the (1996) Western Show announcing our success. In the meantime, we continue to deploy early versions of these modems and our customers are delighted at the high-speed and convenience these modems afford by not requiring customers to tie up a phone line each time they wish to connect to the Internet."

The set of specifications includes a radio frequency (RF) interface specification that was released to 95 vendors that have signed the Data Over Cable System Interface Specification Assess Agreement. This document is under review by the vendor community. The network security specification and operations support system interface have been released. These documents are considered complete. Modems compliant with the specifications will be capable of delivering data to users at a minimum rate of 27 million bits per second (Mbps). So far, a variety of suppliers have indicated an interest in building interoperable modems that comply with this specification.

Meanwhile, the SCTE Data Standards Subcommittee has developed cable modem standards. The Subcommittee Chairman,

1997


To the SCTE and CableLabs, winners of the "Service in Technology Award". We applaud your milestones and efforts in cable and telecommunications.
Congratulations

William Riker

Dr. Ted Woo

David Fellows of Continental Cablevision, has conducted two meetings recently to develop standards related to network architecture. This group is focusing on the funneling of cable modem standards from interest groups such as the Multiple Cable Network Systems (MCNS), a consortium of six major cable operators, and the Institute of Electrical and Electronics Engineers (IEEE) 802.14 committee. Five working groups within the SCTE Data Standards Subcommittee evaluated technical papers covering the following topics: computer interface, operational support system, security, physical layer (PHY) and media access control (MAC), telephony-return models and overall architectural concern guidelines.

Examples of subject matter included the physical layer interfaces, which are defined as using quadrature phase shift keying (QPSK) or 16-QAM (quadrature amplitude modulation) for upstream modulation and 64- to 256-QAM in the downstream direction. The downstream bandwidth capacity should extend to 800 MHz, so that cable modem signals can operate in the "roll-off" spectral zone of a 750 MHz cable system.

The IEEE 802.14, a cable data modem standards setting group, acknowledges the SCTE's downstream transmission standard by including the extended J.83 Annex B in its physical layer (PHY) specification. This is added to the existing downstream transmission format, J.83 Annex A, which is based on a European cable standard.

During this year, new technical papers are expected to suggest how one can best handle high-speed data services, such as the "available bit rate," the "intermediate bit rate" and the "continuous bit rate" services and migration to asynchronous transfer mode (ATM). MCNS plans to grant non-exclusive licenses to vendors wanting to manufacture to these specifications. The MCNS license grant is conditioned upon a manufacturer's agreement to contribute freely, or on a reciprocal, no-cost basis, any crucial intellectual property required to implement a compliant modem.

In Fall 1996, working with some of the key suppliers of digital technology,

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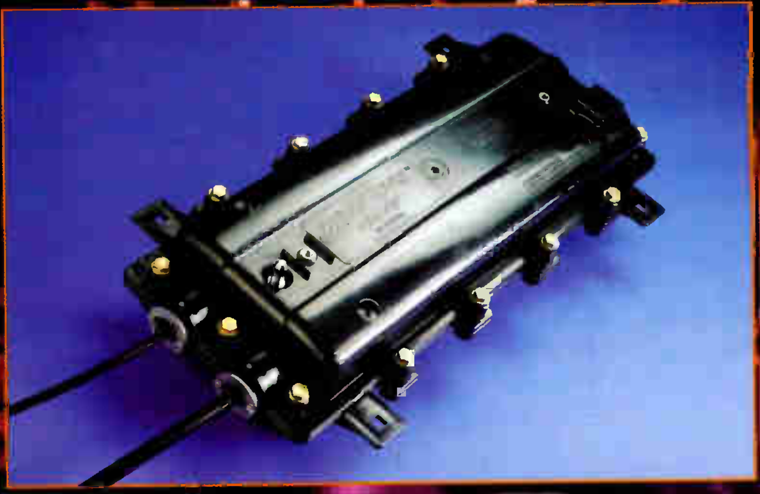

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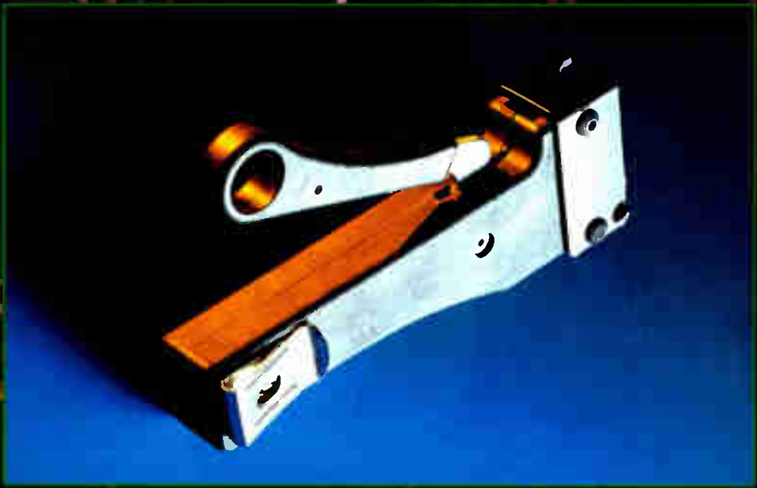

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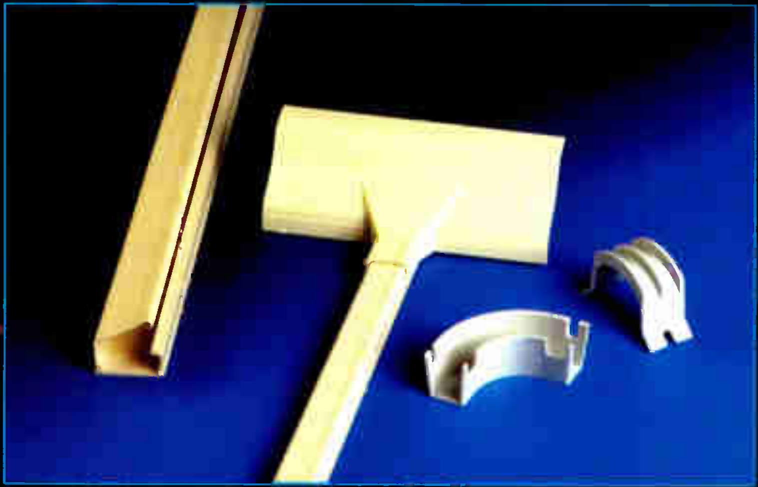

abs and its members agreed upon elements of an interoperable digital e system specification for North Ameri-. This specification establishes the basic uilding blocks of digital services, allowing t-top terminals and data modems built by fferent manufacturers to work together nteroperate) on the same cable system.

igital video transport

CableLabs expects that many of its mbers will purchase equipment that mplies with this specification. The speci-ation covers how cable TV systems will nsport digital video and data on stan-rd 6 MHz cable channels. In the speci-d digital transmission systems, the yload data rate will be between 27 and Mbps. Agreed among the basic areas vered in this specification is that the sys-m will conform to MPEG-2 (Moving Pic-res Experts Group) main profile at main el parameters; the specification trans-t multiplex also will be MPEG-2; and audio element will be the Dolby Audio -3 system. The service information tables for this specification will incorporate the Advanced Television Systems Committee (ATSC) specification. Uniformity in these tables is critical for interoperability.

Downstream digital modulation will conform to the International Telecommunications Union (ITU) standard ITU-T J. 83 Annex B, which calls for 64- and 256-QAM with concatenated trellis coded modulation, plus enhancements such as variable interleaving depth for low latency in delay-sensitive applications such as data and voice. Using 64-QAM, a cable channel that today carries one analog video channel could carry 27 Mbps of information, or enough for multiple video programs. Using 256-QAM, the standard 6 MHz cable channel would carry 40 Mbps. The cable industry is committed to delivering broadcasters' digital video signals to cable customers. This specification is compatible with the ATSC standard definition digital video system, with the exception of modulation.

The ATSC standard incorporates vestigial sideband (VSB) modulation vs. QAM. Because of the characteristics of over-the-air


Dr. Richard Green


Dr. Richard Prodan

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transmissions vs. cable transmission, and the consequent differences in bit rates, the difference in capacity is logically dealt with at the cable headend. The difference in modulation also can be dealt with at the headend, and by having this capability, cable operators will be able to handle any digital signal from whatever source and deliver these signals to cable customers.

Signal security saw an immediate breakthrough when two key suppliers, General Instrument and Scientific-Atlanta, agreed to a royalty-free cross-licensing arrangement for core encryption, modulation and forward error correction technology, with a willingness to license other manufacturers.

Moving ahead, the SCTE's Digital Video Subcommittee, headed by Dr. Paul Hearty, adopted the "Digital Video Transmission Standard For Cable Television." This new standard was approved by the SCTE's standards supervisory group, the Engineering Committee. Now being submitted to the American National Standards Institute for recognition, this new American National Standard, SCTE DVS 031, describes the framing structure, channel coding, and channel modulation for a digital multi-service TV distribution system that is specific to a cable channel. The system can be used transparently with the distribution from a satellite channel, as many cable systems are fed directly from satellite downlinks. The cable channel, which is typically distributed over optical fiber, is primarily regarded as a bandwidth-limited linear channel, with a balanced combination of white noise, interference, and multipath distortion.

The QAM technique used, together with adaptive equalization and concentrated coding, is well-suited to this application. The specification covers both the 64-and 256-QAM. Most features of both modulation schemes are the same. Where differences do exist, the specific details for each modulation scheme will be covered in this standard. (Note: Details of this standard are available. To obtain a copy, contact the director of standards at SCTE.) ➤

In addition, the Digital Video Subcommittee recently adopted two more standards. These standards are to be reviewed and voted upon by the SCTE Engineering Committee. They are 1) "Video Standard to Provide For Two Performance Tiers" (MPEG-2 Main Profile/Main Level, standard definition); and 2) "Audio Digital Television Standard."

A new digital video standard for supporting multilingual subtitling services is now available. Its title is "SCTE Proposed Standard Methods Subtitling Methods for Broadcast Cable." This Digital Video Subcommittee (DVS) standard, DVS 026, sets forth a transmission protocol supporting subtitling services of multiple language to augment video and audio within the MPEG-2 multiplexes. The Digital Video Subcommittee also has adopted SCTE Video Compression Formats, a standard that consists of three tables. They are the Standardized Video Input Format, the Compression Format Constraints for Tier 1, and the Compression Format Constraints for Tier 2. There are 102 standards documents in the SCTE Standards Department. The SCTE Interface Practices Subcommittee (IPS) has 85, DVS has 16 and the Material Management/Inventory (MMI) Subcommittee has one.

Looking ahead

Further, the SCTE will debut The Recommended Practices for Coaxial Cable Construction and Testing Manual at the Cable-Tec Expo in Orlando, FL, this month. It will join the already available "Recommended Practices for Optical Fiber Construction and Testing" also produced by the Design and Construction Subcommittee.

> "The SCTE Data Standards Subcommittee has developed cable modem standards."

And finally, the SCTE Interface Practices and In-Home Cabling Subcommittee submitted the "F" Port (Female Outdoor) Physical Dimensions document IPS SP 400-199x to ANSI earlier this year. IPS SP 400-199x has been approved as a new American National Standard.

Much of cable's growth and maturity is due to the behind-the-scenes labors of both the CableLabs specifications programs and the SCTE's standards programs. We at *Communications Technology* and Phillips Publishing International are pleased to honor their efforts with the Service In Technology Award for outstanding engineering achievements in 1997. CT

Rex Porter is editor of "Communications Technology." He can be reached in Mesa, AZ, at (602) 807-8299.

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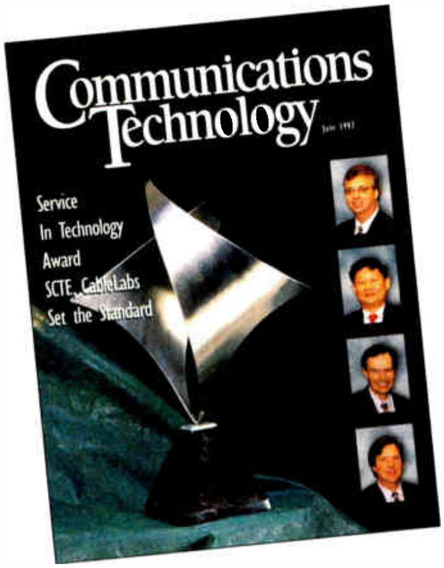

For over 13 years, *Communications Technology (CT)* has been the **OFFICIAL** trade journal of the Society of Cable Telecommunications Engineers (SCTE) and the industry's most respected technology publication.

***CT's* 1997 Readership Study**, conducted by an independent research company, recently confirmed what 25,000 qualified subscribers already knew: ***Communications Technology* is the cable industry's preferred engineering management magazine!**

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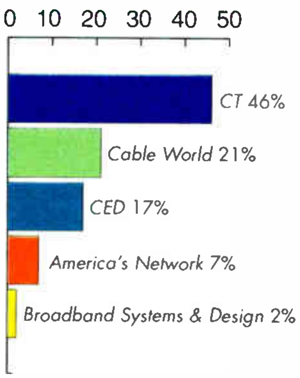

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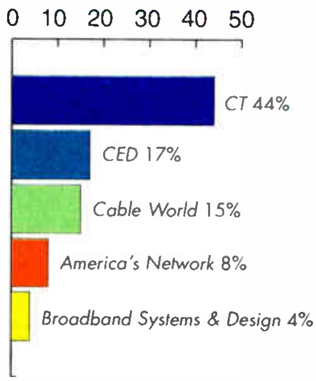

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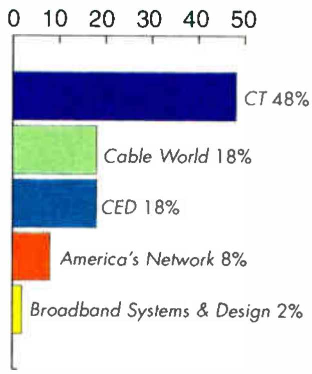

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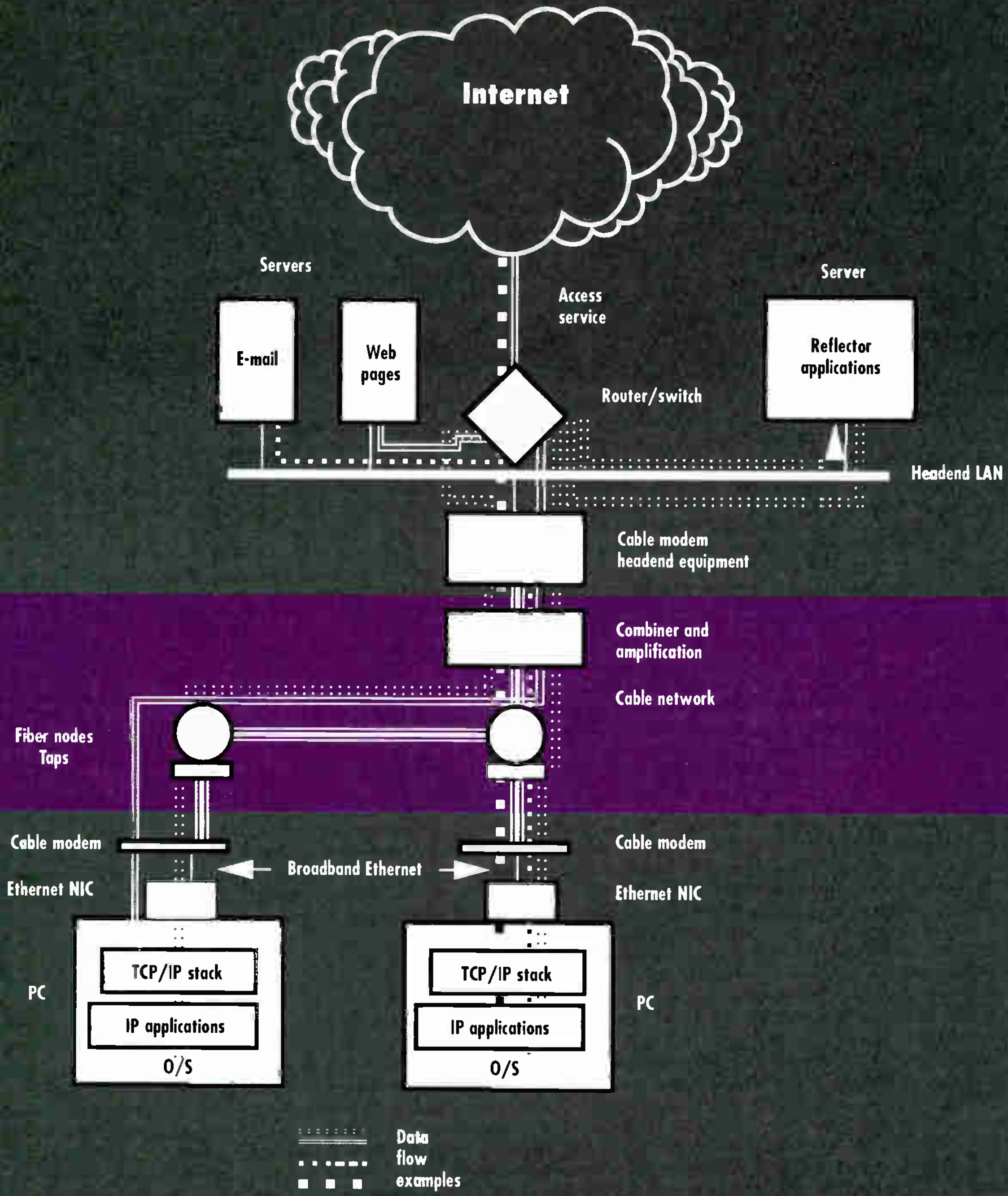
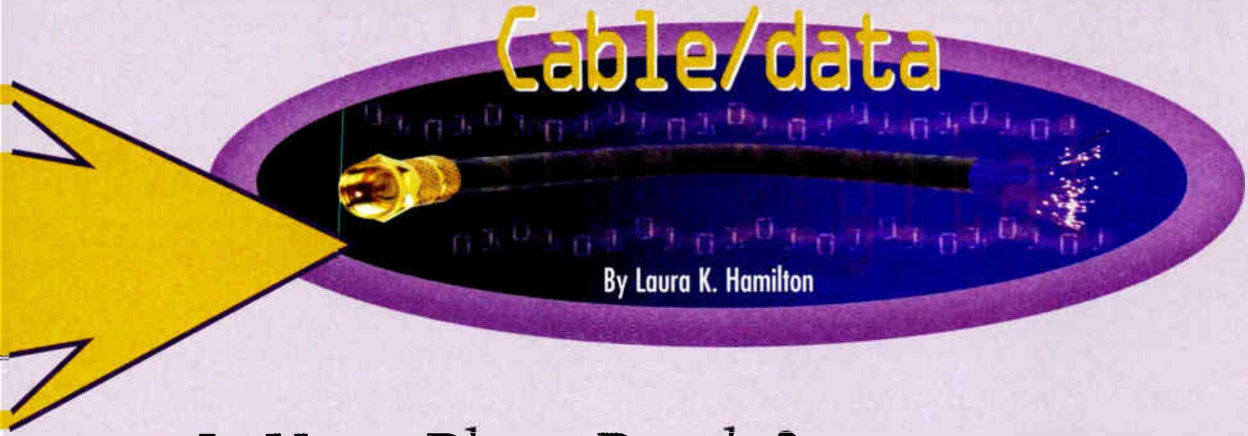


Schematic courtesy of Convergence Systems Inc.



Is Your Plant Ready?

Leakage, Lasers and Network Management

In this special "Communications Technology" report, we've used three categories as a springboard for defining what should be done to get your cable system ready for the grand potentialities of high-speed data delivery. In the May issue, we took on the headend. This month "CT" looks at the transmission system, and in July, we'll tackle the customer premises (where the vast majority of upstream problems are bombarding the two-way network). Like your system, this three-part series is really a network made up of different parts, and each installment should be considered with the others in mind.

Aside from that leakage ugliness at the customer premises everyone is concerned about, you're probably doing pretty darn well when it comes to leakage detection/repair programs in other parts of the plant.

Most likely, you're not up flipping through the infomercials at 3 a.m., fretting about how clean the area between the headend and the home is. And if you are, you're probably too worried about the Federal Communications Commission shutting down channels to have time to think about moving into next-generation services such as high-speed data. After all, the FCC's cumulative leakage index (CLI) reporting requirement has been in place since 1990, and most would say that the industry is doing superior work in finding and fixing leaks.

"The MSOs are doing a wonderful job," says Ken Eckenroth, vice president of Cable Leakage Technologies. "Cable folks are ready to play their ace in the hole, which is their broad spectrum."

General Instrument's Dean Stoneback agrees, "The plant is very robust. There is not an issue in the equipment out there as long as you use good technique or craft." Stoneback does add a particular caveat concerning "good craft," however. "Loose fittings will still kill you, even in the hardline part of the plant," he warns.

CLT's Eckenroth also points out that even though you probably have a firm rein on leakage in the transmission system (apart from the customer premises), patience is a necessary virtue: "Some points of ingress are intermittent. You need to be patient and wait for the problem to occur and track it the best you can." He says here are quite a few tools out now to help. In his opinion, the most valuable is the "channel tagger." It's very fast and allows positive ID of a leak as well as allowing you to find a low-level leak.

So, you're doing a pretty good job with your leakage program in the transmission system, but what else is there? "We all know that the weakest link in the upstream path is the reverse laser," says Coaxial International's Ron Hranac. "The laser's upper dynamic range limit is the onset of clipping, and varies with total composite power and modulation type. It's between the two limits that we have to set a laser's input operating levels, and this is much easier said than done," Hranac adds. *(For further details, read Hranac's column this month on page 36.)*

Patrick Harshman, product manager for transmitter systems at Harmonic Lightwaves, also takes up the laser issue, "People are trying to load many, many return path signals onto a single return path laser. An emerging issue, at headend and hub locations, is isolation as you try to sort out different return path signals and cross-connect switching."

"There's a lot of loss as you go through the required splitters and RF combiners to split out and combine like kinds of signals. That together with noise in the return path signals basically will lead to reduction of the carrier-to-noise ratio," adds Harshman. So one challenge is figuring out how to successfully separate return signals without introducing too much loss and without risking isolation problems.

There's those words again. It seems that if you're serious about high-speed data, you must be serious about what Harmonic's Harshman calls, "adding intelligence to the return path coax plant."

What he means in particular is adding equipment in your system that allow you to intercept an impulse noise occurrence.

One solution Harshman recommends is putting a transponder in the last line extender. Then that's a first point where you can detect impulse noise coming back in the upstream path before it gets funneled together with too many return signals.

Obviously, there are more plant issues in the high-speed data world than can be discussed in this short introduction. The articles that follow take up the issue in detail. CT

Laura Hamilton is senior editor of "Communications Technology."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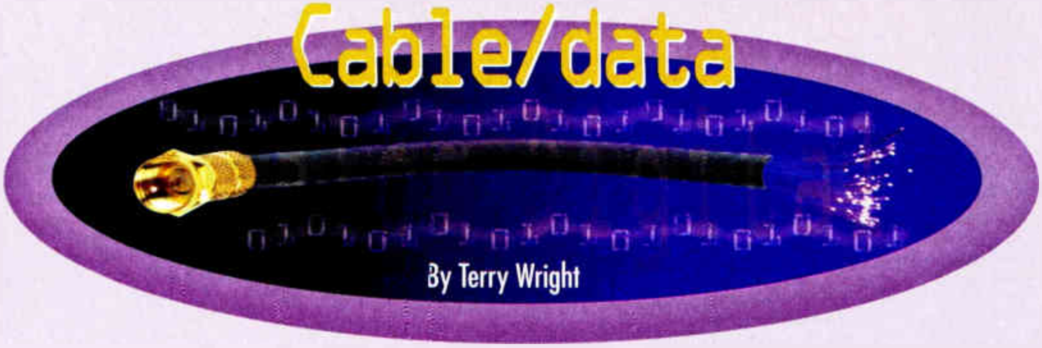

Straight Talk About the Physical Plant

Don't read this article if you're looking for some exotic new formula, fail-safe technique, or technical revelation that you might incorporate to make the deployment of two-way data services as straightforward as activating new entertainment service subscribers. We're dealing with realities here: What you can look forward to is a few basic cable plant topics that will provide you the greatest practical value if you've been tasked with enabling data services over your cable networks.

Deploying cable-based data services, especially where the physical cable plant is concerned, is about common sense and getting back to basics. While this might seem somewhat elementary to many expecting to hear the latest on wavelength division multiplexers or doped-up lasers, overlooked or poorly done basics represent the overwhelming majority of problems encountered when a cable plant needs fixing.

Communication

The most common impediment to preparing the cable plant for the delivery of data services is surprisingly simple, and should be easily remedied. The primary culprit is a lack of communication between ongoing cable plant maintenance and installation crews, and the project crews involved in enabling the data services. Typically, the data services project team is small and focused on bringing up a few test sites in a recently upgraded area.

Traditional maintenance and (cable service) installer crews need to be made aware of the importance the data services team places on the return spectrum. This is often overlooked in cable data service projects, resulting in unnecessary delays and duplicated effort in preparing the return spectrum to carry data services. Plant maintenance and installation crews need to be conscious of the active return plant in their daily activities. If necessary, they also may need to modify installation procedures and routine plant maintenance tasks to accommodate an active return plant as suggested in our discussion below. Before we get started with that, however, there is another less obvious common sense area that often gets overlooked.

> "The single largest problem in most cable systems seems to be in the area of F-connectors."

Because your data services deployment area will likely begin with a few target neighborhoods, it makes sense to eliminate potential sources of cable plant problems until they are included in your data service coverage area. Subscribers (especially MDUs) that do not require reverse capability can be high-pass filtered out! That way, you will gain a better understanding of the noise characteristics of small targeted areas (without external corruption potential), which also will facilitate your understanding of how the addition of cable modems affects the noise floor. By eliminating uncertainties from initial data deployment efforts, you'll gain a more accurate understanding of how data services technologies affect your cable plant—which can greatly facilitate future large-scale service rollout.

Square one

Getting back to the basics of cable plant design, maintenance and installation procedures is essential for optimal deployment of cable-based data services. Making maintenance and installation crews aware of the active return plant is just part of the process. Extending this awareness into how these crews do their jobs is critical. There is no substitute for disciplined basics of good maintenance and installation procedures.

Every cable plant technical employee has been taught to tighten connectors,

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close amplifier housings, and heat shrink splices. As the cable industry evolved, however, the quality of TV and cable equipment in general has improved significantly. This has rendered these "basic" issues less important in the larger scheme of things as plant and subscriber equipment have become more forgiving, and as cable operators strive to reduce costs and improve productivity. However, now that you have

> "Getting back to the basics of cable plant design, maintenance and installation procedures is essential for optimal deployment of cable-based data services."

decided to deploy data services over cable modems, these basics have returned to the top of the priority list.

In general, the small innocuous parts of all cable systems are found to be the leading cause of most ingress or noise leaking into the cable plant. The single largest problem in most cable systems seems to be in the area of F-connectors. As a simple but revealing exercise, try this test: Select any 10 or so random F-connectors installed on your cable plant.

- *Take them off of the fittings and look into them:* Is the center conductor corroded? Is the insulator disintegrating? Is the insulator pushed all the way to the bottom of the fitting?
- *Pull on the connector:* Does it come off in your hands?
- *Look at the crimp:* Is the connector cracked? Is the cable mashed flat?

BOTTOM LINE

Checklist for a Tight Plant

Planning to deploy cable modem-based data services on your system? The following points should make you more successful:

- All cable plant technicians should carry appropriate wrenches and use them to tighten everything (seriously).
- Teach everyone how to close and tighten amplifier housings properly.
- Remind your team that all outdoor splices require proper weather treatment (including heat shrinking).
- If water can find its way into a fitting, so can unwanted signals. If water does get in, it is almost guaranteed that the center conductor will be shorted to the shield.
- Ground blocks and ground wires are essential.
- Proper tools for finding problems (such as signal generators, spectrum analyzers, even bucket trucks) are also essential.
- Hunting ingress is a time-consuming and frustrating task; it is much faster, easier, and cost-effective to do the job right the first time.
- If you have been doing it wrong for years, don't worry, there's still hope. Problems can be found and corrected; it just takes time.

If you've answered yes to any of these questions, then you can easily understand why we are stressing the importance of getting back to basics.

Poorly installed F-connectors are the leading cause of ingress in almost every cable plant. Loosely crimped connectors, connectors that have not been tightened to the fitting properly, double crimped connectors (or crimped with the wrong tool), and incorrectly made connectors (conductor too short or long, insulator not properly seated in connector, shielding sticking out of connector). With the high quality of today's TV sets, it has become less important to guard the quality of F-connector installation, but cable modems and low frequency noise are not nearly as forgiving.

There have been instances of a single poorly made F-connector causing up to 38 dB of noise as seen at the headend. One badly made connector, in a very unfortunate location (next to a radio broadcast tower), caused the entire underlying cable network to be unusable for cable modem-based data services due to signal leakage at that single point.

While it is quite unusual to see so much noise due to a single bad connector, it is not unusual to see large amounts of noise due to the aggregate of hundreds of connectors throughout the network.

On the topic of connectors, snap-on connectors—a recent innovation—seem to perform well, particularly when compared to crimped connectors. For data service deployment, the extra cost of these connectors may be warranted as they provide good connection and virtually eliminate the introduction of noise.

Other issues

After the issue of poor-quality or poorly installed F-connectors, the following issues are common sources of ingress problems on typical cable plants:

- Poorly seated modules in amplifiers,
- Bad equalizers in amplifiers,
- Failed reverse (or forward) modules (actives),
- Badly grounded amplifiers and incorrectly-installed power inverters,

- Minute breaks in cable shielding "micro-fractures"), and
- Technical personnel, influenced by the introduction of new technologies (e.g., cable modems) onto their cable systems, overlooking the "basics."

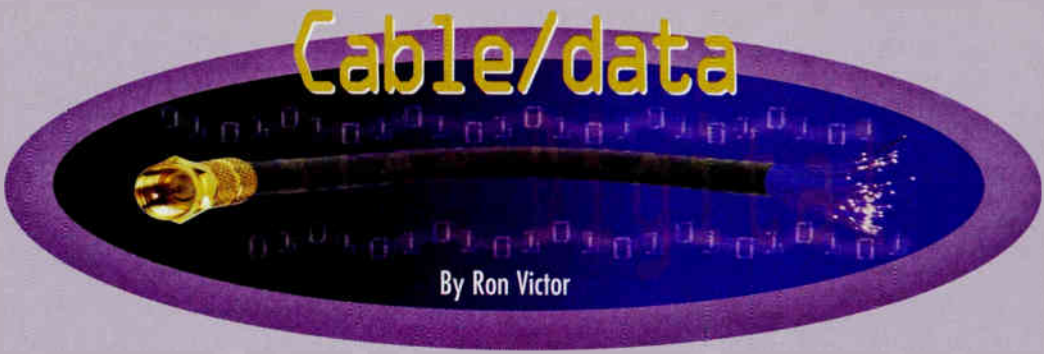
Of course, there's no such thing as a definitive list of data service deployment obstacles in the physical cable plant. I've seen a variety of noise sources and related problems, such as overpowered (and illegal) CB base transmitters, ill-tuned ham radio broadcasters, and in one case, even a grossly out-of-spec (and quite aged) traffic control device radiating noise. (This latter issue was compounded by a crack in the cable shielding near the junction of where this device was tethered to a common trunk run.)

It's important to understand that while active cable plant components and subscriber TV sets have grown much more tolerant over the years to cable plant aberrations, cable modem solutions are going in the opposite direction. Encoding techniques and spectral efficiency goals of cable modems attempt to exploit cable plant spectrum by squeezing as much performance as possible from it, while relying on the technical support staffs of cable operators to maintain systems at or near Federal Communications Commission requirements.

Current use of quadrature phase shift keying (QPSK) and proprietary encoding techniques are giving way to more advanced QPSK, quadrature amplitude modulation (QAM—16-, 64-, 256-), and binary phase shift keying (BPSK) approaches, and the future may include distributed wavelet multitone and other spread-spectrum techniques. The important point to remember is that as cable modem vendors attempt to leverage optimum data-carrying capacity from your cable networks, enabling you to offer the highest-performance data services in town, the quality of your "basics" will become increasingly more important. CT

Terry Wright is chief technical officer of Convergence Systems Inc., an Atlanta-based systems integrator. He can be reached at (770) 416-9993.


LOVE.



A Cure for Data Traffic Jams

Saving Money with Block Conversion

When planning data delivery, your first thought may not be about the impact it has at street level. And that, in fact, is the problem.

Traditionally, cable networks have been used for uni-directional applications—from the headend to the user. Most hardware blocks at street nodes were designed to deal with downstream traffic only. With the advent of cable modems and bi-directional applications such as high-speed Internet access, however, cable networks have to start thinking about the new demands being placed on hardware at street nodes.

One way around the hardware congestion that can clog utility poles and other street node locations is by using block conversion to break down the network into smaller branches. If you're thinking about data delivery, here's why block conversion also may be worth considering.

The reverse dilemma

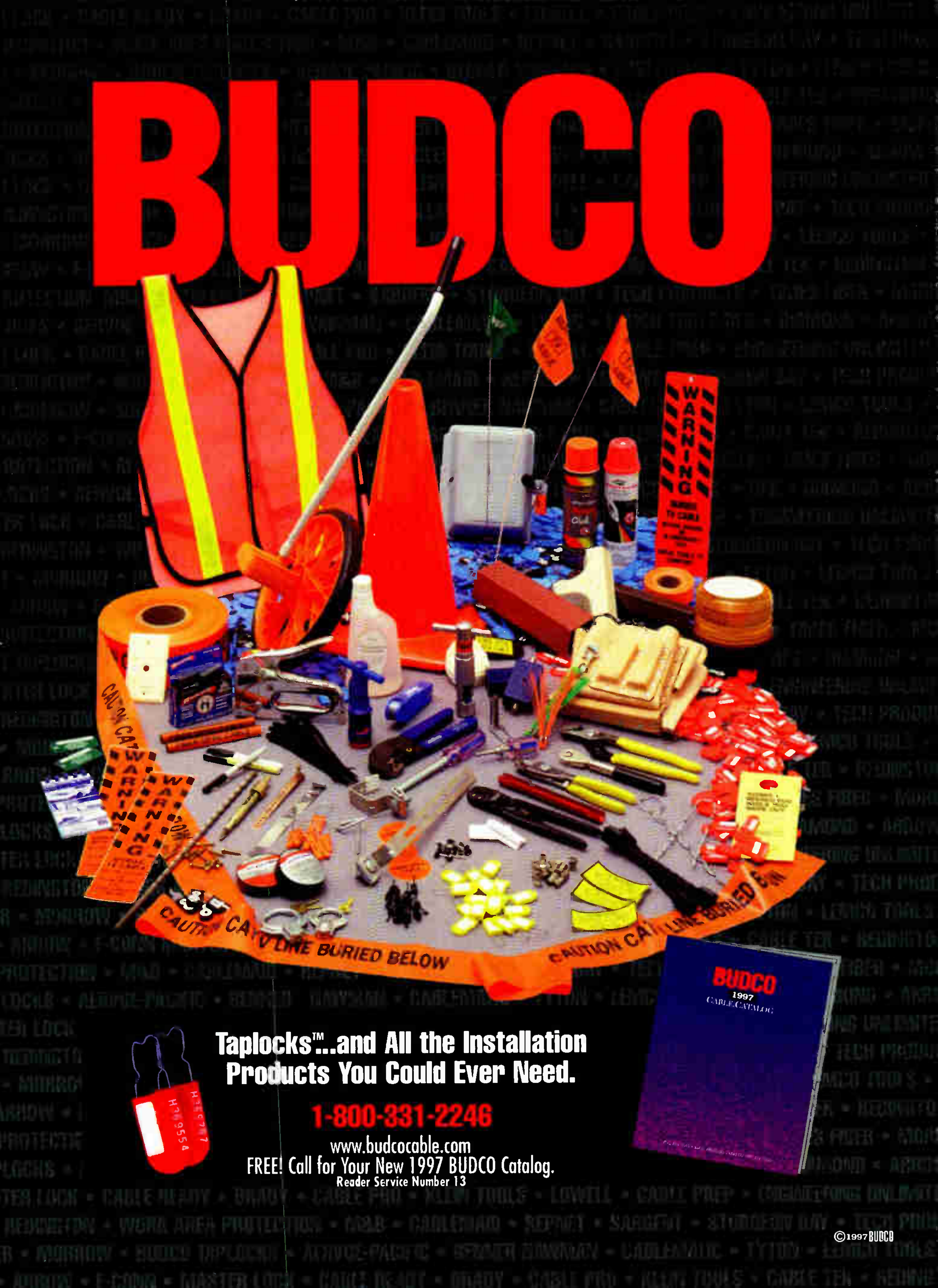
At the time frequency spectrum allocations for cable TV networks were being considered, the primary application for CATV networks was cable TV. Heavy downstream (from headend to user) traffic was anticipated, but only minimal upstream traffic from the user to the headend was ever considered. Thus, most cable networks today use anywhere between 50 MHz to 850 MHz for downstream traffic and 5 MHz to 42 MHz for upstream traffic.

Obviously, the available reverse spectrum for upstream traffic is extremely limited compared to the available downstream spectrum. The emergence of bidirectional multimedia applications over cable TV networks has placed heavy demands on this small available upstream spectrum. As a result, this reverse spectrum has to be used as efficiently as possible.

For example, suppose a cable operator decides to provide bi-directional data connectivity between any two sites (A and B) on a cable network. Both sites are located in a neighborhood that is catered to by the same street node. A high-speed symmetric data rate (E-1/T-1) connection is required between the two sites. Thus, a cable data modem capable of providing the required data rate will be needed at each of the two sites. In addition, a frequency translation device catering to both sites will be needed at the headend.

Assuming that frequency spectrum requirements of the modems are approximately 2 MHz per E-1/T-1 data stream, both modems will occupy 2 MHz of spectrum on the upstream and downstream respectively. Thus, if modem A transmits data between 20-22 MHz, and modem B receives data between 210-212 MHz, the translation

> **BOTTOM LINE**
>
> **The Conversion Factor**
>
> Is there a hidden cost in data delivery? Adding data services dramatically increases the number of hardware blocks you'll need at street nodes to maintain multiple reverse channels. For example, if a node breaks down into four branches, you'll need four optical transmitter/receiver blocks per node.
>
> - **One solution:** "Block conversion."
> - **How does it work?** Multiple 5-42 MHz upstream channels are frequency stacked, upconverted and transmitted to the headend using a single optical transmitter at the street node. Hardware at the headend downconverts these channels to their original frequencies.
> - **What's the payoff?** In a typical example, a cable operator using block conversion techniques may be able to accommodate 44 modem links in the same network, compared to 11 modem links otherwise.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device at the headend will translate the upstream frequency used by modem A to transmit data, to the downstream frequency used by modem B to receive data, and vice-versa.

Now, if the network is capable of using 5 to 42 MHz on the upstream, a total of 37 MHz is available for upstream data traffic. Given noise and ingress considerations in existing cable networks, actual usable upstream spectrum is approximately 20 to 42 MHz. Thus, actual usable upstream spectrum is approximately 22 MHz. Taking into consideration the example mentioned before, the cable operator will be able to accommodate a maximum of 11 modems in the network (2 MHz per modem causes a total upstream spectrum requirement of 22 MHz).

Block conversion

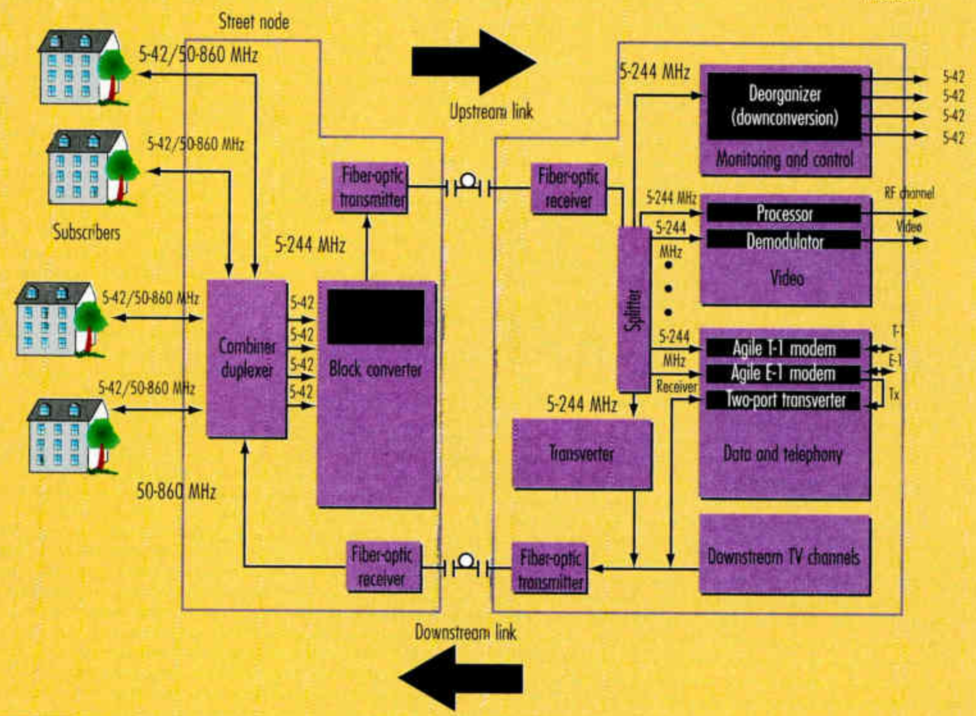
This type of upstream spectrum availability dilemma can be resolved by breaking down the network into multiple branches. This leads to smaller nodes catering to 500-2,000 subscribers per node. Although this does facilitate more upstream bandwidth available per subscriber, each street node still has a limitation of sharing a single 5-42 MHz upstream channel for the entire subscriber base catered to by that street node.

Still, the question remains: How can we provide more upstream bandwidth per subscriber?

One potential solution that has been under consideration over the past few years is "block conversion." Block conversion involves frequency stacking techniques, where multiple 5-42 MHz upstream channels are frequency stacked, upconverted and transmitted to the headend using a single optical transmitter at the street node. Hardware at the headend downconverts these channels to their original frequencies.

This solution incorporates multiple reverse branches per node by segmenting the subscribers per node into smaller neighborhoods and providing an upstream branch per neighborhood. Thus, if the node caters to 2,000 subscribers, without using block conversion, all 2,000 subscribers share a single 5-42 MHz upstream channel. With block conversion, the 2,000 subscribers are broken into neighborhoods of approximately 500 subscribers each, and each neighborhood has its own 5-42 MHz upstream

Block converter at street node upconverts upstream frequency from four network branches



channel. Thus, the same 2,000 subscribers now share four 5-42 MHz upstream channels.

A cable operator can accommodate 44 modem links in the same network when using block conversion techniques, compared to 11 modem links when not using block conversion.

On the flipside

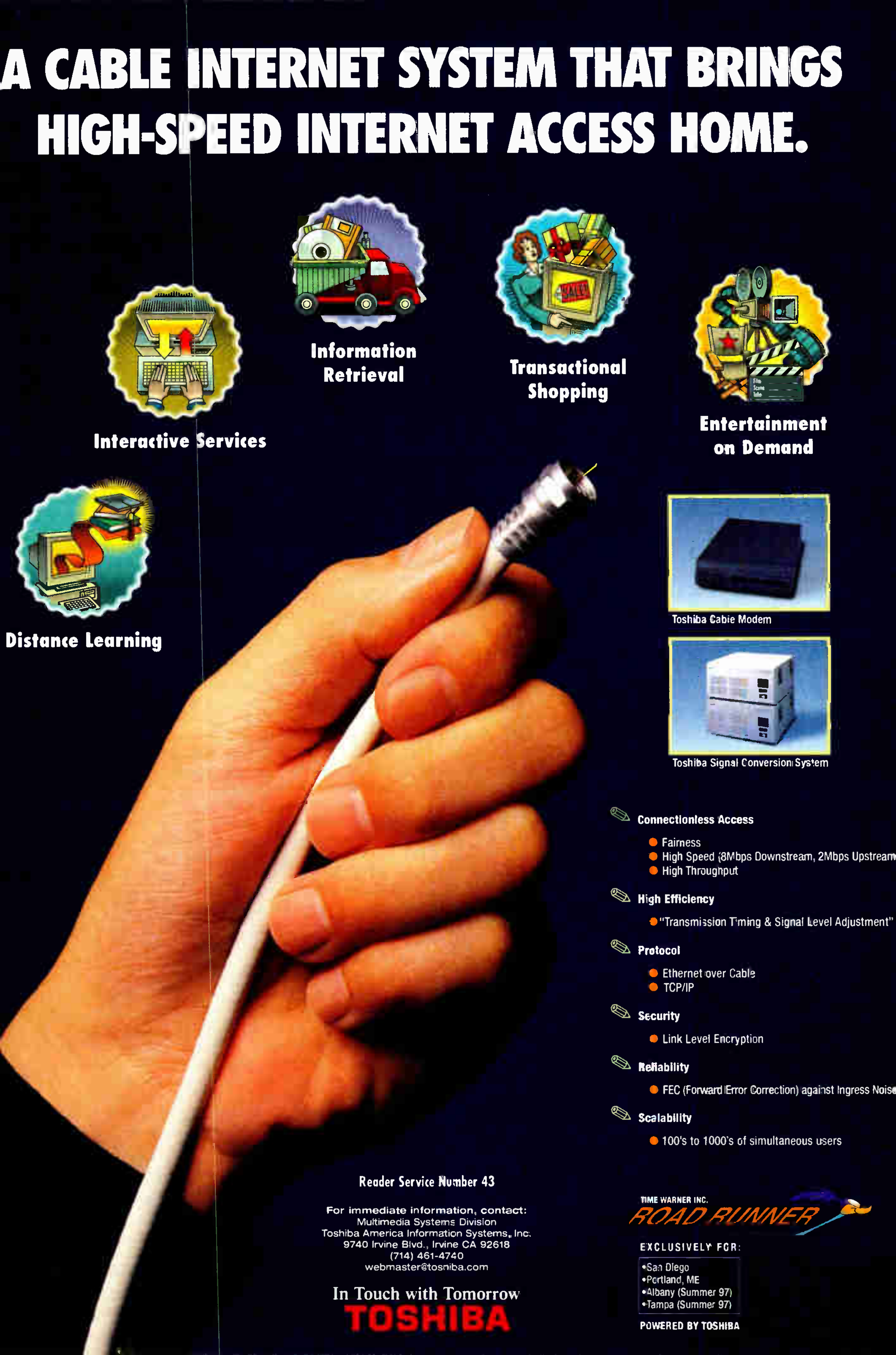
For the sake of argument, let's assume block conversion or other similar techniques never takes off as a solution. What could happen?

First, it's safe to say that the number of hardware blocks needed at street nodes to accomplish multiple 5-42 MHz reverse channels will increase significantly.

Typically, each branch catered to by a street node will require an optical transmitter/receiver. Assuming a node is broken down into four branches, a total of four optical transmitter/receiver blocks will be required per node. This is a costly proposition in terms of dollars and node space.

That's why block converters or frequency stackers must come into play. The block converter at the street node will upconvert the upstream frequency from all four branches in the network. Using frequency stacking techniques, traffic from all four reverse paths can be transmitted back to the headend using a single optical transmitter/receiver. This will greatly reduce cost and space requirements at street nodes. Further integration of block converters (or other similar devices) and optical hardware will reduce these cost and space requirements even more. CT

Ron Victor is director of marketing for Phasecom, in Cupertino, CA. He can be reached at (408) 777-7785.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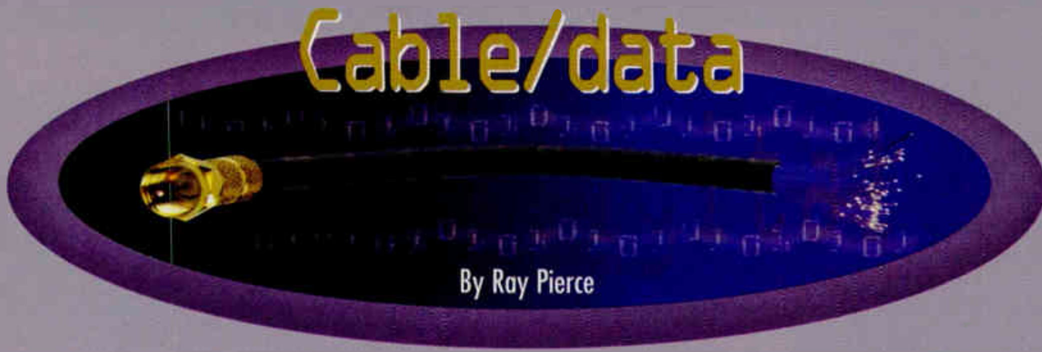


Mirror, Mirror: Simple Steps To Reduce Backreflections

The demand for more transmission capacity has placed new and ever more stringent requirements on fiber-optic systems and components. This need for increased transmission capacity has been satisfied by the development of new laser technologies, increased laser power, pre- and post-distortion techniques, extending the index of modulation of lasers and modulators, chirping, substantially improved fiber-optic connectors and a vast array of additional creative solutions.

In the days when transmission bandwidth was 300 MHz, many of the shortcomings of fiber-optic components could be circumvented. While loss of power and increased distortion have never been acceptable, the demands on today's systems—which have evolved to 750 MHz and beyond—make such flaws intolerable. In the digital arena, error correction and other clever workarounds could make the systems tolerably functional.

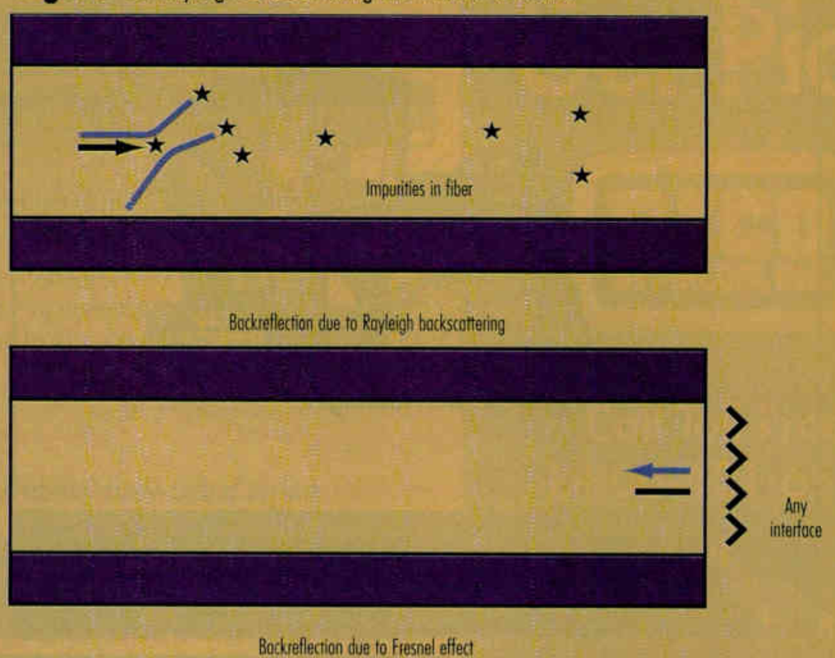
One bothersome flaw in fiber-optic networks is called "backreflection" (also called return loss, reflection coefficient or reflectance). Backreflection is a measure of the attenuation of optical power reflected by the fiber connector interface back to a light source—as opposed to power that is transmitted, absorbed, scattered, or radiated. Fiber backscatter should be considered when the backreflection is measured in an installed system.

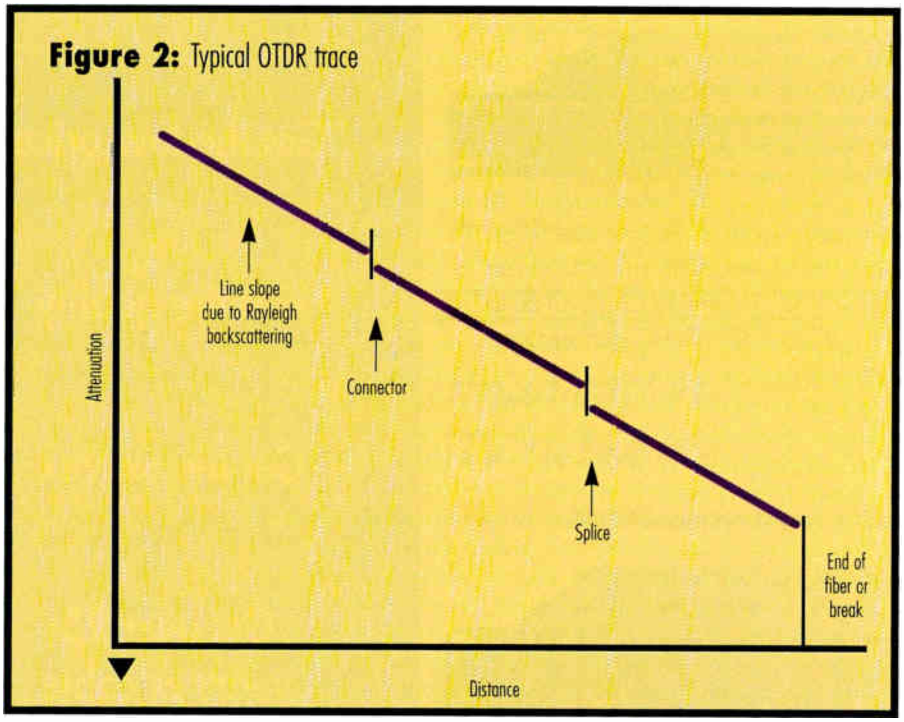
Causes and effects

Reflections in optical systems can come from a number of sources. Primary sources include Rayleigh backscatter in the output port fiber and Fresnel reflections that occur at the junction of two materials with different refractive indices. Typical examples of these junctions are connector and fiber endfaces, splices, improperly terminated couplers, bulk optic interfaces, fiber breaks/fractures and detector surfaces. Rayleigh backscattering is caused by light bouncing off impurities in the fiber and inhomogeneities in the index of refraction of the fiber.

Backreflection affects the laser by inducing power fluctuations, waveform distortion and phase noise. Backreflections also generate a phenomenon called mode hopping, which causes the lasers center wavelength to fluctuate. DFB laser-based transmitters, of either 1,310 nm or 1,550 nm wavelengths, incorporate limited performance optical isolators due to size constraints. The relatively low backreflection extinction ratios can allow light to leak back into the amplifying media of the

Figure 1: Rayleigh backscattering and Fresnel reflection





This measurement can be made with a laser source, a power meter, a short length of dowel and a coupler, or, more conveniently, with a dedicated backreflection meter.

The "background noise," composed of Rayleigh backscattering and Fresnel reflections and attenuation in long fiber sections (see Figure 1 on page 83), is measured with an optical time domain reflectometer (OTDR). It is best seen as the slope of an OTDR trace as in Figure 2.

While power meters, backreflection meters or OTDRs may be used to determine backreflection, each device uses a different technique to make this measurement. The very name of the OTDR, "optical time domain reflectometer," indicates that it measures the time it takes for a pulse to travel out to a reflection source and be reflected back to the detector. Because light in the fiber travels at 201,202 km/hr (calculated for a fiber index of refraction of approximately 1.49), it is very difficult to measure small distances with an OTDR.

When using an OTDR in a system as intended, the operator must take care to separate the returned signals from each successive device in the optical path. If a connector is spaced a meter or so from a splice, it would be virtually impossible to tell which component was contributing the reflected signal.

Conversely, a backreflection meter is ideal for determining the performance of an individual connector pigtail or jumper cable. This type of meter is dependent on a power calculation as described above, and not the measurement of a pulse of light over distance. A good engineer or technician will be aware of the advantages and limitations of the tools he or she uses and will provide accurate data with which the system can be optimized.

The connector connection

Early fiber-optic connectors were terminated with a very slight radius of curvature, designated as "flat." These early designs allowed engineers and technicians to overcome many tolerance inadequacies in the manufacturing process, at a performance cost, however, in backreflections and sensitivity to endface contamination. The APC connector was then introduced, reducing backreflections substantially. However, it initially created many problems as manufacturers of fiber-optic connectors were then required to meet tighter tolerances.

As transmission technologies have advanced, so have fiber-optic connectors. SMA, biconic, ST, FC/PC, FC/UPC, FC/APC (in either Seiko Instruments or

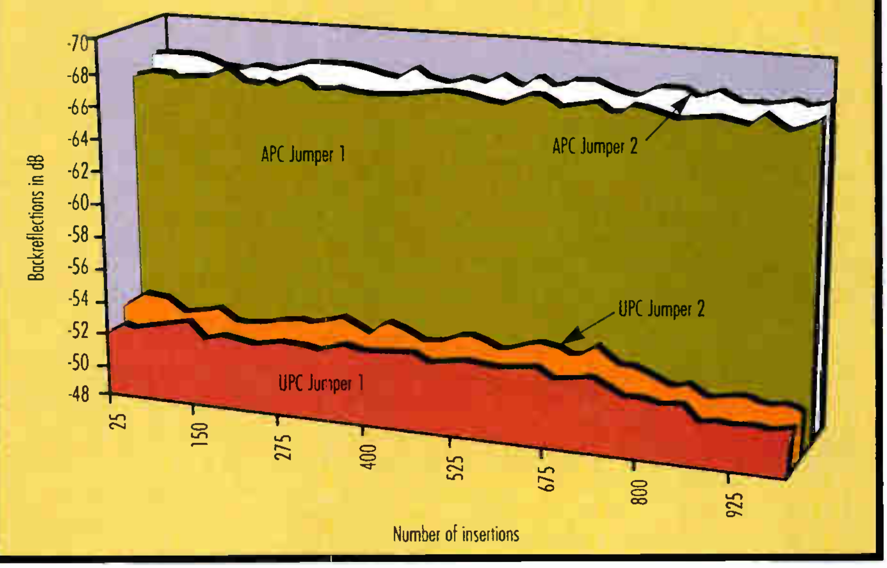


Figure 3: Backreflections of UPC vs. APC connectors with number of insertions

Seikoh Giken /JDS standards), SC/UPC, SC/APC....the list goes on.

Each connector has brought its own advantages and—much to the chagrin of the engineers and technicians tasked with the optimization of these communications systems—a few shortcomings.

The practical manufacturability limit of the backreflection of Ultra PC polishing appears to be -55 dB. Generally, -45 dB or -50 dB will suffice for digital systems. However, for many high-bandwidth analog cable TV systems (above 550 MHz), -60 dB is necessary. Achieving -60 dB and beyond can only be done by using an APC connector.

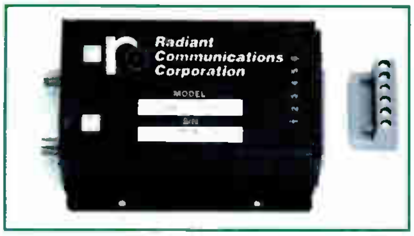
Functionally, the much harder ceramic of the APC connector ferrule prevents plastic deformation and damage of the glass of the fiber under the pressure of mating. For this reason, you should avoid having the fiber protrude from the end of the ceramic ferrule. If the fiber is under-polished, the resulting protrusion will cause physical damage to the glass end face. Over time the protrusion will cause the epoxy to slip and push the mating connector's fiber end face into the mating ferrule. This creates a gap which, when consequently mated to a different connector, will allow for backreflections, losses, power fluctuations and waveform spikes. Severe fiber undercut resulting from over polishing can cause the same symptom.

High backreflections, poor carrier-to-noise ratio (C/N) performance, power losses and inconsistency in connector repeatability can be caused by key width mismatches, fiber eccentricity, angular misalignment, lateral displacement, air gaps, surface finish quality, dirt, numerical aperture mismatches and core diameter mismatches. If these problems were not enough to deal with, more subtle issues such as mismatched fiber types being either depressed clad fiber (AT&T) or matched clad fiber (Corning) and polarization misalignments (where applicable) also add to the complexity of system optimization.

Solutions

One solution that has gained wide acceptance is the SC/APC fiber-optic connector (square-subscriber/angled physical contact) developed by NTT around 1986. This connector employs a rectangular cross-section of highly accurate injection molded thermo-plastic as well as a uniform dimensional standard. This design avoids many of the problems associated with the FC style connector. It has an easy to use push-to-insert and pull-to-remove locking mechanism which prevents rotational misalignment. An audible click lets you know that the connector is fully engaged.

The SC performs with very low insertion loss, low backreflection, and has good packing density (smaller panel space), which



Cost-Saving Fiber Optic CATV Control Systems Now Available On One Fiber

Why are you still using leased phone service for communication to remote headends? Radiant Communications has fiber optic systems compatible with all major OEM equipment...GI Omnistar, GI Set Top (TNA), GI Digital Headend, SA System Manager, SA Pegasus, Superior Cheetah, AM Communications. All systems are now available using only one fiber and will generally pay for themselves in a few months.

Reader Service Number 103

Low-Cost Fiber Optic 5 Channel Broadband System

A low-cost fiber optic 5 channel broadband system for applications that require more than one channel is available from Radiant Communications. The Series VL2500 transmits channels 2 through 6 via singlemode fiber for distances up to 40 Km. A multimode fiber version for college campus requirements is also available. A true plug and play system, no adjustments are required. Radiant supplies other low-cost AM fiber optic broadband systems for 24 and 80 channels as well as a 16 channel FM system.

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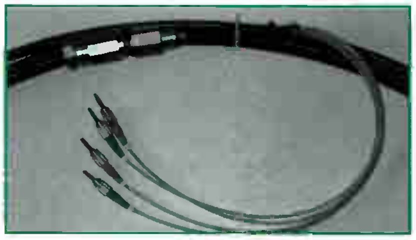

Fiber Optic CATV Drop Cables

Radiant offers a full line of fiber optic cable plant products. The company guarantees drop cables with back reflections of –60dB for ultra polish terminations and –70dB for angle polish terminations. Available from 2 to 12 fibers with customer specified node connector. Also available are fiber optic assemblies, couplers, fiber management systems plus the industry's first and best low backreflection attenuators, both fixed and variable.

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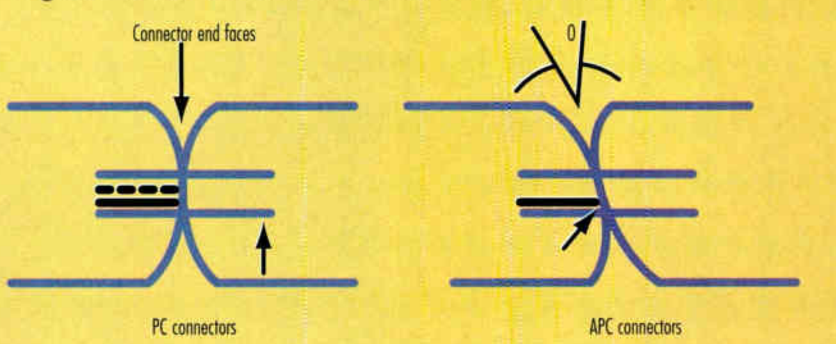
Figure 4: How low backreflection is achieved for PC vs. APC connectors



is useful in multicable installations. A pull-proof feature also is employed that maintains optical contact when the cable is pulled outward or sideways. This ensures negligible power loss fluctuations if the cable is disturbed. The SC was adopted by the "ANSI/TIA/EIA-568 Standard for Commercial Building Wiring."

UPC vs. APC

There are various trade-offs between super PC (or Ultra PC) and APC connectors. APC connectors have lower backreflection; when received from a reliable manufacturer, the connectors will perform equally well with reference to repeatability and insertion losses (see Figure 3 on page 87). System operators who order UPC style connectors by their specification sheet performance alone, may not be aware that low backreflection due to Ultra PC polishing degrades with repeated connector matings. APC backreflection does not degrade.

Low backreflection for Ultra PC connectors depends on the surface finish of the fiber. The finer the grain structure, the lower the backreflection. When connectors are mated and remated, each fiber end face receives some very minor scratching from the other fiber end face. This scratching does not significantly affect insertion loss; however, backreflection is compromised. Minor scratching has no effect on backreflections in APC connectors (see Figure 4).

Fortunately we have come a long way in the last few years, and there are now manufacturers who both understand the needs of the system operator, and are able to produce an APC style connector as competently as a UPC. The currently accepted price premium for an APC style connector is now mostly a marketing issue.

Given the high performance requirements of today's communications networks, you should avoid hand-polished connectors. There are some vendors who are willing to sell connectors manufactured in such a fashion.

The experienced manufacturer of fiber-optic components understands the physics of the devices and how the manufacturing process is affected by the various stages of manufacturing. Quality control and the information it acquires is then fed back into the manufacturing process to assure that each device performs optimally while also being of a reasonable cost to manufacture. High-quality products include measured interferometer photos, insertion loss and backreflection figures for each connector. Serialization of each connector also ensures the traceability of each connector and can be invaluable in the process of manufacturing transmission systems, communication network design and maintenance and the troubleshooting of a variety of problems found in fiber-optic systems.

The system operator puts a great deal on the line by investing in the latest technology to deliver a quality service to their customers. These systems cost thousands of dollars for each transmitter and thousands more to install and optimize. Operators clearly want the best possible system for their efforts. Yet, somewhere along the line, if someone decides to save a few pennies here or there, they are effectively throwing hundreds of thousands of dollars away by using a few ineffective components.

The Devil is truly in the details... CT

Ray Pierce is president of Photonic Components Inc., of San Jose, CA. He can be reached at (408) 436-2380.

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> "There's no reason to go down a winding path, because, in DAVIC 1.2, we already have much of the map needed."

DAVIC operates with an aggressive timetable. In a little more than two years, DAVIC has developed versions 1.0, 1.1 and 1.2 levels of its specifications. Since the specifications cover the physical layer up to the application layer, the success of this effort is commendable. Some companies are already basing their digital video deployment plans on DAVIC specifications. For example, Time Warner's Pegasus will use portions of DAVIC specifications.

DAVIC ties all the technology components together for a total delivery mechanism. An end-to-end delivery standard avoids the fragmentation that results when different aspects of the problem are addressed by different organizations. Some of the work items that DAVIC is addressing are shown in the accompanying sidebar.

The high road

Following a regional or single-industry path to digital video standards would inevitably lead to market fragmentation. But there's no reason to go down a winding path, because, in DAVIC 1.2, we already have much of the map needed for many industries to access a digital video superhighway.

Supporting the efforts of DAVIC does not remove the need for efforts by other standards-setting bodies. There is plenty of room for organizations to build on the framework of DAVIC 1.2 and develop complementary specifications for such areas as content security.

Let's face it: In an era of open competition and mushrooming technology, the cable industry can ill afford to be on its own technological island.

To share in the benefits of an open, growing marketplace for digital video services, the industry and its suppliers need to share in the responsibilities for creating a common map that will get all parties where they want to go. CT

Paul Pishal is director of technology systems planning for Scientific-Atlanta.

BOTTOM LINE

The Road to DAVIC

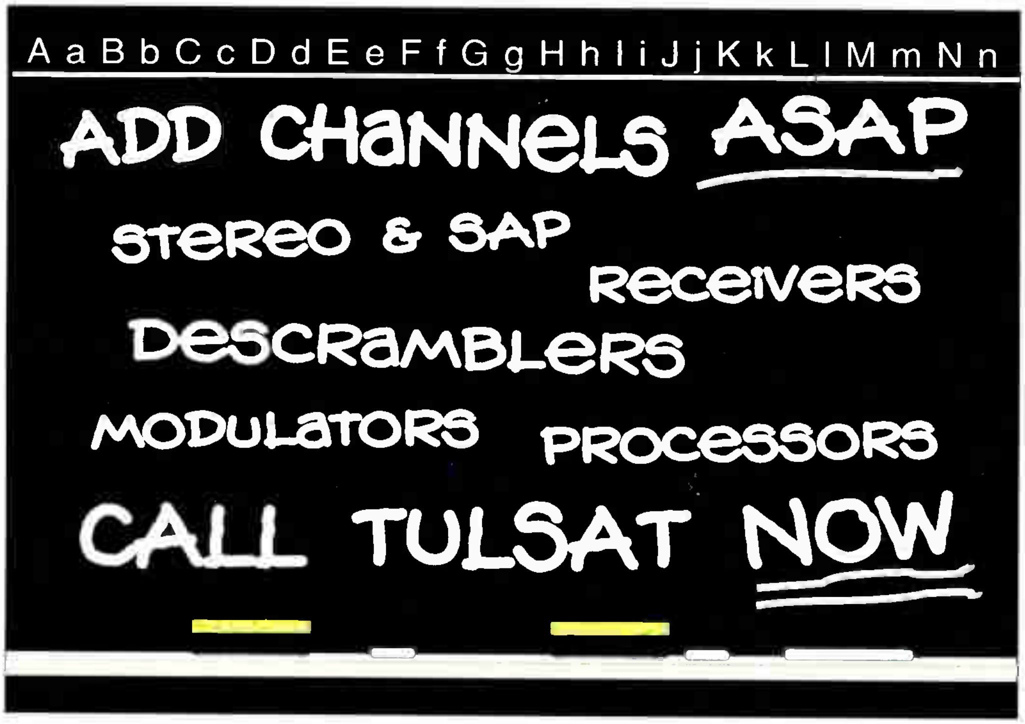
The benefit of developing technical standards in an era of new service opportunities is obvious: Standards make it possible for multiple equipment manufacturers to develop interoperable products that operators and consumers all over the world can purchase with confidence.

What is DAVIC? Perhaps the most far-reaching effort underway for developing digital video standards is that of the Digital Audio-Visual Council. DAVIC, an international consortium that meets quarterly, aims to promote the success of digital audio-visual applications and services based on specifications that maximize interoperability across countries, applications, services, networks and devices.

Key critieria for wide acceptance:

- Broad membership with expanded backgrounds and views.
- Aggressive development schedule for standards.
- Creating standards applicable to market needs and opportunities.

DAVIC's diversity of membership across many industries has produced specifications that not only solve today's interoperability issues but also build a solid foundation for addressing future issues. Cable must stay at the DAVIC table.



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Pointers on Picking RF Upconverters for Digital

By Marc Ryba and Joseph B. Waltrich

Choosing a digital RF upconverter may seem to be a trivial decision compared to the selection of other digital headend components, but it is an important one. An improper digital RF upconverter can degrade signal performance to the point at which it is impossible to obtain error-free reception at the subscriber's home. This article will point out some factors that affect upconverter performance for digital RF transmission.

l signals are downlinked from a te or generated by a local encoder headend. With satellite reception, egrated receiver/transcoder (IRT) rts the signal from the quadrature shift keying (QPSK) satellite lation format to 64-QAM (quadra- mplitude modulation) for cable nission. If a local encoder is used, coder output is modulated as a 64-QAM signal. In either case, the 64-QAM output is an intermediate frequency (IF) signal centered at 44 MHz. The IF output of the IRT or modulator must be upconverted to RF before being transmitted over the cable system.

Performance

Figure 1 provides a functional block diagram of a typical frequency-agile, dual-conversion RF upconverter. Automatic gain control (AGC) is used to supply a constant analog input level to the upconversion section. (AGC should be disabled for digital inputs.)

For a dual-conversion upconverter, two mixers are used. The first upconverts the signal to a fixed high IF. This high IF eliminates any resulting spurious carriers by placing them

igure 1: Upconverter block diagram

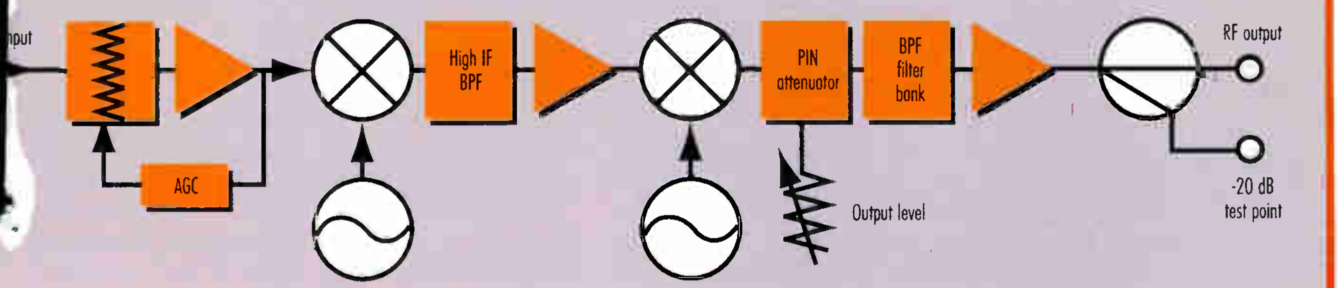


Figure 2: 64-QAM constellation with phase noise

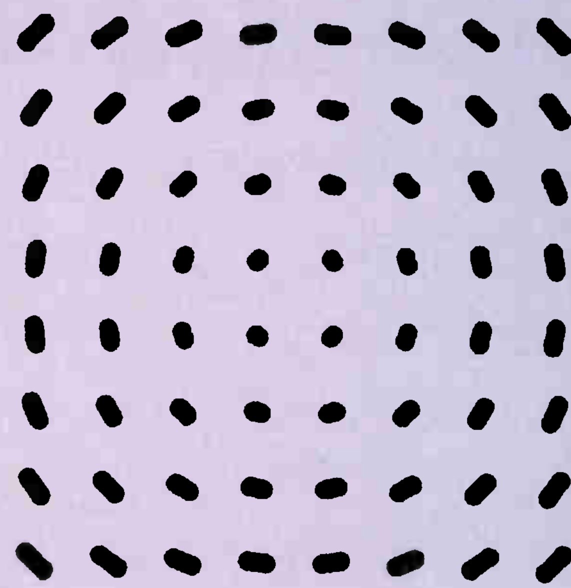


Table 1: Upconverter performance comparison

Parameter	Converter I	Converter II
Maximum gain	19 dB	30 dB
Maximum output	50 dBmV	60 dBmV
Phase noise	-125 dBc/Hz	-95 dBc/Hz
Es/No (inband)	68.2 dB	68 dB
Passband flatness	5.3 dB	±0.5 dB p-p

Table 2: BER vs. Es/No

Es/No (dB)	Converter I BER	Converter II BE
20.00	2.50E-02	2.50E-02
20.40	6.90E-03	5.70E-03
20.80	6.90E-04	6.60E-04
21.00	1.50E-04	1.40E-04
21.20	4.20E-05	3.20E-05
21.40	2.40E-05	1.60E-06
21.60	9.00E-06	3.40E-0
21.80	2.60E-06	2.80E-0
22.00	3.00E-07	

above the converter's upper frequency range. The high IF mixer output is then filtered, amplified and applied to the sec-ond mixer for conversion to the final output frequency. The second LO frequency is controlled by a microprocessor to set the specific channel frequency for tuning.

The RF output of the second mixer is applied to a variable loss PIN attenuator and can be adjusted for desired output level. The RF signal is then applied to a bandpass filter bank selected by the microprocessor according to the desired output frequency. Broadband noise can be minimized with an appropriate bandpass filter that allows for unlimited signal combinations without external filtering. The signal is then applied to a wideband low-distortion amplifier for signal distribution.

The RF upconverter selection can affect the digital signal in the following ways:

- Phase noise—Although an upconverter's LO phase noise may be suitable for converting analog signals, its effect on digital signals can be quite different. The digital signal is more sensitive to phase noise than its analog counterpart. LO phase jitter can cause bit errors if the jitter causes enough oscillation for the constellation points to cross decision boundaries. Figure 2 shows a typical example of a 64-QAM constellation with phase noise. The effect is more severe if higher orders of modulation, such as 256 QAM, are used.

An upconverter's phase noise can be measured with an unmodulated analog carrier.[1] If the phase noise performance is on the order of -100 dBc/Hz, measured at 10 kHz offset, it should have little effect on the digital signal.

- Flatness—The filters in some upconverters may produce spectral tilt within the transmission channel. The digital demodulator's adaptive equalizer can correct this tilt. However, this correction results in unnecessary use of the demodulator's equalization budget, which leaves less room for handling the echoes present in the cable system and subscriber's home. Inband tilt should be checked by a spectrum analyzer. The upconverter should not add more than ±1 dB of spectral tilt to the digital signal.
- Frequency accuracy and stability—Frequency drift does not cause problems with most upconverters. However, frequency accuracy and stability should be checked before using the upconverter. They can be tested by applying an unmodulated carrier at the IF input of the upconverter and measuring the RF output frequency. If the analyzer has a maximum-hold function, it can be used to check frequency stability.

Performance comparison

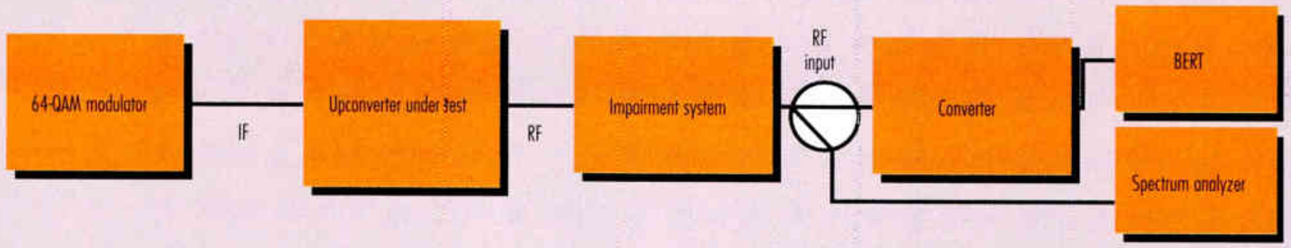
The following test results illustrate performance differences among various upconverters. Figure 3 on page 102 provides a block diagram of the test setup. This testing was conducted to determine the effects of different upconverters on a digital 64-QAM signal. Basic parametric performance and system measurements were made on the test units.

The test setup was designed to represent a typical headend configuration. A Broadcom 64-QAM modulator (which contains a built-in pseudorandom binary sequence generator for data testing and ITU J.83(B) forward error correction supplied the 44 MHz IF signal to the IF input of the test upconverters at a 30 dBmV signal level.

Output power

The test units upconverted the IF signal to EIA Ch. 52. Channel

Figure 3: Test setup block diagram



output power was different for both units. These units were off-the-shelf upconverters. Converter I was a fixed-frequency, single-conversion modulator. Converter II was a frequency-agile, dual-conversion upconverter. Both were operated as black boxes with the output level adjusted for maximum output power. Both test unit outputs were attenuated to deliver an RF signal of 0 dBmV at the downconverter's input.

> "Frequency accuracy and stability should be checked before using the upconverter."

Performance degradation

To observe any performance degradation from the test units, typically encountered impairments were introduced into the transmission path. The downconverter used was a production DCT-1000 digital set-top modified for BER performance measurements. It supplied both clock and data to the BER tester for performance measurement purposes. All impairments were

Figure 4: IF input to upconverter

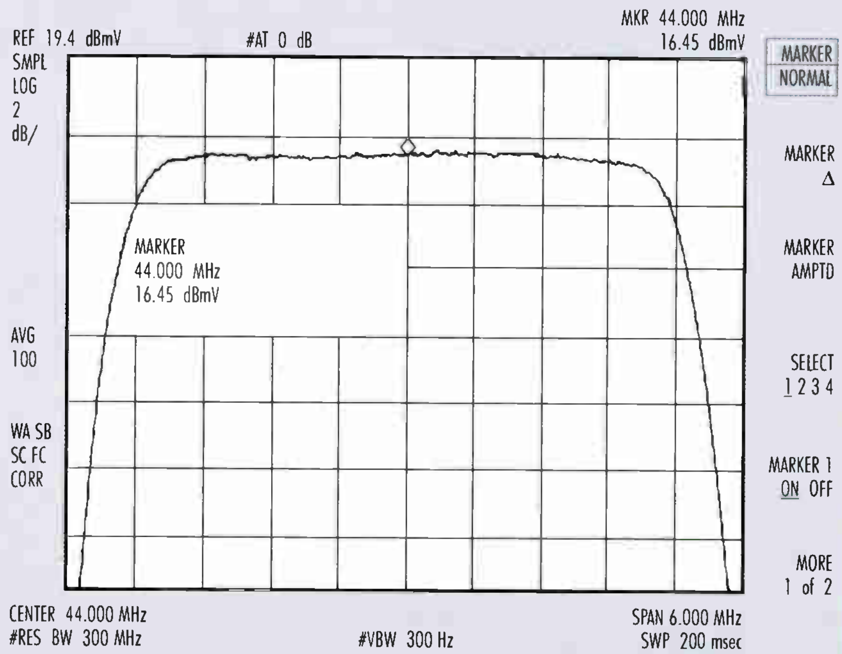
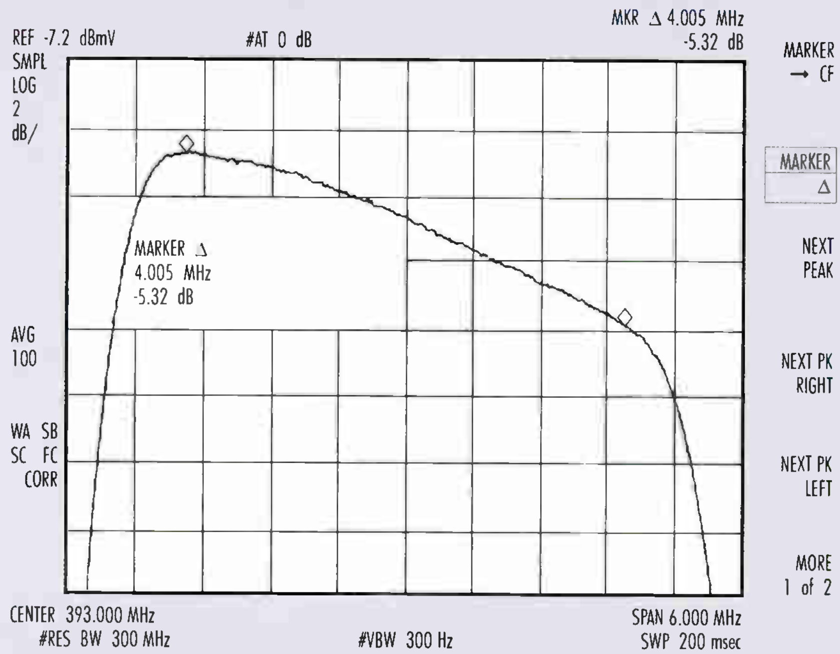
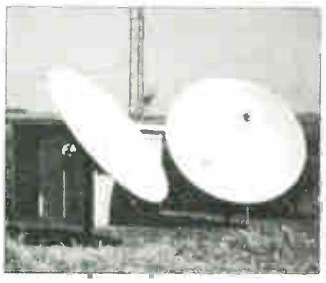


Figure 5: Converter in-band tilt



added at RF. All units but the test upconverters remained the same throughout testing.

Each upconverter's gain and output levels were tested to determine if manufacturer's specifications were met. When the 64-QAM signal was introduced, Converter 1 lacked the



proper gain, and its obtainable maximum output level was 10 dB below the analog RF output specification. Converter II met the manufacturer's specifications in both gain and output level. (See Table 1 on page 100.)

"Passband tilt has an adverse effect on system performance for digital transmission."

Phase noise

Each unit's phase noise was satisfactory. The single-conversion test unit, Converter I, had better phase noise performance than Converter II, the dual-conversion unit. This outcome was expected, since Converter I uses a fixed frequency local oscillator (LO) while Converter II's LOs are agile. Converter II's phase noise performance was well below the point at which any significant degradation would be added to the signal. The in-band Es/No for each unit was comparable and added no significant signal degradation.

Flatness, tilt

Passband flatness was considerably different for the units. The IF input spectrum to the upconverter is shown in Figure 4, and Converter I's RF output is shown in Figure 5 which are both on page 104. Note the 5.3 dB tilt imposed on the 64-QAM signal in the channel bandwidth. Converter II was within the manufacturer's specification and had a negligible effect on system performance. Passband tilt has an adverse effect on system performance for digital transmission. ➤

The overall effect of Converter I's tilt caused the adaptive equalizer in the digital demodulator to try to compensate for the impairment. This attempt placed undue stress on the system and degraded overall system performance. The BER recordings in Table 2 on page 100 reveal this performance degradation. The first test consisted of BER measurement vs. Es/No performance. The BER measurements were averaged over 100 errored seconds at each value of Es/No. Figure 6 on page 110 shows the associated plot of BER vs. Es/No. A difference of approximately 0.4 dB existed between Converters I and II. This difference corresponds to approximately two decades of carrier-to-noise (C/N) degradation in system performance.

Long-term BER tests were performed to find inband tilt's effects on system performance. Additive white Gaussian noise (AWGN) was added at RF to simulate cable distribution noise degradation. The Es/No was fixed at 28.8 dB to simulate a less-than-desirable system. For Converter I, the BER recorded after 2.5 days was 4.8E-6. This rate is excessively high for this Es/No setting. A corresponding test, performed on Converter II for approximately the same duration, ran error-free.

BOTTOM LINE

Choosing Upconverters

Making the RF upconverter selection can be difficult. When deciding, remember the differences between upconverters used in analog transmission and those used in digital transmission—*upconverters that work for analog may not work as well for digital.*

Passing the test. Upconverters should meet performance standards for phase noise, passband flatness and frequency accuracy and stability. These factors tend to affect the digital signal, so a good idea is put upconverters through rigorous tests to avoid potential digital signal degradation down the line.

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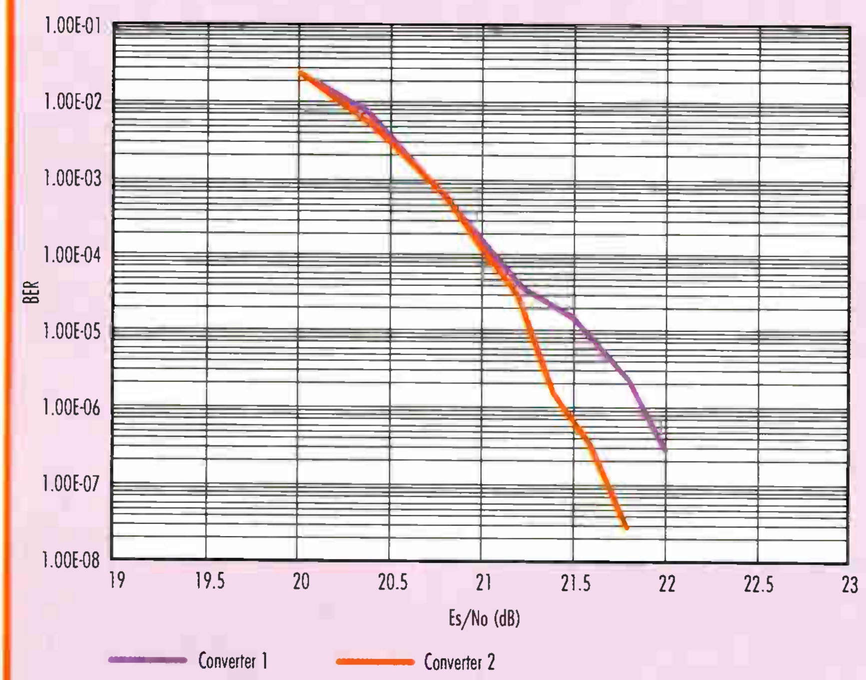
Figure 6: BER performance comparison



Long-term testing also was performed without introducing AWGN to the system. The test for Converter I ran for 48 hours, 32 minutes with a BER of 6.9E-10. The test for Converter II ran for 15 hours, 36 minutes with zero errors.

Conclusion

When selecting the components of a digital headend, it is important to choose the proper digital RF upconverter. Upconverters that were used successfully for analog transmission do not guarantee the same success for digital transmission. Testing these upconverters first can prevent digital signal degradation.

Note

1 J. Waltrich, "Implementing Digital Compression at the System Level," *Communications Technology*, March 1995.

Marc Ryba is senior project manager and Joseph B. Waltrich is manager, digital special projects for the NextLevel Broadband Networks Group of General Instrument Corp.

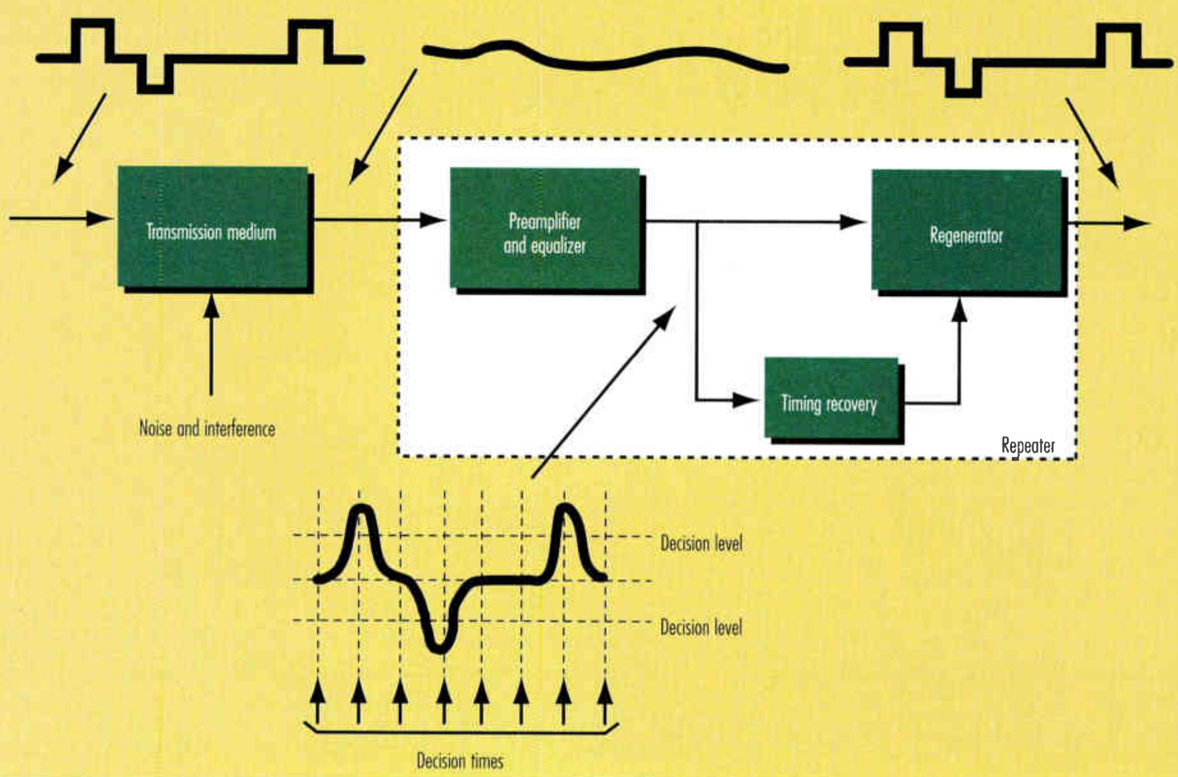
GOING DIGITAL? THINK BIT ERROR RATE

By Kenneth H. Metz

Market forces are driving the transition of existing video entertainment services based on traditional analog transport techniques to a broad range of new potential services utilizing digital video technology. Many opportunities also exist for the introduction of competitive telephony and high-speed data services, both of which are implemented using digital processing and transport technologies. An added bonus for the viewers of digital video services is the high level of visual quality that can be achieved, including crystal clear pictures and the absence of nonlinear distortions.

For these new services, the traditional analog impairments associated with broadband hybrid fiber/coax (HFC) networks no longer tell the whole story of signal performance. They must be supplemented with the common denominator of signal quality for all digital services, the bit error rate (BER). The BER is simply the average fraction of received bits in a digital signal that arrive at their destination in a state that is opposite to their transmitted state. That is, one or more "0" bits that have been changed to a "1," or vice versa. *[Editor's note: BER also is defined as the ratio of the number of errored bits received to the total number of bits received.]* Bit errors can occur as the result

Figure 1: Digital signal regeneration



of several different causes, most notably noise that confuses the digital receiver into mistaking the true identity of one, or perhaps several bits.

Different services are affected differently by bit errors. In the case of data services, the presence of errors can lead to disaster such as credit card billing inaccuracies or erroneous bank account balances. Traditionally, data communications systems have supported the detection of bit errors and have provided mechanisms for retransmitting errored information. In contrast, "real-time" services, such as broadcast video, do not allow for the possibility of retransmission, thereby requiring careful broadband network engineering and periodic system maintenance procedures to reduce the occurrence of errors. Moreover, techniques exist for the partial or complete *correction* of digitally transmitted signals, allowing for the restoration of the original bits in a way that is unthinkable in pure analog systems.

Figure 2: Quantization (signal waveforms)

Uncorrected bit errors can result in severe, albeit temporary perceptual artifacts, such as "tiling" in video frames and audible "pops" or "clicks" in telephony signals. The use of compression can greatly magnify the impact of a single bit

BOTTOM LINE

Bits and Pieces

Your best efforts at offering digital two-way services could be thwarted if you don't keep your transmitted bit error rate (BER) under control.

- What is BER? The average fraction of bits in a digital signal that are received in a state opposite to their transmitted state. Bit error often occurs in analog-to-digital conversion. These bit errors also can be caused by noise confusing the reciever into mistaking the true identity of one or more bits.
- The down side: Uncorrected bit erros can cause some perceptual artifacts, such as "tiling" in video frames and audible "pops" or "clicks" in telephony signals. Compression can magnify the impact of a single bit error.
- What to do: Consider error correction techniques. Additional bits can be transmitted along with the digital service and separated at the receiver. Bit error "masking" displays previous video frames or mutes audible errors.

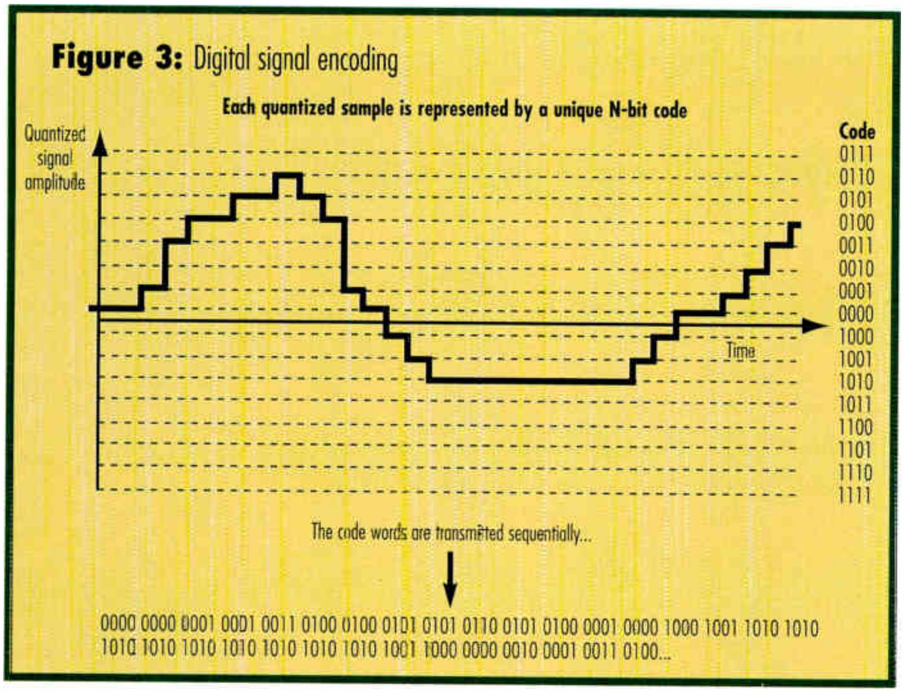


Figure 3: Digital signal encoding

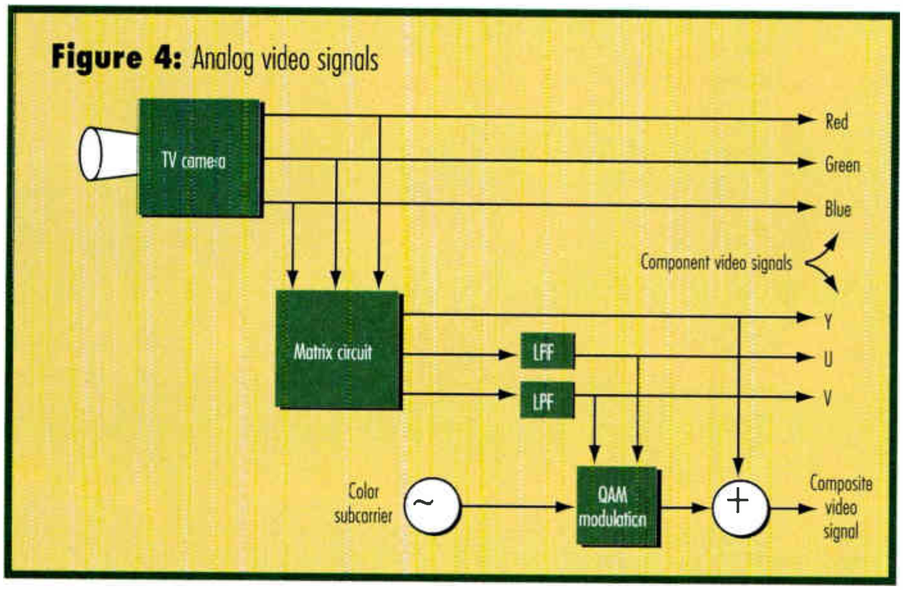


Figure 4: Analog video signals

error. However, techniques have been developed to "mask" such errors, for example by displaying the previous video frame or by muting audible errors.

In the final analysis, the most direct, objective measure of the performance of a digital service is the BER associated with that service. The BER directly affects the perceived quality of the service and acts as an indirect measure of network impairments that constitute the root cause.

Why digital?

The primary advantage of digital technology is its ability to overcome the fundamental difficulty of analog transport systems, the gradual accumulation of noise and transmission impairments that slowly but surely degrade the perceived quality of the received analog signal. In the case of traditional cable TV, this includes the steady decrease in carrier-to-noise ratio (C/N) and the increase in nonlinear distortions such as composite triple beat (CTB) and composite second order (CSO) along a cascade of active devices, with their well known impact upon visual quality. Once these cumulative impairments have been added to the desired video signal, they *cannot* be removed. In contrast, in digital transmission the possibility exists to (almost) completely restore the state of each transmitted bit, thereby eliminating the effects of transmission impairments.

Figure 1 on page 112 illustrates the principle for the case of baseband digital transmission. This technique, commonly used in digital telephony transport (for example, synchronous optical network—SONET and various pulse code modulation—PCM—digital video transport systems), consists simply of turning the transmitting device intermittently "on" or "off," corresponding the presence of a "0" bit or a "1" bit (or vice versa). Therefore, the receiver needs only to distinguish whether the received signal is in either of these two states. This can be more difficult than it seems for the following reasons.

First, the received signal level is reduced by the attenuation of the transport medium, so that additive noise can momentarily make the signal state appear to change. In addition, dispersion associated with the medium can cause spreading of the waveform, making it difficult for the receiver to distinguish one bit from its neighbors. In fact, dispersion is frequently the dominant factor in limiting the maximum transmission rate (in bits per second) of a baseband digital transport system. Nevertheless, in a well-engineered system, the true identity of each bit can be determined with high probability. Even after an error has occurred, it may be possible to detect and even correct them using forward error correction (FEC) techniques. The BER of the resulting bit stream is simply the probability that any particular bit has been received in error.

Unfortunately, there is a cost that is inseparably tied to the benefits of digital services implementations: digitized signals require more bandwidth than their analog counterparts.

Digital services

Other than pure digital data, which has no true analog counterpart, the conversion of existing analog service to digital can greatly increase the required transmission bandwidth. The classic example is the evolution of long distance telephony transport from analog to digital. Prior to the introduction of digital technology, telephone signals were transported over long distances using frequency division

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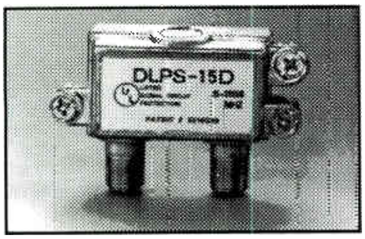

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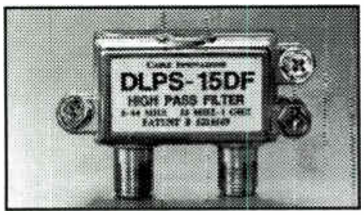

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multiplexing of single sideband modulated signals. These signals were subject to the same limitations as analog cable TV, greatly reducing the perceived quality of long distance telephone calls.

Over the past 30 years, all long distance telephony has been converted to digital transport and some service offerings (such as, integrated services digital network—ISDN) provide digital service all the way to the office or the home telephone set. But in the process, the required transmission bandwidth has grown from approximately 3 kHz to over 64 kHz per voice channel. This is the result of some fundamental principles discovered earlier this century.

The process of converting an analog signal to a digital signal consists of three steps: sampling, quantization, and encoding. In effect, these amount to making measurements of an analog waveform at regular intervals with limited, but well defined precision and then assigning combinations of 1s and 0s to uniquely represent the value of each measurement.

The upper portion of Figure 2 on page 115 depicts the operation of sampling, whereby a continuous waveform is represented by a sequence of sampled values with samples taken at equal intervals.

Although it seems somewhat counterintuitive, it was demonstrated by Harry Nyquist during the 1920s that *all* information contained in a waveform can be completely captured through sampled values if they are gathered at a rate at least as great as twice the bandwidth of the signal. (Here, bandwidth is interpreted to mean the frequencies at which the signal's spectrum essentially drops to zero.) In the case of telephone voice channels, the theoretical sampling rate is twice 3 kHz and the practical rate that was chosen is 8 kHz.

The next step in the process is to define the precision of each measurement taken at the sample times, a process known as quantization. There is no fundamental principle that determines the necessary precision. Rather, it is a matter of establishing how *little* precision is needed to render the original signal waveform and the quantized waveform perceptually identical. In practice, different applications require more or less precision. For example, 8 bits of precision was chosen for digital telephony, but 16 bits were needed to provide high fidelity audio for compact discs. Similarly, 8 bits of precision were deemed adequate for digital video applications.

Eight bits of precision corresponds to 256 different values (2 raised to the power 8) that can be used to approximate a signal waveform. The maximum error between the actual and quantized waveforms is one half of 1/256, or approximately one half of 1%. The lower portion of Figure 2 shows a waveform that has been both sampled and quantized, in this case with 4 bits of precision. In fact, this example should be quite familiar to most readers, as the common ruler that we use to measure small distances provides precision to 1/16 of an inch; that is, it provides a precision of 4 bits per inch. ➤

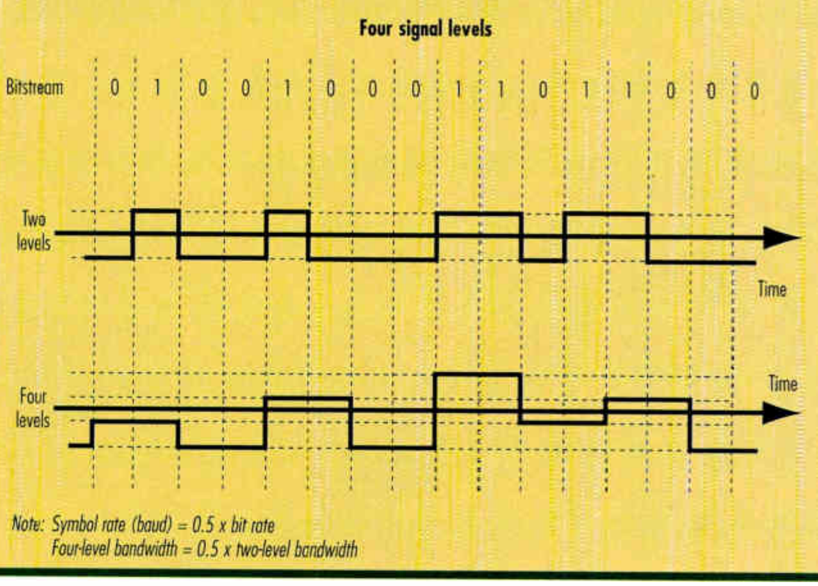


Figure 5: Digital transmission

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. In the case of 8-bit quantization, there are 256 different combinations, ranging from 00000000 to 11111111. Figure 3 on page 116 illustrates this process.

With 8,000 samples per second and 8 bits per sample of a telephony voice signal, the aggregate bit rate is 64,000 bits per second. In the case of digital video, there is an international standard, known as CCIR-601, that defines the sampling rate and number of quantization bits. Video differs from voice in that it is multi-dimensional with three primary signals corresponding to the three additive primary colors that can be perceived by human beings. Color TV cameras produce red, green and blue primary signals that are subsequently combined to form a standard composite video signal. In digital video, these primaries are transformed into one luminance and two chrominance signals (Figure 4 on page 116), which are then sampled and quantized. Although all three signals are quantized with 8 bits (256 levels) of precision, the luminance is sampled at 13.5 MHz and each chrominance signal is sampled at 6.75 MHz. This amounts to 108 Mbps for the luminance and 54 Mbps for each chrominance component for a total of 216 Mbps for the CCIR-601 signal.

The basic issue becomes the question of how much bandwidth is required to transport these digital signals. There is no single answer. In the case of two-level baseband transmission, described before and shown in Figure 1, the required bandwidth ranges from a value equal to the bit rate up to a value equal to twice the bit rate. Thus, a 64 kbps digital bit stream would require between 64 kHz and 128 kHz of valuable spectrum. Similarly, the CCIR-601 signal would require between 216 MHz and 432 MHz of bandwidth. This corresponds to between 36 and 72 analog video channels!

Multilevel signaling

The amount of spectrum required in baseband digital transmission can be reduced through the use of multilevel signaling. In the case of four-level signaling, this entails taking pairs of bits from a serial bit stream and using them to create streams of "symbols" at one half the original bit rate. Because there are four unique combinations of two bits (00, 01, 10 and 11), each pair can be used to specify one of four different signal levels. Thus, rather than transporting a digital bit stream as a sequence of waveforms with two distinct levels at the original bit rate, it is possible to accomplish the same objective using another sequence of waveforms (the "symbols") possessing four distinct levels at one half the rate. Figure 5 compares these two approaches. The use of waveforms that change state half as frequently reduces the bandwidth requirement by a factor of two.

However, there is a price associated with the bandwidth reduction achieved using multi-level signaling. As indicated in Figure 5, the maximum signal levels are approximately the same for both two level and four level signaling, as required to maintain the same transmitted power in both cases. The net result is that the four level waveform is more sensitive to noise and interference, because less noise is required to make the received signal appear to be at a different level corresponding to a different two bit combination.

One characteristic of baseband digital transport is that it fully occupies the entire spectrum from DC up to the maximum frequency required (between one and two times the bit rate). This is basically contrary to traditional cable TV systems that use frequency division multiplexing to transport a multiplicity of different analog video programs. Indeed, this is a great advantage because it allows any 6 MHz portion of the spectrum to be used to transport any type of service, be it analog or digital, thereby permitting the peaceful coexistence of both traditional and new technologies and facilitating a graceful and cost-effective evolution into the future.

Fortunately, two other technologies facilitate the introduction of digital services in cable TV systems. Digital compression can greatly reduce the number of bits per second that are required to represent a digital video signal with more than adequate perceived picture quality. Typically, 3 Mbps to 6 Mbps have been found to be sufficient for most programming material and new techniques may reduce these numbers even more. Still, two level baseband digital transmission would require between 3 MHz and 12 MHz to transport these signals.

The excessive bandwidth problem of digital video services is solved through the use of "higher order" digital modulation techniques. This approach can restrict bandwidth utilization to 6 MHz increments while simultaneously providing high digital capacity. For the sake of brevity, this discussion will be limited to two digital modulation schemes, quadrature phase shift keying (QPSK) and quadrature amplitude modulation (QAM).

In both cases, a carrier wave is modulated by signals that are derived from the digital bit stream. With QPSK, a total of four different phases of the carrier wave are chosen to represent all combinations of 2 bits. Unlike the constant carrier amplitude characteristic of QPSK, QAM involves different combinations of both amplitude and phase. Current technology supports 64-QAM, in which 64 different combinations are used to represent groups of 6 bits. QPSK, which also can be viewed as special case of QAM (i.e., 4-QAM, is more robust than 16- or 64-QAM and is better suited to noisy environments, such as the return path of HFC systems).

Figure 6 illustrates the basic QAM process for the case of 16-QAM. A serial bit stream is first converted to four streams that flow in parallel at one-fourth the original rate. This reduced rate is known as the "symbol rate." The four streams are next processed as two pairs of two bits each. Because there are four unique combinations of two bits (00, 01, 10 and 11), each pair can be used to specify one of four different signal levels that double sideband amplitude modulate one of two different high-frequency carriers at the symbol rate. The two carrier frequencies are identical but differ in phase by 90°, allowing different combinations of amplitude and phase of the composite QAM signal that is obtained when the two modulated carriers are added together in the final stage of processing.

As in the case of multi-level baseband transmission, the good news about these modulation techniques is that they provide more bits per second per unit of bandwidth than does two-level baseband digital transmission. The theoretical optimal bandwidth efficiency of QPSK, 16-QAM and 64-QAM are 2 bits per second per Hertz, 4 bits per second per Hertz and 6 bits per second per Hertz, respectively. These also are the number of bits used to represent each symbol. The required transmission bandwidth is reduced by the same factor that the symbol rate is reduced from the original serial bit rate. These theoretical efficiencies apply only in the case of perfectly sharp bandpass filters with bandwidth equal to the symbol rate. In reality, practical filter designs can increase the actual bandwidth from 15% less to 50%, with lower efficiency being achieved at lower cost. Thus, a typical digital transport capacity for 64-QAM is 30 Mbps. With approximately 10% allocated to error correction bits, 27 Mbps remains for four to nine digital video signals within a 6 MHz bandwidth.

The bad news about high-order modulation techniques is that they are more sensitive to noise, interference and transmission impairments than is two-level baseband digital transport, similar to the case of multi-level baseband transmission. In fact, greater bandwidth efficiency is associated with reduced robustness. The situation is illustrated in Figure 7 on page 122, which shows the symbol error rate for different values of a quantity known as E_b/N_0 for 4-QAM (same as QPSK), 14-QAM, 32-QAM and 64-QAM. The BER in each instance is calculated by dividing the symbol error rate by the number of bits per symbol and the signal-to-noise ratio (S/N) is obtained from E_b/N_0 after converting from dB by dividing by the number of bits per symbol. It can be seen that the symbol error rate (and BER) drops rapidly as E_b/N_0 (and S/N) increases and that bit error performance becomes increasingly sensitive to S/N with the number of bits per symbol.

Bit error sources

Bit errors are produced by a variety of causes, as illustrated schematically in Figure 8 on page 124. These are first manifested in the raw bitstream that has been recovered at the receiver. Bit errors at this point are created by noise as strongly influenced by the digital modulation technique, which determines the noise sensitivity. Noise can occur in several forms, including random thermal noise that appears as "snow" in analog video signals, as well as bursty noise, caused by electrical discharges from electrical power lines and a wide range of electrical equipment. There also can be interference from ambient continuous wave signals (such as those associated with citizens band radio), that enter the cable system, particularly in the return path.

The impact of noise on BER also is strongly influenced by a phenomenon known as intersymbol interference (ISI), whereby the waveforms of adjacent symbols inadvertently overlap. This can occur because the actual symbol waveforms are not actually square waves, as shown in the aforementioned figures for the sake of simplicity. Rather, typical waveforms are oscillatory in nature and the result of creating an end-to-end transmission characteristic that is described as a Nyquist filter. Such filters possess certain symmetries in both amplitude and phase that cause the symbol waveform to cross through zero signal level at the instant of time when adjacent symbol waveforms reach their peak values, eliminating any interference at that instant. Interference does occur at other times in an amount that is largely

Figure 6: Digital quadrature amplitude modulation

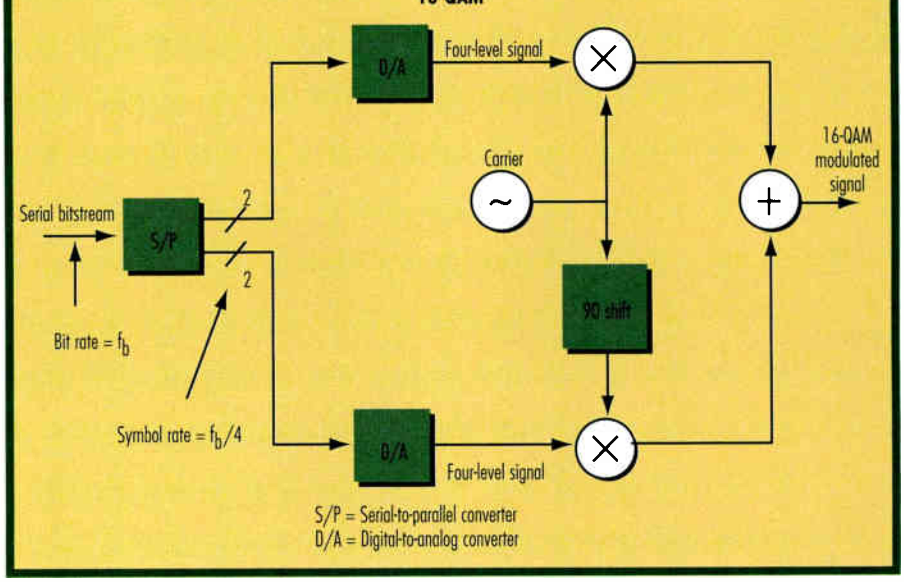
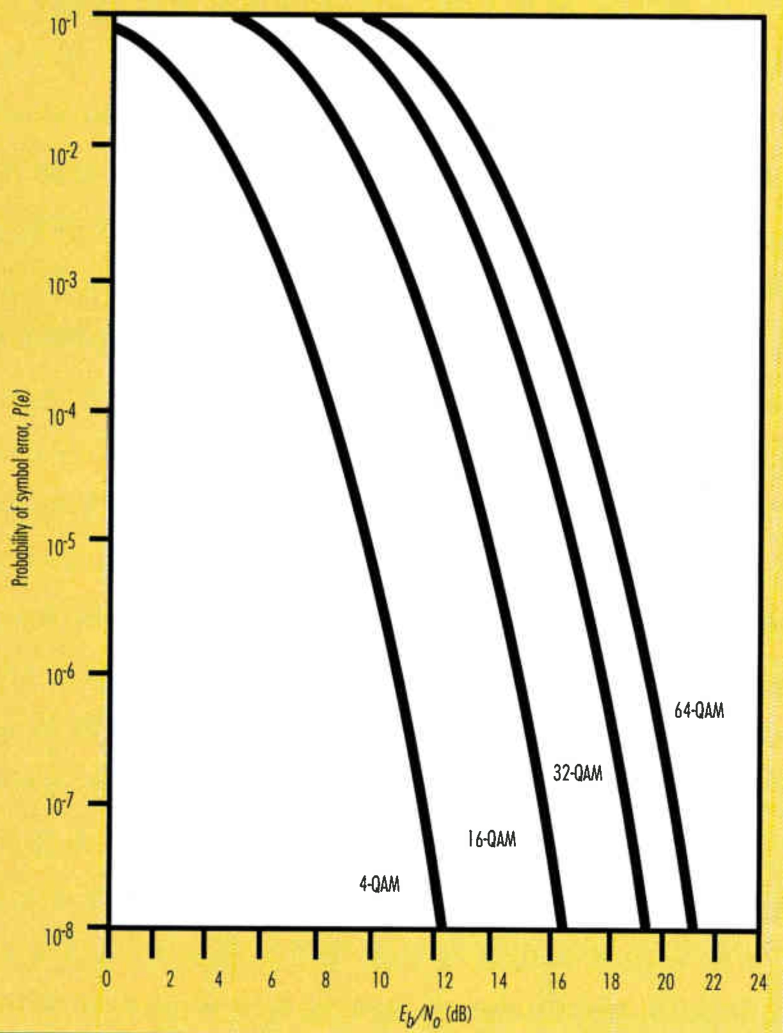


Figure 7: Error performance for QAM



determined by the overall sharpness of the Nyquist filter characteristic, known as the degree of filter roll-off. Sharp filter roll-offs provide the greatest bandwidth efficiency but create greater potential interference, whereas gradual filter roll-offs are less likely to produce interference but require as much as twice the bandwidth of sharp roll-off filters.

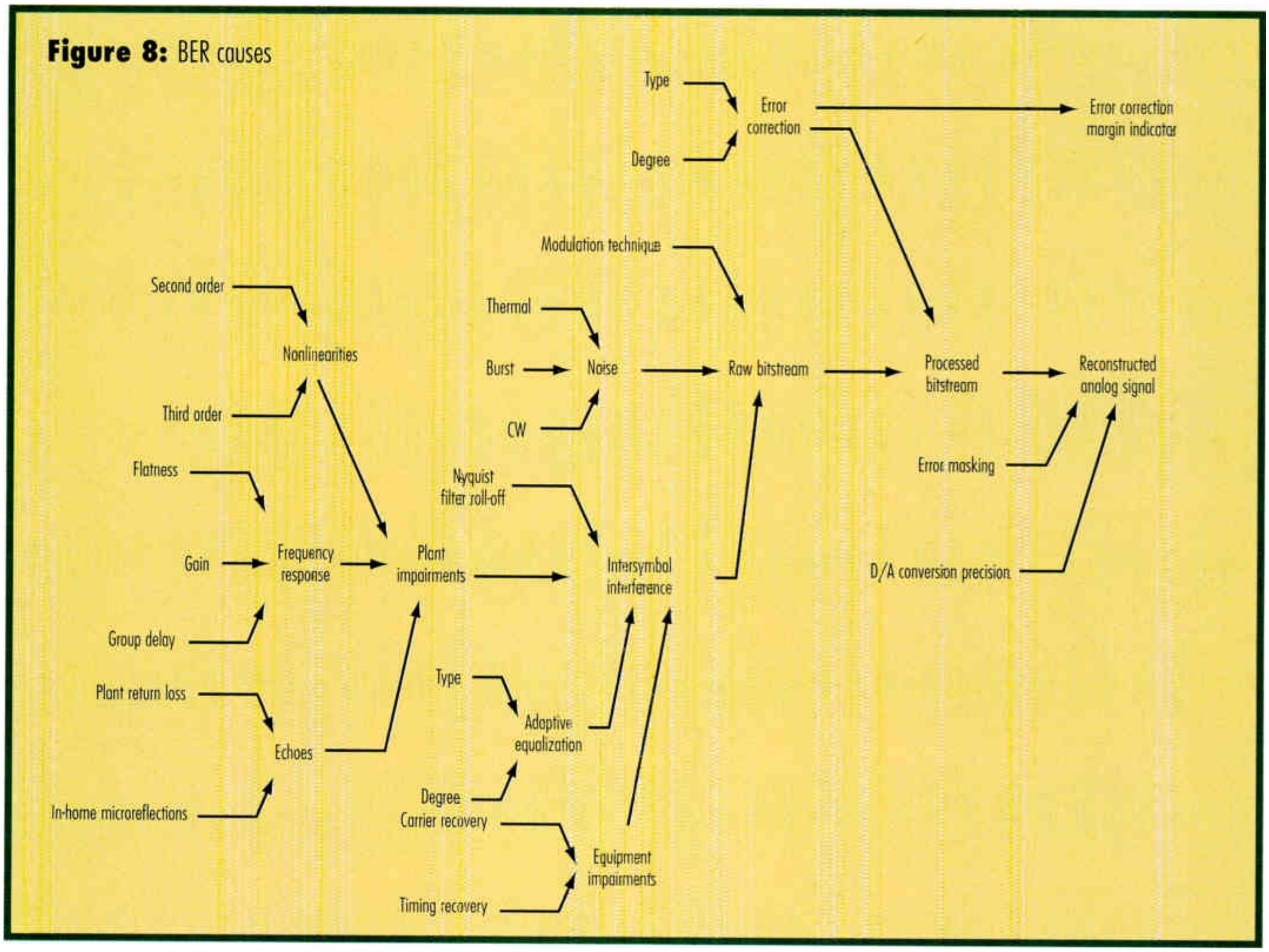
In a well-balanced cable system, ISI is minimized. However, significant departures from a flat frequency response and group delay characteristic alter the overall end-to-end transmission characteristic from the desired Nyquist filter, creating interference between adjacent symbols in the process. Typically, receivers are capable of performing adaptive equalization of the transmission channel and partially compensating for peak-to-valley and undesired phase variations, as well as departures from unity gain within limits that depend upon the complexity of the design. Of course, the more complex the design, the greater the cost of implementation. Signal reflections due to impedance mismatches and nonlinearities also can lead to ISI, but effective compensation for these impairments is more difficult. The best solution to all these problems is a well-tuned system that is properly maintained.

Countermeasures

A great advantage of digital transport is the existence of effective error correction techniques. Additional bits that are cleverly chosen can be transmitted along with the digital service and separated at the receiver. The mathematical relationship between these error correction bits and those of the digital service can be used not only to determine the presence of errors, but to pinpoint and correct those bits that have been received in error. The error correcting bits introduce a form of overhead and their presence requires the overall bit rate to be increased, thereby requiring additional transmission bandwidth. The amount of overhead increases with the degree of error correcting capability required. A low BER (before correction) requires a smaller proportion of error correction bits; a high pre-correction BER demands a larger proportion. The burstiness of bit errors also effects the error correction scheme with different techniques applied for errors that generally occur in groups, rather than singly. Typically, a combination of both types of techniques is employed to provide protection for both types of errors.

The use of error correction techniques can effectively reduce the BER to the extent that is equivalent to increasing the received S/N by several dB. This quantity is known as the *coding gain*. Unfortunately, most error correction schemes are capable of providing significant coding only over a limited range of BERs and can actually *increase* the post-correction BER at higher values of pre-correction BER. Thus, with such schemes the post-correction BER can be very sensitive to small changes in S/N and the presence of external interference.

Because BER is the most fundamental measure of digital transmission performance, it is highly desirable to access bit error performance on an operating basis. Indeed, in SONET transport systems for telephony applications, BERs are measured at various points within the network for all 15-minute intervals over a full 24 hours. Moreover, categories are assigned to characterize the severity of errors and with sufficiently high error rates, the overall service is deemed to be corrupted. This approach not only provides a direct measure of quality of service but also provides a means to isolate the source of technical difficulties. By monitoring changes in BER throughout the network over time, it may be possible to anticipate problems before they occur, thereby eliminating potential service outages. Although accessibility to BER information in equipment supporting



digital video, high-speed data and telephony is highly desirable, very little commercially available products actually support this capability.

In addition, because error correction techniques can effectively mask changes in the pre-correction BER, and therefore the underlying root causes in the network, it also is equally desirable that information be made accessible that is indicative of the degree to which error correction is taking place. This is important because, as received bit errors increase, more and more of the error correcting capability is consumed and eventually the ability to accommodate additional errors is reduced to zero. Thus, some measure of the remaining error correction "headroom" would be valuable in assessing otherwise hidden problems that would reveal their existence only after a major service outage has occurred.

Although there is currently much effort expended in the development of technical standards supporting digital services offerings over HFC systems, the present generation of equipment differs in all manner of modulation scheme, error correction technique and the gamut of low level transport protocols. Thus, any measure of error correction margin must be very generic in nature and provide a consistent and straightforward indication of the remaining error correction capability.

> "In the case of data services, the presence of errors can lead to disaster such as credit card billing inaccuracies."

A simple example might be a status indicator that can occupy any of three basic states, "green," "yellow" or "red." The green state could correspond to at least 50% remaining error correction capability, the yellow state could indicate between 50% and 75% remaining and the red state could signal less than 25%. While many other possibilities can be enumerated, it is important that existing standards bodies and industry forums address this issue in earnest, so that the next generation of digital services equipment fully meets the cable systems operators' needs to access relevant bit error information.

Reference

Smith, David R., *Digital Transmission Systems*, Van Nostrand Reinhold Co., New York. CT

Kenneth Metz, P.E., Ph.D., is executive vice president of engineering for Integration Technologies in Englewood, CO.

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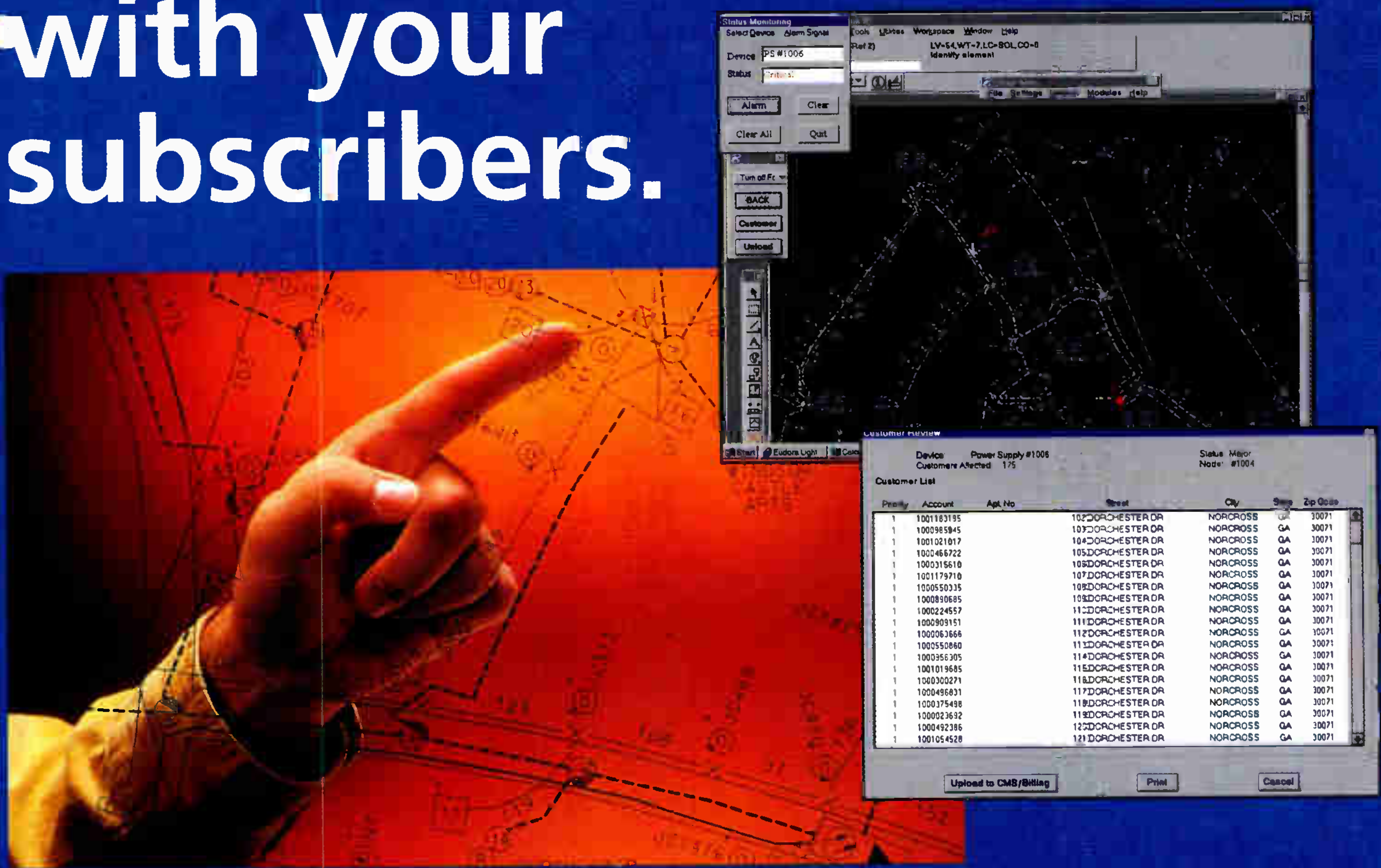

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Q: WHAT DOES IT OFFER?

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Reader Service Number 114

CableLabs Takes MPEG For a Test Drive

By Robert Wells

Five CableLabs researchers—Dr. Majid Chelehmal, Dr. Mukta Kar, and David Eng along with Rhonda Hilton, senior member of the technical staff, and Richard Prodan, chief technology officer—presented findings from the performance-testing project in a paper at this year's National Cable Television Association convention in New Orleans, LA. Their paper, "Subjective Effects of Bit Error on MPEG-2 Video" was published in "1997 NCTA Technical Papers," pages 258-265.

"The whole MPEG transmission, from the satellite to the headend to the consumer's home—we think its' going to work. I don't see anything that's going to stop it."

That's the assessment, delivered calmly by Dr. Majid Chelehmal, acting director of research and development at CableLabs, in a March interview at the research consortium's Louisville, CO, office. Chelehmal, along with Dr. Mukta Kar, a member of the CableLabs technical staff, discussed their recent work helping MSOs avoid technical pitfalls if they follow the industry trend toward offering a digital overlay of MPEG-compressed video. (MPEG is the acronym for Moving Pictures Experts Group, the body that defined the MPEG-1 and MPEG-2 digital video compression and transport standards.)

The stakes are high, since cable faces challenges from direct broadcast satellite (DBS) and digital video display (DVD), two competing platforms for digital video program delivery. Impediments to successful delivery and display of MPEG video can be caused by burst-noise impairments in the physical network, but CableLabs views those problems as manageable through reasonably high standards of construction and maintenance.

Encoder testing

Of more concern—and the chief focus of Chelehmal's group's work—is making sure that the digital bitstreams coming out of cable headends are formatted so that they are intelligible to digital set-tops. What would keep them from being so? One pitfall, said Chelehmal, is garden-variety random bit errors while reading from storage media or receiving from transmission media. A tougher-to-diagnose error source would be failure of an MPEG encoder to produce bitstreams formatted according to the complex requirements of the MPEG-2 standard. Or, related to that, the encoder design may produce bitstreams that have inadequate protections against errors ("error concealment").

> "To be fully interoperable, manufacturers have to cooperate and share some of their design information."

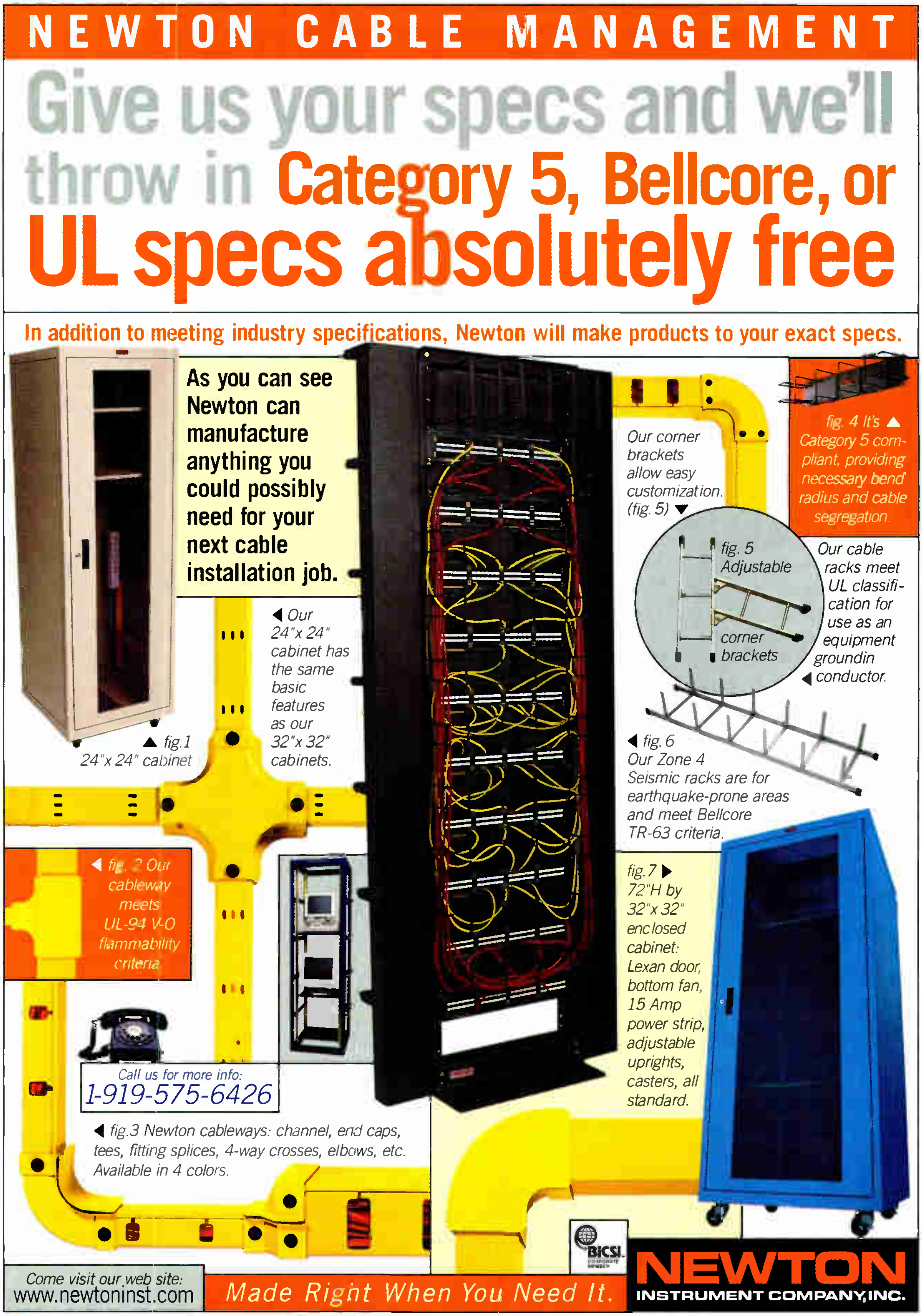
A program of rigorous "conformance tests" of MPEG encoders was begun last year by Chelehmal, Kar and David Eng, director of laboratory testing, under the leadership of Dr. Rich Prodan, chief technical officer. As of April, three vendors' encoders had been certified as conforming to the myriad of requirements for a compliant MPEG-2 bitstream.

Compliance is crucial, said Kar, not only so that any particular encoder's output is understood by set-tops but, equally important, so that MSOs will be able to choose among, and swap-out as needed, multiple vendors' encoders and decoders—the familiar Holy Grail of interoperability.

Perhaps surprisingly, quite a few design choices have been left up to vendors. "MPEG has defined a core generic standard, but did not define the entire application," Kar said. "To be fully interoperable, manufacturers have to cooperate and share some of their design information. Otherwise, interoperability is just a word, and may not happen in the real application phase."

Error-concealment and error-correction are areas, in particular, where encoder designers have had substantial wiggle-room in their software implementations, Kar said.

CableLabs has nurtured a relationship of trust with vendors, most of whom are comfortable showing their wares to CableLabs and seeking constructive feedback, said Kar. Some sensitive issues, he added, "are kept to vendors and ourselves" during confidential exchanges, and vendors often respond to CableLabs' suggestions by making changes. This collaborative relationship with vendors not only helps promote true interoperability, noted Chelehmal, but it also helps MSOs by



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Testing steps

Sample MPEG-encoded bitstreams are acquired in two ways: either from lab tests conducted at CableLabs or from 8 mm Exabyte tape recordings of digital output sent to the lab by vendors. The bitstreams are demultiplexed and decoded using MPEG-2 Main Profile at Main Level software decoder tools jointly developed by CableLabs and by DiviCom, a unit of C-Cube Microsystems Inc., which was hired to assist the CableLabs' conformance testing project.

Close to 200 checks are performed on encoder compliance against benchmarks of MPEG syntax and semantics, program multiplexing information, buffering, timing, synchronization and video parameter ranges.

Some important lapses in encoder performance are infrequent enough that they can't be detected from files of recorded output—the files become prohibitively large. To test for them, CableLabs has a plan to create special equipment that monitors encoder output in real time and keeps running totals of problems it detects. "The real-time and non-real-time tools complement each other," said Kar.

"CableLabs has nurtured a relationship of trust with vendors."

In addition, the encoders are "performance tested" before human viewers, who express their subjective reactions to video shown to them. Both untrained viewers (college students) and the trained viewers (from CableLabs, MSO companies and others) are being employed. In most cases, the viewers' perceptions of impairments have coincided with those picked up by the test equipment.

In addition to testing output straight from various encoders, the test team devised a "bitstream editing software tool," which is used to intentionally introduce bit errors at random locations in bitstreams so that their effect can be measured. Later, using conformance tools, bit errors have been characterized.

From all this work, a conclusion has emerged that, to paraphrase George Orwell, some bits are more equal than others. Or rather, some bits, if they're missing or in error, can be a lot more damaging to system performance than others.

There's a hierarchy, explained Chelehmal. Of the packets that make up the overall "system/transport stream

(TS) layer," those in the transport header, such as the sync byte or the packet identifier (PID), are more crucial than random bits in the video packet payload. Because of its larger relative size, however, the payload has a larger incidence of bit errors. "You can introduce three or four errors in some areas (of a packet) and the eyes may not even notice," said Chelehmal. "But if you go into the transport layer and wipe out the transport header or the sync byte, you may lose several pictures."

This ranking of bits by their importance was known to those who devised the U.S. high definition TV (HDTV) system, said Chelehmal. Relying on work done by the Advanced Television Research consortium, they designed HDTV to degrade gracefully, rather than failing abruptly as digital systems tend to do. In general, bit error rates (BERs) in the range of 10^{-9} to 10^{-11} are likely to produce video of acceptable quality, while a BER of 10^{-4} will cause serious problems, Chelehmal said.

Error performance

To avoid errors, vendors use various types of error protection. One of these is "data interleaving," by which contiguous bytes are separated in the bitstream in order to minimize the impact of burst errors. How vendors do their error performance is left up to them—which is one of the reasons why encoders perform differently, said Chelehmal. But vendors, who have been under the gun to ship encoders soon and at affordable prices, are still busily tweaking and redesigning, Chelehmal said. Similarly, he added, CableLabs is still improving its internally developed test tools. CableLabs plans to focus more attention in coming months on creating tools for testing set-top decoders and on testing the encoders, he said. CT

Robert Wells is a technical writer who frequently writes about Cable Television Laboratories Inc. (CableLabs).

BOTTOM LINE

Common Language

In order for "interoperability" to become more than a word, CableLabs has put out a call to manufacturers to make it so.

Testing: CableLabs has been testing MPEG encoders for syntax and semantics, program multiplexing information, buffering, timing, synchronization and video parameter ranges and working with vendors to ensure that products are conformance- and performance-tested.

There's a hierarchy for bits. Bits in the transport header, such as the sync byte or the packet identifier (PID), are more crucial than random bits in the video packet payload.

SCTE Standards Quarterly Update

By Dr. Ted Woo

This is the second quarterly article designed to share recent significant events in standards development through the Society of Cable Telecommunications Engineers. Publication of this column is scheduled for every three months in major trade journals of the cable telecommunications industry. If there are any questions or suggestions for this article, contact the director of standards at SCTE, (610) 363-6888, ext. 228. The SCTE Standards Development Organization meeting schedule is posted weekly at the Society's Website: www.scte.org.

The *Recommended Practices for Coaxial Cable Construction and Testing* manual, a product of the SCTE's Design and Construction Subcommittee, is scheduled to debut at Cable-Tec Expo this month. It will join the already available *Recommended Practices for Optical Fiber Construction and Testing*, which the same subcommittee produced. These manuals simplify and organize a standard state-of-the-art system for designing and documenting coaxial and fiber systems. Even after construction of the systems, forms are used to compile a system document for troubleshooting, tracking, emergency restoration and repair. These manuals are intended to provide information and specifications to supplement written agreements between contractors and operators. While these manuals will not create contractual obligations and responsibilities for SCTE, the manuals may be incorporated by reference into an agreement such that the provisions impose obligations or responsibilities on contractors.

The coaxial manual includes chapters that cover project management, cable handling and equipment, aerial cable placement, underground enclosure specifications and installation, bonding and grounding, cable preparation and connectorization, plus other topics and a glossary. In addition to these areas, the fiber manual covers fiber enclosures, splicing, field testing of single-mode optical fiber cable systems, optical fiber documentation, emergency restoration, as well as maintenance of fiber broadband optical systems. The final draft of the coaxial construction manual is currently up for approval by the SCTE Engineering Committee.

Digital standards

A new digital video standard for supporting multilingual subtitling services is now available. Its title is *SCTE Proposed Standard Subtitling Methods for Broadcast Cable*. This Digital Video Subcommittee (DVS) standard, DVS 026, sets forth a transmission protocol supporting subtitling services of multiple languages to augment video and audio within the Moving Picture Experts Group (MPEG-2) multiplexes. The transmission format for subtitles consists of one or more compressed bitmap images, along with optional rectangular backdrops for each.

With the bitmap method, any language can be supported, as opposed to those supported within the memory of the decoder, and the author of the subtitle stream has complete control over the appearance of the

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BOTTOM LINE

Standards at a Glance

Here's an overview of recent Society of Cable Telecommunications Engineers' standards activities:

- *The Recommended Practices for Coaxial Cable Construction and Testing* manual will debut this month at Cable-Tec Expo '97.
- A new digital video standard to support multilingual subtitling services—*SCTE Proposed Standard Subtitling Methods for Broadcast Cable*—is available now.
- *Data Service Extensions for MPEG-2 Transport* represents transmission formats for isochronous and asynchronous data services.
- The Digital Video Subcommittee has also adopted *SCTE Video Compression Formats*, a standard that consist of three tables: "Standardized Video Input Format," "Compression Format Constraints for Tier 1" and "Compression Format Constraints for Tier 2."
- Interface practices test procedure standards are currently undergoing laboratory testing.

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characters including the font and kerning. Characters and symbols that are not a part of any standard read only memory (ROM)-based character set can be transmitted and displayed, such as those characters in ideographic languages that represent proper names. In the horizontal axis, the coordinate system used to locate characters and bitmaps for this standard is based on the number of pixels available horizontally in the display grid for the target video format. Standard digital National Television System Committee display provides 720 pixels horizontally, clocked at a 13.5 MHz rate; high definition TV (HDTV) formats include modes with up to 1920 pixels horizontally.

Vertical coordinates are specified by raster lines. Raster lines are counted after interlace, and the counting method does not correspond with the usual way of counting lines in interlaced NTSC. The target display format is defined for subtitle message, and defines frame rate and the horizontal and vertical dimensions of the active display grid. This standard supports up to 16 colors for one screen of subtitle display. The count 16 includes all colors used for subtitle characters, frames, and outlines or drop shadows. This standard was approved by the SCTE Engineering Committee as an SCTE standard in January. All standards documents are available to individuals and organizations.

> "There are 100 standards documents under development by the Society."

Data Service Extensions for MPEG-2 Transport is a standard that represents transmission formats for isochronous and asynchronous data services, compatible with digital multiplex bitstreams constructed in accordance with the international standards ISO/IEC 13818-1 (MPEG-2 Systems), the Advanced Television Systems Committee Standard A/56, and the General Instrument extension to the ATSC standard.

In simple terms, synchronous implies that data sent is with the timing of the clock where data retrieved also is with the timing of the clock. The sending and receiving are locked together by the same timing. Isochronous implies that the sending and receiving are drifting and nearly locked together. Asynchronous implies that the start and stop are random, and the clock is not locked at all—that is, not having a clock sent along. In this case, every packet is to be re-synchronized in the process for receiving.

Isochronous data is carried as a packetized elementary stream (PES). The PES payload, which follows the PES header specified by MPEG-2, begins with an isochronous data header, which is followed by isochronous data access units. The isochronous data header is present even when the PES header does not include present time stamp (PTS). Asynchronous data is carried in MPEG private section syntax, in private stream as specified in the international standard. The syntax supports rates between 300 bps (bits per second) and 288,000 bps. A compliant decoder must support at least 1,200, 2,400, 4,800, 9,600, and 19,200 bps. This standard was approved by the Engineering Committee as an SCTE standard in January, and its document designation is DVS 027.

The Digital Video Subcommittee also has adopted *SCTE Video Compression Formats*, a standard that consists of three tables. They are the "Standardized Video Input Format," the "Compression Format Constraints for Tier 1," and the "Compression Format Constraints for Tier 2." Illustration of video standards (e.g., SMPTE, ITU), active lines and active samples per line are listed. The vertical size value, horizontal size value, aspect ratio information, frame rate code and progressive sequence are shown as well. The general idea of this standard is to have a listing of formats that specifies how many lines or pixels at what data rate to formalize the existing formats in data transmission for set-top boxes. It is not a new concept. This standards document serves as a guide to designers, is approved by the Engineering Committee as an SCTE standard, and is designated as DVS 033. ➤

Interface practices

The Interface Practices Subcommittee (IPS) currently is conducting laboratory testing on test procedure standards at Hewlett-Packard in Santa Rosa, CA. Interested parties were invited by the authors to participate in the tests performed. SCTE standards document designations and titles of the eight standards are: IPS-TP-201 *Insertion Gain and Loss, Frequency Response and Bandwidth*; IPS-TP-202 *Test Method for Return Loss*; IPS-TP-203 *Test Method for Isolation*; IPS-TP-205 *Noise Figures*; IPS-TP-206 *Composite Triple Beat Distortion*; IPS-TP-207 *Composite Second Order Distortion*; IPS-TP-208 *Cross Modulation Distortion*; and IPS-TP-211 *Test Method for Group Delay*.

After the completion of these tests, each of the standards documents will be reviewed, modified if necessary, and balloted by the interest organizations in accordance with American National Standards Institute due process. Upon the IPS and Engineering Committee approval, each standard will be submitted to ANSI for approval as a new American national standard.

Presently, there are 100 standards documents under development by the Society, of which IPS has 83 documents, DVS has 16 and the Material Management/Inventory (MMI) Subcommittee has 1. ANSI/SCTE SP 400-1996 "F" *Port (Female Outdoor) Physical Dimensions* has been an ANSI-approved standard since December 12, 1996.

International Telecommunications Union (ITU-T) accepted SCTE DVS 031 standards document *Digital Video Transmission Standard for Cable Television*, and it is being reviewed for recognition as an international standard.

Society of Cable Telecommunications Engineers, 140 Philips Road, Exton, PA 19341-1318. Phone (610) 363-6888. Fax (610) 363-7133. Web site ww: .SCTE.org. CT

Ted Woo, Ph.D., is director of standards for the Society of Cable Telecommunications Engineers.

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Reader Service Number 205

Convergence-Era Standards

By Robert Camden-Britton and John Dahlquist

Traditional cable-only operators are faced with a new set of standards and equipment construction requirements as they migrate into the world of telecommunications and attempt to converge the services of cable TV, data transport, telephony and other advanced services. As operators execute communication system upgrades and rebuilds, or undertake new installations, they are affected by the regulations for product safety and radio frequency emissions and immunity.

This article provides an overview of the domestic and European standards and regulations pertinent to providers and users of hybrid fiber/coax (HFC) transmission equipment.

Laws and regulations governing compliance already exist in the United States, Canada, Europe, Japan and Australia, and are quickly spreading throughout the rest of the world. System operators are increasingly specifying compliance criteria in their contracts with broadband equipment manufacturers. But why the global attention? What are standards, and why do they matter?

Standards are an important means of regulating the products that equipment manufacturers develop, manufacture and distribute. Without regulation, there would be no means of ensuring the safety and quality of individual pieces of equipment. Standards protect the manufacturer, the customer and the operator.

Critical areas

Product regulatory requirements are divided into three general areas: safety, emissions and immunity. Each facet of regulatory compliance addresses a different need or potential hazard. When addressed in concert, these three areas cover all main aspects of equipment operation and ensure that each piece of equipment is safe to use, and that the use of one unit will not interfere with the functioning of another.

- Safety requirements cover potential hazards such as fires, electrical shock and exposure to radiation that may arise from the design, construction and usage of equipment. The goal of regulatory compliance is to ensure that operators' exposure to hazards such as hot surfaces, flammable materials or optical energy is minimized. By standardizing on a minimal level of safety compliance, regulation protects operators against potential threats.
- Emissions requirements relate to the magnetic and electrical fields that arise during equipment operation. Emissions can result from many signal generating sources in equipment such as oscillators, video displays, power supplies, etc. Compliance is required to guard against interference with neighboring equipment. For some types of emissions, these requirements are more than a quality issue, as they also define acceptable levels of emissions that are potentially harmful to humans. Emission standards cover harmful factors such as high intensity optics, high-power microwaves, radiation, etc.
- Immunity requirements cover the equipment's ability to accept magnetic and electrical field interference without harm to the equipment or the operator—in other words, the equipment's "immunity" to electrical or magnetic noise from neighboring equipment. In this case, the aim of compliance is to ensure that the equipment operates correctly in the "real world" where radios, appliance motors, and other nearby equipment can cause localized electrical and magnetic noise.

Operators who purchase and install equipment that meets regulatory standards in these three areas have made a basic investment in their systems and in their employees.

U.S. agencies

Governmental agencies establish regulatory control. In the United States, there are multiple federal, state and local government agency rules, regulations and laws pertaining to various products. Despite the proliferation of these rules,

BOTTOM LINE

Don't Forget Compliance!

Standards are means by which products that equipment manufacturers develop, manufacture and distribute are regulated. Product regulatory compliance addresses safety requirements, emissions requirements and immunity requirements.

There are three primary federal agencies that issue and enforce product regulations for the U.S. cable industry: 1) The Food and Drug Administration's Center for Disease and Radiological Health (laser safety); 2) The Department of Labor's Occupational Safety and Health Administration (product safety); and 3) The Federal Communications Commission (product emissions and immunity).

regulations and laws, there are just three primary federal agencies that are empowered to issue and enforce product regulations for the cable industry:

- The Food and Drug Administration's Center for Disease and Radiological Health, which administers laser safety.
- The Department of Labor's Occupational Safety and Health Administration, which administers product safety.
- The Federal Communications Commission, which administers product emissions and immunity.

European agencies

Similar to the U.S. format, European countries may have both national and local regulations. But in order to bring unity to their common market interests, and to reduce the costs of doing business among themselves, many European countries jointly created and gave mutually binding legal authority to a joint governing body known as the European Union (EU). In 1996, the following countries were participating members of the EU: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden and the United Kingdom.

One of the EU's first roles was to clarify, issue and enforce regulations to protect the health of consumers and workers, as well as the environment of the member nations. To this end, the EU created an internal European Council (EC) to focus on product and environmental requirements. The EC has authority to issue directives, which are adopted by each participating member nation as law. The EC also adopts common standards that ensure that products meet the requirements set forth in directives. During this process, the EC combines and reconciles already-existing regulations and standards. This reconciliation step is extremely important; by selecting one standard that best meets the intent of the respective directive, the EC simplified the testing and certification process for manufacturers. Instead of having to comply with ten or more nations' separate—and possibly contradictory—regulations, manufacturers now need only show compliance with the EC standard.

U.S. conformity

The product manufacturer is required to demonstrate product safety conformance through testing and certification by a nationally recognized test laboratory. Several companies can provide this service; probably the best known is Underwriters Laboratories (UL). For emissions and immunity testing, companies may self-certify. This means that companies can do their own testing, create a record of the equipment construction and test results, and declare compliance. The FCC is the responsible party for investigating product conformance if there is a complaint. Finally, for laser safety, the FDA's CDRH requires the filing of a laser product report with information about the laser, such as output power, wavelength, etc. FDA safety analysts

Reader Service Number 114

then review all reports for compliance. The FDA also conducts on-site audits to ensure that the information provided by the company is correct.

EC conformity

There are three common routes to compliance with European Community directives: self-declaration, mandatory certification and voluntary certification. *Self-declaration* means that the manufacturer declares it is compliant with all applicable directives. As in the United States, to substantiate conformance, the manufacturer must create a technical product file containing construction and test information. *Mandatory certification* is required for some medical and machinery products. This certification must be issued by a "European notified body," an accredited test laboratory residing within one of the member countries. *Voluntary certification* often is used by manufacturers to ensure that their products really do conform with all applicable directives. For U.S. companies, this certification is usually performed to create positive, factual evidence of compliance, to be used for any potential product liability suit.

Who's responsible?

The manufacturer is ultimately responsible for the accuracy of its technical file and declaration of conformity. The manufacturer must implement internal measures to ensure that the product remains in conformity over time, as changes occur to both the standards and the product's design. Part of compliance with the ISO 9001 quality system standard is to establish internal controls to ensure ongoing conformity.

Conclusion

The recent harmonization of standards by the European Union is a large step toward simplifying standards because it enables manufacturers to comply with one well-documented set of directives and standards recognized by over 15 nations. Without this joint regulatory agency, equipment manufacturers could face disparate and possibly contradictory regulations and standards, resulting in complexities of development and high compliance costs.

Another important facet of standards and regulations is the standardization of parts. This type of standardization can allow operators to select the equipment that best fits their network, without having to worry about if the different elements will work together. In addition, as parts become standardized, economies of scale can be realized. Ultimately, open competition reduces the product cost and increases ease of operation for the user. CT

Robert Camden-Britton is vice president, quality assurance and John Dahlquist is vice president, marketing at Harmonic Lightwaves Inc.


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Reader Service Number 190

Network Management Tips

By Bob Vogel

Over the past few years a significant amount of focus and emphasis has been placed on the topic of element management for broadband networks. Much of the attention is based on the discretionary nature of element management and issues related to the justification of capital expenditures and the desired system architecture. Broadband networks are evolving as video, data and telecommunications services converge. In addition, networks are becoming more complex and hybrid in nature. System designs of today make use of products from multiple vendors, some of which are new comers to the marketplace. All of these issues pose significant challenges on the goal toward an industry-embraced network monitoring standard.

The growth and product deployment that the industry has realized is extremely exciting for all organizations that have an opportunity to participate and compete. These increasingly complex networks require a common thread within all of the deployed technologies in order to provide an acceptable unification at the element management level. As the various technologies become unified, so must their respective and available management systems.

Much emphasis has been placed on the topic of network monitoring because of the nontrivial costs associated with a system deployment effort. The service providers that are enthusiastic about network monitoring are those that place a significant amount of emphasis on service quality. It is difficult to envision any organization classifying itself as a quality service provider unless a clear and succinct network monitoring strategy has been defined and actively supported. Network monitoring is a key element in the delivery and continued support of a total quality system.

Suppliers are already being asked to specify and support products that adhere to standard interfaces, which are interoperable with existing element management and high-order network management systems.

As standards evolve, so will the economies of scale and interoperability that traditionally breed cost reduction possibilities and the preservation of initial investments. The objective of every system designer and supplier is to provide products that have significant technical and financial advantages, which support the necessary compatibility. The objective of all industry service providers (i.e., MSO, telco, regional Bell operating company) is to enthusiastically encourage the competitive juices of all organizations to flourish while adhering to agreed-upon and mutually supported industry standards.

Much of the recent network monitoring efforts within the industry have been focused on dictating not only the required capabilities, but also how the product should be designed. Standards that are developed, accepted and adhered to are traditionally developed with the cooperation and mutual support of the industry technology participants. How the agreed-upon standards are integrated into actual vendor-specific products must be left to the creative spirit of each industry designer and supplier.

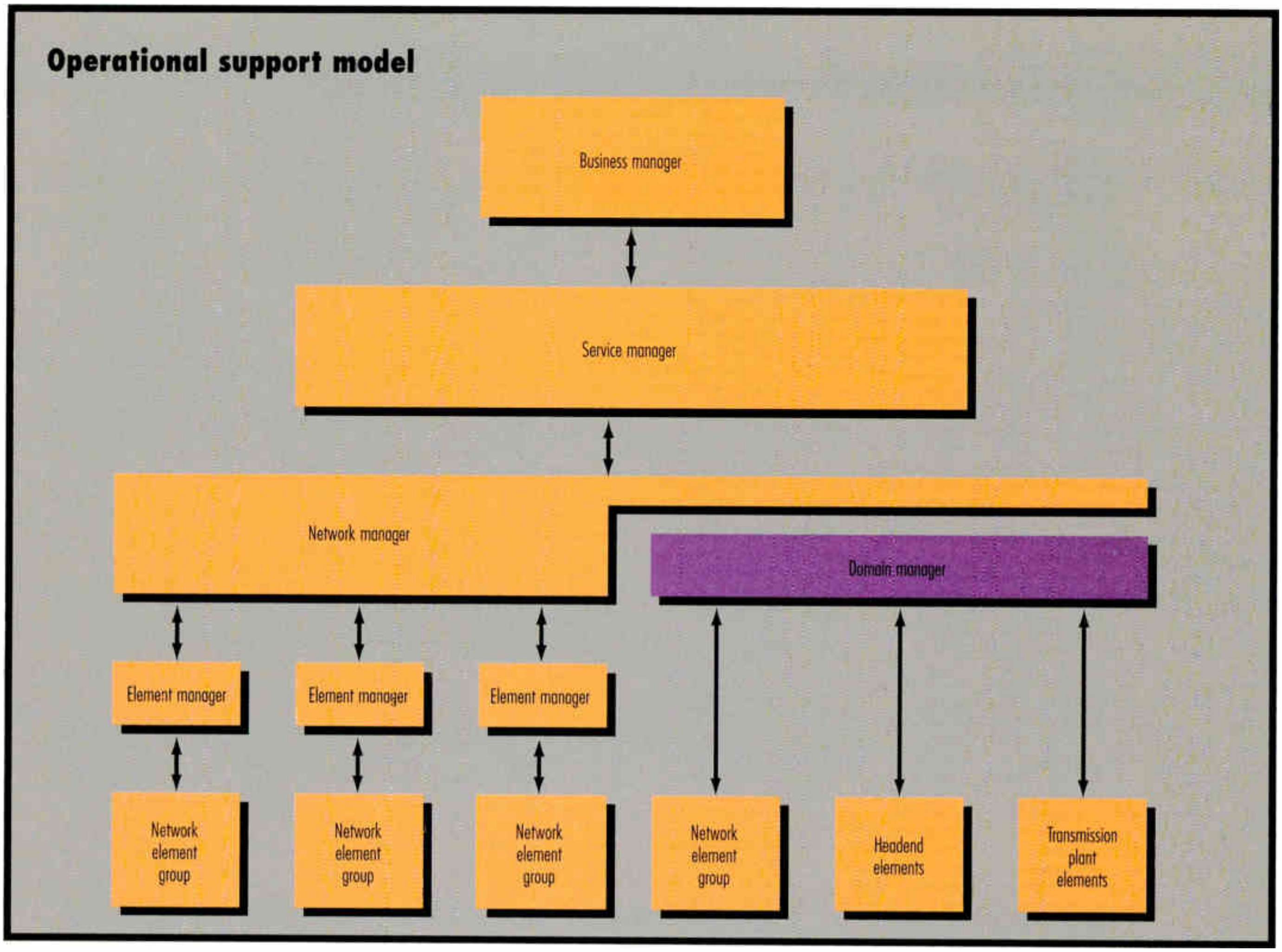
At this point, the stage has been set for discussing the issues that are of primary concern when attempting to establish standards within the element management domain. The remaining focus of this article will be on the logical and physical issues associated with establishing standards within the industry. The key areas of focus will consist of the following:

1) Definition of the network monitoring model
2) Element management RF protocol
3) Physical interfaces
4) Graphical user interface (GUI) software

Network monitoring model

In current systems, the element manager serves as the basic single point of entry for

> **BOTTOM LINE**
>
> **Network Know-How and Standards**
>
> Those that participate within the network monitoring arena believe that element management systems can improve network availability and reliability and provide better information about the given network to the service provider.
>
> **Why standardize within the network monitoring domain?** To facilitate the following key benefits:
>
> 1) **Interoperability** of multi-vendor hardware and software solutions.
> 2) **A common command** and control language, via the defined protocols, which support the control of field deployed and headend products.
> 3) **Improved reliability.**
> 4) **Hybrid hardware solutions** that can be monitored and controlled by a single and consistent user interface application.



any viable and accepted network monitoring solution. A more interoperable and consolidated system makes use of a domain manager, which is intended to ease the interface task by supporting multiple element management systems. The domain manager is responsible for the configuration and monitoring of the multiple network elements, thus providing an enterprisewide network monitoring architecture. Network elements traditionally consist of headend devices (e.g., optical transmitters, optical receivers, etc.) and field transmission devices (e.g., power supplies, amplifiers, etc.).

A basic network operational model, supporting a domain manager, is represented in the accompanying figure.

The benefit of implementing a domain manager is to provide a single network monitoring system that supports the activities of a number of different classes of elements (such as headend and transmission plant). Economies of scale are gained by moving in the direction of a single system that supports a consistent user interface for all monitoring operations, regardless of the device being monitored. Interoperability is the key to the success of any new network monitoring and management system. A significant need exists to manage the network with the information depth of traditional systems and the breadth of more recent higher order systems.

RF protocol

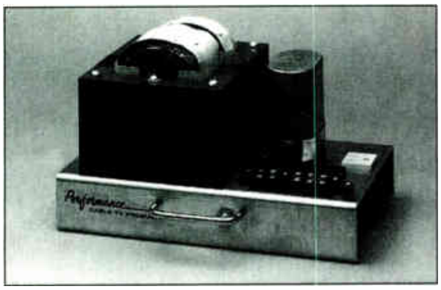
The focal point for system performance, operation, capability and interoperability is defined by the protocol and the control engine that supports the polling, communication and interrogation of the transmission plant and headend products. The RF protocol serves as the command language that is used to configure and control the transmission plant and headend transponders, in addition to attain the valuable status and performance information about the devices actually being monitored. The RF protocol serves as a critical and common fiber in the fabric of the entire element management system.

The RF protocol should be viewed as the foundation of any element management standards efforts. By developing and establishing a single element management RF protocol, the task of implementing an open monitor and control architecture is significantly simplified. If this strategy is implemented any third-party supplier that adheres to the rules of the RF element management protocol standard can support, manage and control the respective transmission plant and headend products.

The element management control engine or master control unit, along with the individual transponders, will support the standard RF protocol. Incorporated into the protocol standards will be basic minimum and industry accepted performance metrics. These metrics will define the speed at which the system will operate and the supported conditions.

Transponder technology

Much of the recent element management standardization efforts have focused



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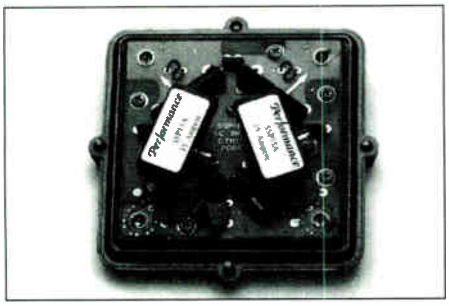

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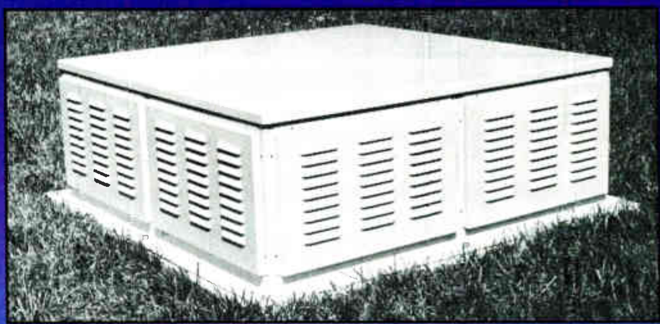

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on the actual transponder technology. This can be readily justified since the transponder device is the voluminous product in any network monitoring system and the one device that is inserted into the actual optical nodes, amplifiers and power supplies. The key issues that need to be addressed when attempting to standardize transponder technology are the actual physical, logical and electrical interfaces supported by the transponder and the respective station, power consumption and current ratings, voltage sources, maximum physical dimensions, input/output (I/O) support, on-board memory requirements, and the minimum accepted monitoring and control capability.

The physical, logical and electrical interfaces define exactly how the transponder will connect to the given optical node, amplifier and power supply. This interface will provide organizations with the ability to eliminate or minimize the number of external cables necessary to connect the given transponder.

The standard functionality of the transponder will define what level of monitoring and control it possess. The definition of this standard will drive the design requirements of the transponder. Functionality that has become recognized as typical of most competitive transponders is frequency agility, downloadable firmware/protocol software, and switching control.

The method of design and strategy for implementation can easily dictate the physical characteristics of the given transponder. Clearly, the first step in achieving an embedded strategy is to define an agreed-upon and standard system. Accepted standards will minimize risks that will encourage organizations to design products that may reveal enhanced features at significantly lower prices.

Although the transponder is a product that has captured much of the attention of recent standards meetings, it is not the most common element in the network monitoring architecture. The actual transponder hardware is easily overshadowed by the firmware that is necessary to support communications back to the element management control engine or master control unit. The actual standard software is addressed by the RF protocol software component that is specific to the transponder platform. ➤

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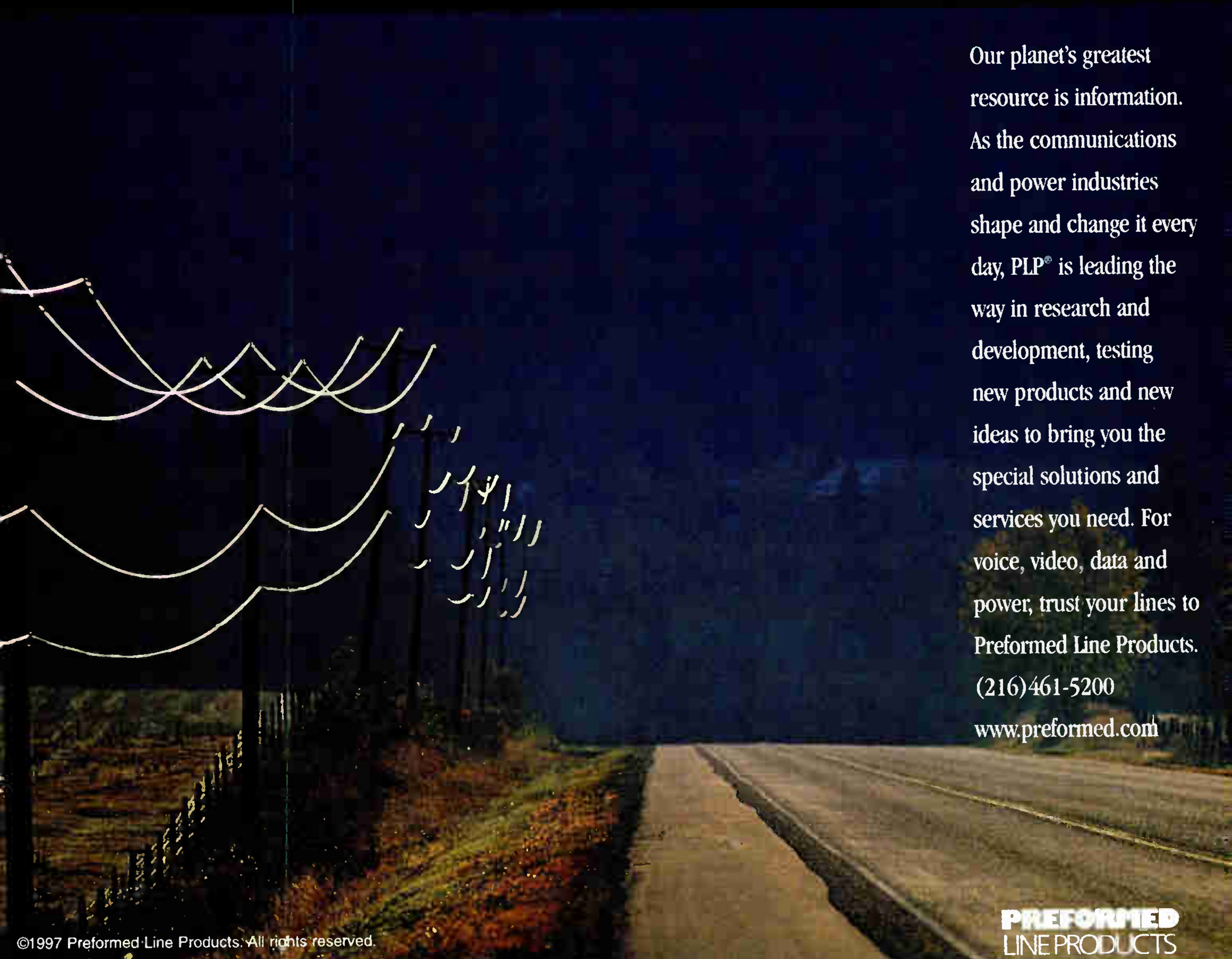

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A standard and reliable network protocol is required to support communications between the actual control/polling engines, database server, and GUI software. This approach is required in order to remain compatible with industrywide, current and emerging management systems.

SNMP

In current systems, the simple network management protocol (SNMP) provides the proven and industry-accepted basis for delivering necessary and requested information to open network management systems. A number of industry suppliers have adopted SNMP as a cost-effective means of monitoring and managing heterogeneous and distributed network elements.

In addition to SNMP, the common management information protocol (CMIP) is attaining a high level of notoriety. CMIP has been identified as a protocol that will provide service level management within the telecommunications and broadband network environments.

Proxy agents will be required to support communications from element management systems to high-order network management systems. Proxy agents are readily available for SNMP and CMIP. They act as the common thread for interfacing the elements that comprise the given network to the defined network management platform. Most of the SNMP management platforms available today offer dual mode protocol support for both CMIP and SNMP.

GUI

The GUI is the software that enables access to the information that is monitored and maintained by the given element management system. Other than supporting the standard interfaces for accessing the controlling elements of the system, the GUI software does not need to abide by any specific standards or rules. Although this is the case, the GUI presents those organizations that compete in the network monitoring marketplace with any opportunity to define itself.

> "Clearly, the first step in achieving an embedded strategy is to define an agreed-upon and standard system."

Products available today are developed under Microsoft Windows NT and UNIX operating systems. Significant detail is spent on designing and implementing compelling methods for presenting information specific to the elements being monitored. Any truly competitive product is designed to support client/server activities. Software modularity is essential for the end user. System software needs to be scaleable and capable of handling virtually any size system through the addition of software modules as the given need arises. Software module additions are made to support enhanced capability or to generally increases performance.

Typical features of current element and domain management systems are bulleted in the accompanying sidebar.

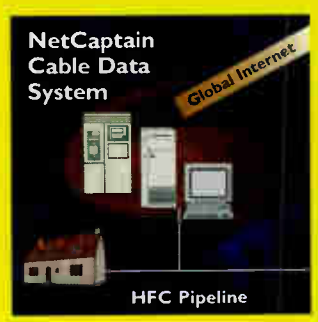
As the density of network monitoring systems increases, it will become increasingly important that these systems support interoperability standards. This issue is critical to ensure an open and consistent architecture that lends itself to network reliability and multi-vendor system solutions. The evolution and implementation of standards also provides the ability to define reproducibility guidelines, on a systems solution basis, which is consistent across all vendors products. Regardless of who is designing and manufacturing, a product that meets industry-accepted standards must have similar behavior characteristics.

Summary

In order to validate that participating organizations are all adhering to the defined standards and that their respective products are within specification, it is typically necessary to establish a standards body that is responsible for certifying that a given product is compliant.

This article assumes that the deployment of network monitoring solutions is one that has been accepted as a necessity of doing business, not a discretionary investment. Those that participate within the network monitoring arena strongly believe that element management systems can improve network availability and reliability and provide better information about the given network to the service provider. This added technology has been proven to contribute to the primary objective of delivering a quality service on a customer demand basis. CT

Bob Vogel is vice president of marketing at AM Communications.



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Get 99.99% Availability

By Gordon Greenfield

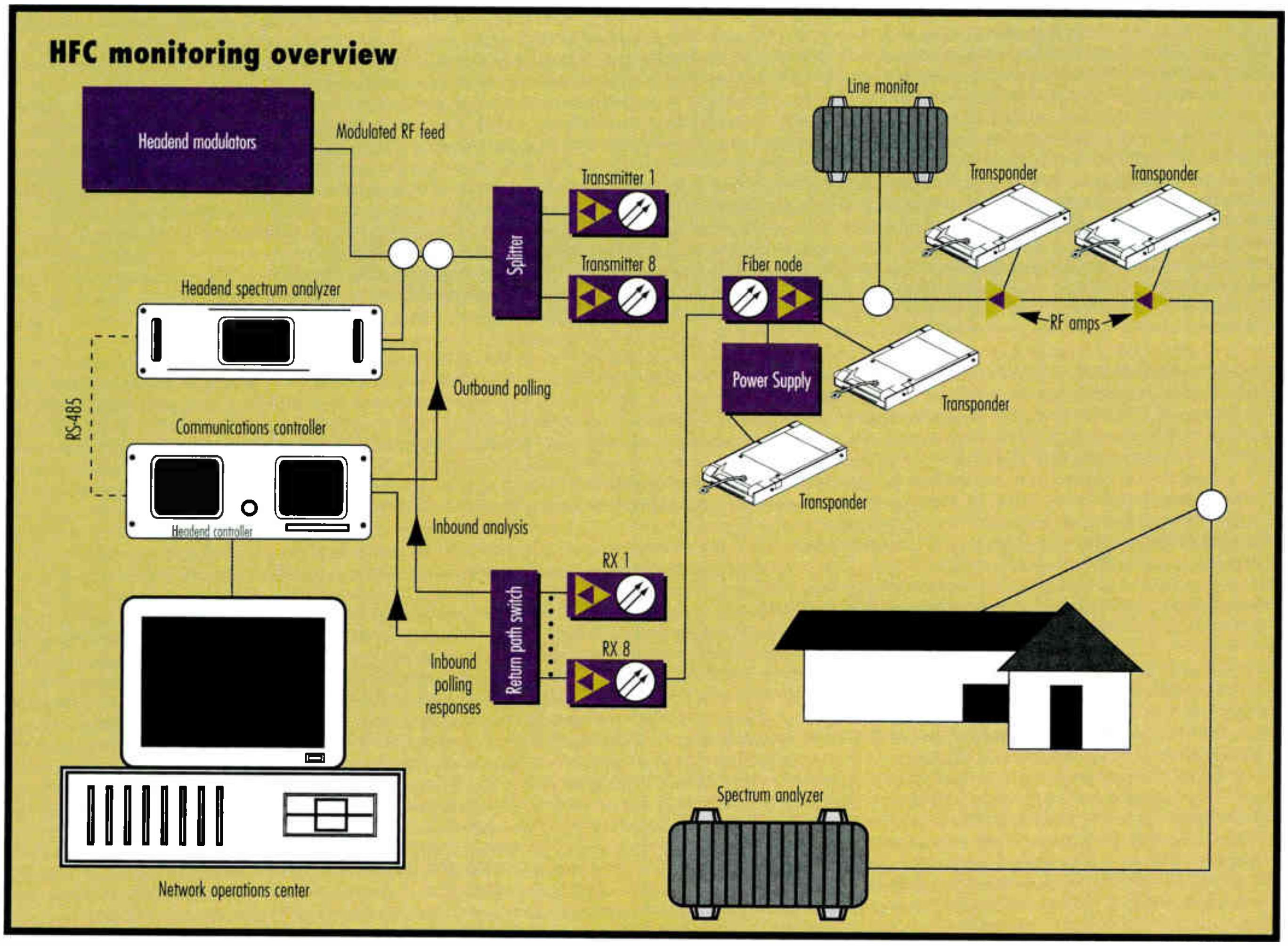
During this period of rapid convergence of telephony, data and cable services, network availability benchmarks mean more than just satisfied cable viewers. New technical services such as telephony, digital video, digital audio, video game services and high-speed Internet access demand much higher availability ratings than cable providers historically have achieved. As the cable industry sorts through new legislation created by the passage of the Telecommunications Act of 1996, a shooting match will commence and the target will be 99.99% availability.

While the 99.99% standard may become the target, industry competition will determine acceptable availability ratings. What is not being debated is that competition during this new era of cable calls for new services with unprecedented availability and reliability. Availability is the amount of time a network properly performs, and reliability refers to the innate functionality of a cable network's design.

In order to achieve improved availability and reliability ratings, system operators are reviewing and improving maintenance practices, pushing fiber further out into the plant, reducing the number of actives and implementing improved standby powering systems. As operators make major investments to rebuild their plants, it is not unusual to see 10 to 15% of the rebuild budget be invested in monitoring solutions.

Monitoring benefits

Monitoring the status and performance of the hybrid fiber/coax (HFC) domain helps system operators improve overall



plant performance and increase network reliability and availability ratings. By monitoring their HFC networks, system operators can realize considerable improvements in the following areas:

1) Identify failures before service is disrupted. One of the most common causes of network failure is powering problems. In large networks the layout of power grids may make a power failure in part of the system invisible in the headend. A monitoring system immediately informs the system operator that power supplies have switched into standby mode.

   Without monitoring, the standby batteries will simply drain, delaying the failure but not eliminating it. With an alarm, the operator can perform field maintenance or get a generator to the site before the service is disrupted. Although status monitoring systems cannot prevent power outages, they can reduce maintenance costs, improve reliability and enhance network availability by providing warning signals before batteries completely drain.

2) Clean up the return path. Two-way services obviously require a clean return path. But how do you know ingress is disrupting services until customers call to complain? The solution is a return path monitoring system that continuously measures ingress.

   An approach such as an automated ingress management system provides operators the ability to not only alarm on ingress, but also to measure it and identify the source down to a node level. This allows operators to roll trucks directly to the problem area while maintaining communications with all other nodes.

BOTTOM LINE

Aim for 99.99%

The cable industry's moves into high-speed data and telephony has made *availability*—the amount of time a network properly performs—more important than ever before.

Hitting 9s: Much ballyhooed has been the telcos' boasts of around 99.99% availability. Some may say those claims aren't exactly reality, but nevertheless, something very close to that level of performance is what cable must shoot for.

- Identify failures before service is disrupted.
- Clean up the return path.
- Find slowly degrading signals.
- Speed repairs by quickly finding the root cause of a failure.
- Monitor the most critical part of your plant—the headend.
- Simplify Federal Communications Commission compliance and test year-round.

3) Find slowly degrading signals. With performance monitoring hardware and a powerful software system, system operators can complete trend analysis on plant performance. Testing for signal distortion, as well as levels, gives system operators a more complete picture of what their subscribers are seeing. Measurements should be performed in-service, allowing system operators to continuously monitor important parameters such as carrier-to-noise and composite second order distortions without interrupting service.

4) Speed repairs by quickly finding the root cause of a failure. It is inevitable that network elements will fail. The problem system operators typically face is identifying the source of the failure. It is impossible to maintain high availability if it takes hours to identify the source of a failure. While some simple monitoring systems may not have the capability to identify the root cause of a failure, a comprehensive network monitoring solution—complete with automated status and performance monitoring systems—will allow cable system operators to target truck rolls directly to problem areas.

A powerful filtering system needs to be embedded in the monitoring software that sorts through alarm storms. For example, a failure of a node will cause all active devices beyond that node to "fail," as well. The monitoring system should have the capability to identify the node as the most likely cause of the failure. This will significantly improve response times.

5) The most critical part of your plant—the headend. When a failure occurs in the headend, the entire plant, or a significant portion of it, may be affected. Nothing damages availability ratings quicker or more significantly than broad-scale failures.

A monitoring system should immediately alarm on failures in laser transmitters and other critical headend devices. This must be integrated with the multi-vendor distribution plant monitoring and offer correlation of alarms.

6) Simplify Federal Communications Commission compliance and test year-round. The FCC never intended operators to be in compliance only two times a year. The mandatory, biannual tests were intended as a minimum test requirement to document year-round compliance. Today's new technical services make these testing requirements alone an inadequate benchmark.

System operators need an automated monitoring system that will continuously test the plant so that they can ensure high-quality performance—at or above FCC requirements—all year long. CT

Gordon Greenfield is vice president/marketing for Superior Electronics Group.

An Architectural Summit
Jones Shares Lessons

By Pam Nobles

His coffee was stale and cold, but he took a sip anyway as he poured over the maps one more time. The windows were dark. It was finally quiet in his office. Corporate wanted to see another design scenario to justify his rebuild budget. It's hard to sit down and think about design models and powering when he has a system to run. "Too many hats," he thought. "I'm just spread too thin."

He wished they would come to a decision—any decision. Either determine how to do the rebuild and move forward, or just let him go back to the job he knows best—running his system. If he had stronger guidelines to work from, he would feel a little more confident. He wondered what other systems do...

Sharing lessons

Innovation and creativity have always been a source of pride for the cable industry. Many, many lessons have been learned from the trial-and-error way in which we have worked. In the face of competition, however, the old trial-and-error way of doing business will no longer suffice; the risk is too great. We need to move quickly; we need to be able to balance unique solutions with proven best practices or standards. Sharing lessons learned between operating systems has always been practiced at Jones Intercable. We want to formalize this process through our Architectural Summit.

The purpose of the Architectural Summit is to share the lessons Jones associates have learned and provide a path to get there. A select group of Jones engineers and managers is meeting in Orlando, FL, this month two days prior to SCTE's Cable-Tec Expo. Here we will discuss our company's bandwidth migration philosophy with respect to RF, powering and fiber. We will equip our engineers with the tools for successful implementation.

Since this article was written prior to the early-June Summit, it will focus on events leading to the meeting and how Jones plans to share lessons learned, both within the company, and with the industry. Additional conclusions will be shared in future issues.

Why the Summit?

Competitive forces, technology, regulatory issues and a customer focus have all caused Jones Intercable to fine-tune its business strategy and philosophy. A company Strategic Action Team was charged with this task, and in October 1996, presented an implementation plan for all corporate department teams to emulate. Departments were instructed to do whatever was necessary to align their teams with the new business direction. So, "no sacred cows." Department team strategies were completed early in 1997.

An outcome of this strategy is a new corporate structure that allows the corporate leaders and specialists to work more directly with the systems. A team within this new structure is charged with the introduction of the company's bandwidth migration philosophy, an upgrade and rebuild plan.

Migration philosophy

In the past, we knew that new channels and services would be needed to meet our customers' future needs, but how much is enough? As technology evolved, our systems built extensions to existing cable plant to 330 MHz, to

> **BOTTOM LINE**
>
> **Lessons to Be Learned**
>
> Competition, technology, regulatory issues and a commitment to improving customer perceptions of reliabilty have led to a slew of lessons learned in the cable telecommunications engineering arena.
>
> Some in the technical community have called for cable's system engineers—regardless of MSO affiliation—to make a **renewed commitment** to sharing solid engineering practices as the industry moves into delivering new services.
>
> In its early June "Architectural Summit," major MSO Jones Intercable will bring together a select group of its engineers and managers to discuss the company's **bandwidth migration philosophy** with respect to RF, powering and fiber.
>
> **What does this mean to engineers outside of Jones?** What makes the meeting interesting to everyone in the cable engineering community is Jones' commitment to sharing knowledge gained at its summit. Watch the pages of this magazine for more...

400 MHz, 450 MHz, 550 MHz and now to 750 MHz, with some anticipation, but with little definition as to the services this extra bandwidth would carry.

Jones recognizes that a strategy for project pre-engineering and management is necessary for the company to be successful in this area. We need to define who we are and what we stand for, and develop our rebuild guidelines from there. Are we Nordstroms or Wal-mart, or somewhere in between? Are we on the "leading edge," or will we allow others to take the initial technological plunge?

> "It's people, not technology, that gets the job done."

What we have come up with is a philosophy, supported by our new corporate structure, of being a fast but cautious follower of new technology. Considering the stories of past successes and failures of systems that have endeavored to take on large construction projects as well as corporate-sponsored research, we are developing a bandwidth migration plan. This plan will document guidelines for increasing bandwidth for upgrades and rebuilds as related to RF, fiber, and powering. This plan, still evolving, is the focus of the Architectural Summit.

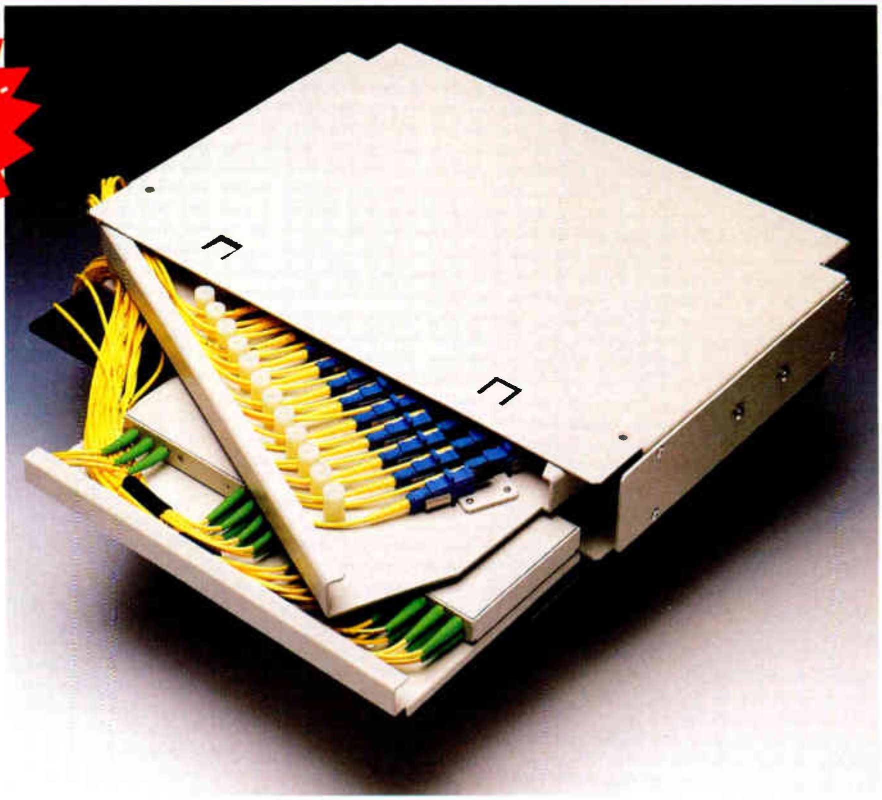
Share lessons learned

The Summit is slated to kick off with our philosophy. Drivers of the strategy, current and future businesses and services, will be explored, as will how to balance the cost of unused bandwidth with the prospect of future services. In addition to the bandwidth migration plans, guidelines for selecting and managing contractors will be reviewed. Each topic will be covered in enough detail so a system can immediately apply what is learned.

Associates targeted for the Summit include regional engineering directors and managers, construction and project

Solve Your Headend Management Problems

A new product announcement from the Fiber Optics Division of AWC - Adirondack Wire and Cable.



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CATV Fiber Optic Management Hardware

CATV Fiber Optic Distribution Shelf –
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Adirondack Fiber Optics Division introduces the **Headend Manager™**, a compact fiber-optic distribution shelf designed for CATV headend installations. It specifically was designed to distribute signals from a headend or feeder to the Outside Plant, node or other locations. The **Headend Manager™** is an integrated termination, splice, and coupler housing with customer-designed configurations for various signal splittings of (6) 1 x 4, (8) 1 x 3, (12) 1 x 2 and others as required. Overall shelf dimensions are 2.5 inches high and are easily rack mountable in standard 19" or 23" equipment bays and racks.

It features a swing-out termination drawer with capacity for up to 24 bulkhead interconnections. A platform shelf has the capacity for two (2) splice trays /24 fusion splices. The unit also has a pull-out coupler/splitter module drawer and has hinged front and rear covers for easy access to all connection and splice points within the cabinet.

Terminations are offered in industry standard APC/FC or APC/SC configurations, all meeting high performance single-mode values of -65dB Return Loss, -0.25 dB Insertion Loss, and Bellcore GR-326 compliance.

Adirondack Fiber Optics Division can provide all passive components from the splitters, interconnects, APC/FC or APC/SC pigtails and fully tests the cabinet prior to installation. Another innovative product to save time and money, but more importantly, to **effectively and efficiently "manage" fiber optic distribution within the CATV headend.**

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managers, and system engineering managers. The key associate to the success of any system's project is the project manager. All major rebuilds will be managed by a project manager specifically dedicated to the project. This person is the common denominator in all projects and the link back to the corporate specialist team. Since the project manager will concentrate his or her efforts on the project, the project manager frees the system engineering manager to run the system. The profile of our ideal project manager will be discussed at the Summit so systems will have guidelines for their search for this person.

Lessons learned include research that corporate has sponsored. Early in 1997, Craig Beesley and Jones Intercable's Network Design Group completed research to examine different powering methods, and recommend a powering strategy for the company to use when powering cable systems.

Experience also is an important ingredient when sharing lessons learned. Jim Williams of Jones has used his experience and talents designing headends to compile a comprehensive plan for others to follow. The conclusions of his work also are published in this issue of *Communications Technology* on page 168.

Importance of leadership

We recognize at Jones that people are more than company assets. They are unique, emotional, creative individuals, needing relationships, all with their own gifts, all wanting to have purpose in their

The Jones Companies' strategy

- **Vision.** We will be recognized and sought after for the value we create for our customers, associates, and investors.
- **Mission.** To provide profitable delivery of high value entertainment, education, communications and information products and services to our target customers.
- **Values.** Customer focused, speed, results and respect.

The Jones values, which characterize the Jones leader of the future, include:

- Providing outstanding customer service.
- Building a learning culture.
- Working with imagination and quality (the Jones "IQ").
- Embracing change.
- Practicing participative self-management.
- Predisposition to attack opportunities.
- Appreciating diversity and individual differences.
- Encouraging teamwork.
- Achieving integrative thinking.
- Creating intangible leveraging.

lives. A goal of our leaders is to create an environment that allows associates to flourish, one that allows us all to use our unique gifts.

Leaders lead by creating an environment of self-management, where motivation factors—achievement, recognition, challenging work, responsibility, and growth—are intrinsic to a job. Leaders instill a sense of significance, an experience of equality, a contagious enthusiasm, a commitment to growth, and a unifying passion. Leaders create a vision to be shared. Shared ideas and beliefs become duties to which people willingly respond. This is the type of environment we hope to create at the Architectural Summit and throughout Jones. The accompanying sidebar further details Jones' corporate strategy and values.

Values and stories

The Summit also provides an opportunity to strengthen the values by which Jones operates. Although the Jones values are known by associates, they can be made stronger through face-to-face interactions. Stories can be used to strengthen these interactions. Associates need a forum where they can ask questions and synthesize their learning. All associates, existing and new, need to be aligned with the company's overall culture and philosophy.

Why stories? One could look at life as a story, in which we all have a role to play and contributions to make. Stories carry the shared culture, beliefs and history of a group, and can therefore install values and promote a group's philosophy. In order to know where we are going, we need a starting point. Stories provide the initial vision, create this common experience, and give us all something in which to believe. Sharing the stories of successes and failures is a theme woven throughout the Summit.

In his book *Leadership is an Art*, Max DePree, CEO of Fortune 500 company Herman Miller, relates a story of a Nigerian village that just received electricity. Every family had a single light bulb and soon light bulb watching started to replace the nighttime gatherings at the tribal fire, where storytellers would pass on the history of the tribe. He goes on to say that every corporation needs a tribal storyteller. The penalty for failing to listen is to lose one's history and values.

It is everyone's job to ensure that things like light bulbs (e-mail and procedure manuals) do not replace our company storytellers. Jones needs to have "tribal storytellers" to keep the culture alive, and develop and tell their own success stories. At the Architectural Summit, we will be these tribal storytellers, and in this way, continue to share lessons learned. It's people, not technology, that gets the job done. CT

Pam Nobles is manager of technical development for Jones Intercable.

The 90 VAC Solution

Powering Needs Considered In MSO Study

By Craig Beesley

We've all heard from power supply vendors or read in the trades that 90 VAC network powering needs to be considered. The information looked promising, but we wanted to know how it would work in a our systems. That's why Jones Intercable initiated an extensive 900-hour study that examined the powering of 1,500 mile of hybrid fiber/coax (HFC) network. The objective of this study was to examine different network powering methods and recommend a powering strategy that would balance reliability and cost.

This article will discuss the results of the study, factors and issues that need to be considered when looking at higher voltages and centralized powering designs, and outline our powering strategy. Early on we recognized any powering strategy would need to consider the investment in 60 volt distributed power since it has been an industry standard for over 15 years.

Study details

We started the project by selecting 40 miles of a newly rebuilt HFC network. The 40 miles was divided into 20 miles of typical urban (100 homes per mile) and 20 miles of rural (35 homes per mile). We designed the 40 miles of plant with the following six powering scenarios:

1) Traditional 60 VAC distributed cable powering
2) 60 VAC distributed cable with 30% penetration cable phone
3) 90 VAC distributed cable powering
4) 90 VAC distributed cable with 30% penetration cable phone
5) 90 VAC centralized CATV
6) 90 VAC centralized cable with 30% penetration cable phone

The system design criteria of the modeled network included the following:

- Designed at 550 MHz analog and spaced at 750 MHz
- Two-way activated HFC plant
- Urban node size modeled at 500 homes per node
- Rural node size modeled by RF cascade distortions
- End-of-line signals designed at carrier-to-noise (C/N) = 49 dB
- Composite second order (CSO) = -52 dB, composite triple beat (CTB) = -52 dB, and cross modulation (X-mod) = -52
- Power inserter device (PID) total power consumption = 3.06 watts
- Minimum voltage at active = 42 volts
- Minimum voltage at PID = 40 volts

This 240 miles of power design demonstrated that in both rural and urban networks, increasing the voltage from 60 to 90 volts reduced the overall system current draw by 34% as illustrated in Figures 1 on this page and 2 on page 164. This could allow the systems to be designed with a greater reach from the power supply. There was no difference in the current draw for the 90 volt distributed and

Figure 1: Network current draw (urban)

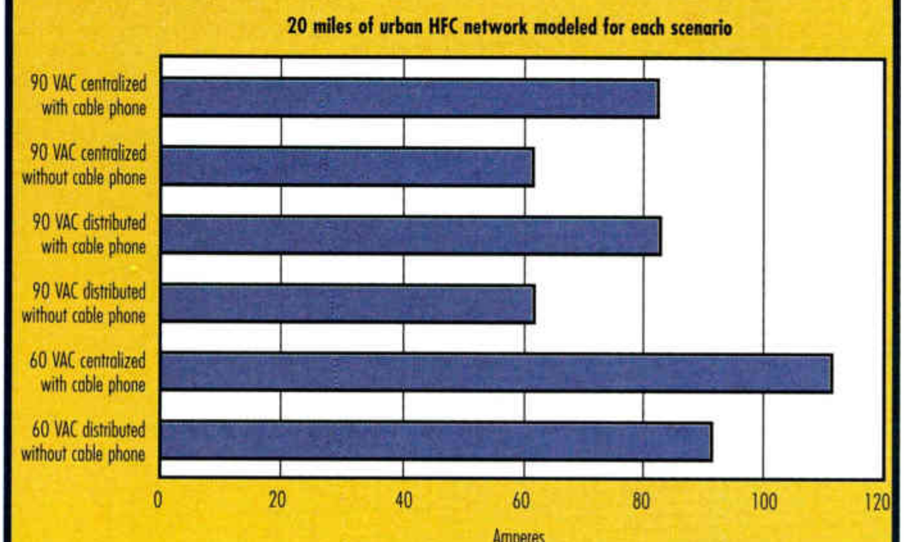
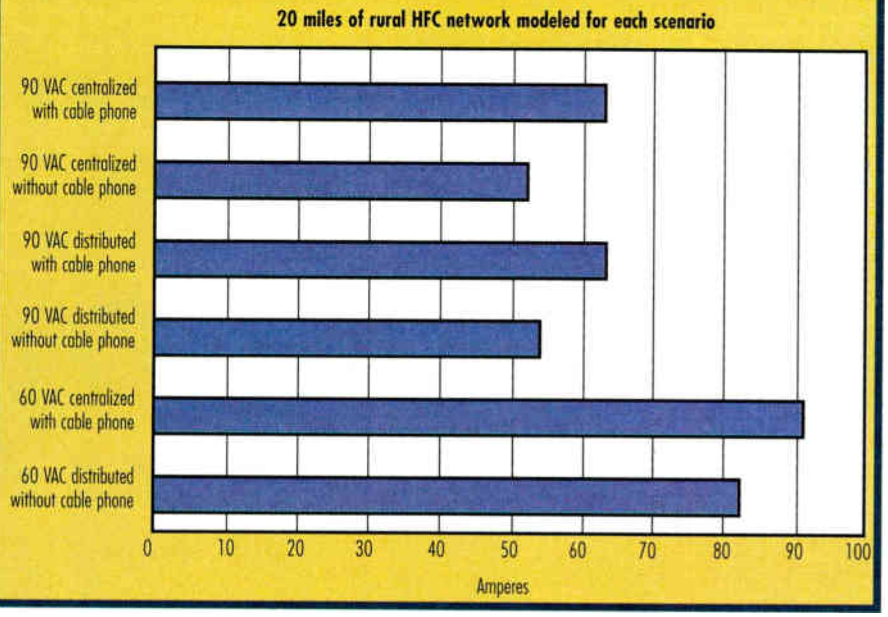


Figure 2: Network current draw (rural)



centralized designs. However, by designing with a centralized approach the number of power supply locations was reduced by 50% in the urban scenario and 43% in the rural scenario compared to distributed 60 volt scenarios. The reduction was even greater when cable phone powering was included in the design as illustrated in Figure 3.

Design/service balance

There is a trade-off between designing a cost-effective powering system and improving reliability that must be balanced based on the types of services you're going to provide. Our study compared the cost of the equipment and labor to install for traditional battery backup 60 volt and 90 volt distributed powering, and 90 volt centralized powering, with and without cable phone, for urban and rural areas. It also compared the cost of 90 volt systems that were provisioned to have generators installed. Only one cost study is shown for 90 volt powering with cable phone. The cost per mile for different powering scenarios, which are shown in more detail in the accompanying table on page 167, ranged from $801 to $3,536. The major cost difference was due to the installation of backup generators to provide cable phone services.

After we completed the initial study of 240 miles of network powering, we wanted to confirm the 90 volt centralized powering results on a complete system to ensure we would see the same efficiencies. This portion of the study included 325 miles of HFC network with the same system criteria as listed earlier in the article. We started with 60 VAC distributed powering as a baseline, then designed with 90 VAC centralized powering with and without cable phone. We also determined that a migration strategy should be considered for some systems that are upgrading their network in incremental steps. Since a number of the 90 volt power supplies are designed with 60, 75 and 90 VAC power taps, we wanted to look at a migration strategy that would implement a higher voltage design over time. This would allow existing 60 volt power supplies to be used. New higher voltage power supplies could be installed and operated at 75 VAC until the system was ready to migrate to 90 volts.

This part of the study realized a 33% reduction in overall system current draw between the 60 volt system and 90 volt powering system, which was only 1% change from the initial 240 miles studied. The 75 volt powering had a 21% reduced current draw compared to the 60 volt system. The number of power supply locations for 90 volt centralized powering was reduced by 60% compared to the 60 volt powering. This was a 10% greater reduction over the previous models. The greater reduction was accomplished by finding power supply locations that could feed more than one fiber node.

Reliability

Reliability must be a consideration in choosing any powering design. The amount of powering reliability will depend on the types of services provided, and customers' expectations. For example, if lifeline services are planned, you must meet telephone industry standards for availability as outlined in Bellcore Technical Advisory, TA-NWT-000909, which states that eight hours of battery reserve backup must be available. In the case of more traditional cable systems that provide video programming and data services, competition and your customer will be the driver for higher reliability. Methods that increase power supply reliability include:

- *Uninterruptible power supply (UPS).* This provides consistent power to the equipment through batteries in the event of the loss of AC line power.

BOTTOM LINE

The 90 VAC Option

Jones Intercable recently completed a 900-hour study that examined the powering of 1,500 mile of hybrid fiber/coax (HFC) network. The much talked about 90 VAC option was part of the study.

Is 90 VAC the way? Jones concluded there were several pros and cons. **Positives?** Design reach is 35% greater than 60 VAC, equipment and installation for 90 volt powering with traditional battery backup costs the same as 60 VAC, power supply locations are reduced by 50%, and more.

Negatives? More stringent safety procedures are needed, powering at 90 volts may be an issue in meeting National Electrical Code (NEC) voltage limits when powering home-premises devices from the coax drop, power supply locations are more costly and more difficult to obtain permission due to their larger size, and more.

- *Power supply status monitoring.* This is an excellent way to receive feedback from the network powering system rather than using the customer as your monitor. An example of this would be an alarm that indicates when a power supply switches to the battery backup because of a utility feed failure. This would give the operator an opportunity to determine the nature of the outage and prepare to deploy a mobile generator if necessary.
- *Power supply redundancy.* This provides an N+1 feature. This N+1 is an extra power supply housed within the cabinet that automatically switches over the power load upon failure of one of the active supplies.
- *Independent sources of input power.* These are a type of redundancy that can be utilized if the power supply is located in an area that can tie into two power grids.
- *Extended standby backup power provided by a permanently housed generator at the power supply location.* This would provide long-term backup. This type of reliability would be used for lifeline services.

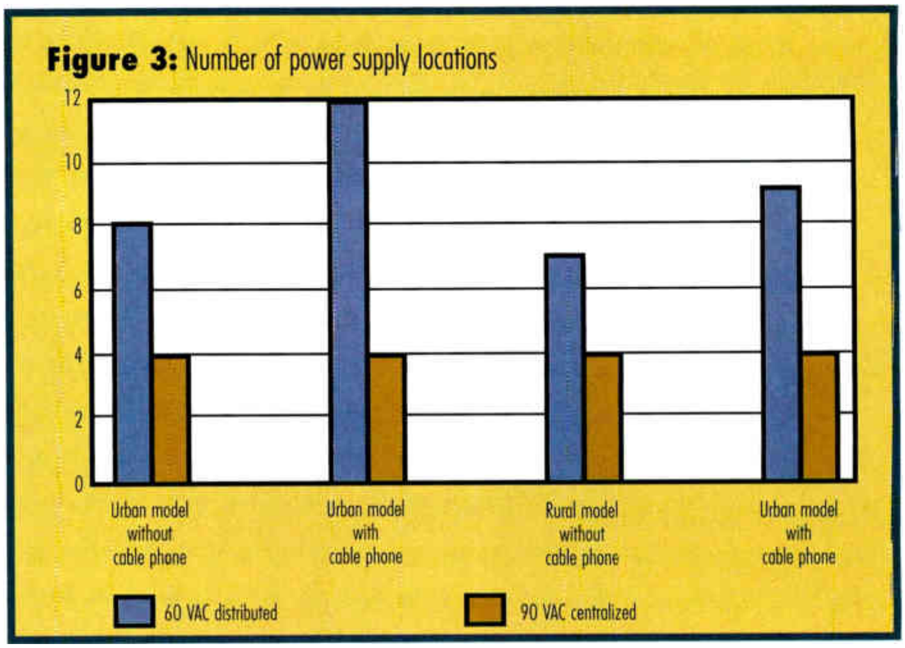


Figure 3: Number of power supply locations

Centralized powering is another way to increase reliability. In centralized powering, power supplies are located at a central point in the system. In most cases, there may be more than one power supply co-located.

Express power cables (dedicated low-loss cables from the power supply to the inserter location) may be used to insert power further down the system, or into another fiber node. Centralized powering will reduce the

Understanding 90 Volt Centralized Powering

Advantages

- Design reach is 35% greater than 60 VAC
- Equipment and installation for 90 volt powering with traditional battery backup costs the same as 60 VAC
- Power supply locations are reduced by 50%
- Typically one power supply location per node
- Fewer permits needed due to power equipment co-locations
- Low mean time to perform power supply maintenance
- Easier to deploy portable generator for extended power outages
- Provides for incremental deployment of capital as business grows
- Multiple modules share cabinet (RF, power and fiber-optic equipment)
- Generator backup capability

Disadvantages

- More stringent safety procedures needed with higher voltage
- Powering at 90 volts may be an issue in meeting National Electrical Code voltage limits when powering home-premises devices from the coax drop
- It may not be more efficient to operate 90 volt powering if additional voltage is burned up in cable resistance
- Power supply locations are more costly and more difficult to obtain permission due to their larger size
- Centralized power supply locations could cause a larger area outage than distributed powering
- Existing actives and passives may not be able to handle 90 volt powering (replacement might be necessary)

Initial equipment cost is higher

- Cost and reliability/maintenance of express power feeder must be considered
- Old 60 volt power supplies must be redeployed elsewhere, sold or thrown away

number of power supply locations. If proper design is used, fewer power supply locations means improved reliability, making it easier to maintain and less costly. It's important to limit the length of express power feeder cable to the shortest length as practical. The longer the express cable, the greater the cost of installation, maintenance and a greater chance of a service outage problems.

Design considerations

When upgrading or rebuilding a system with 90 VAC centralized powering, there are many design considerations. Examples include finding locations to place larger power supply cabinets; the need for standby generators; the length of express power feeder cables; and power supply efficiency ratings.

Finding locations for larger power supply housings can pose a problem. This requires more planning during the design to ensure space is available in the field. Aerial installations may be impossible or impractical for a centralized powering design. If generators are going to be installed, the noise levels may be a problem to customers or potential customers. Generators will also require a fuel source such as natural gas or propane.

Express power feeder cable will be used in centralized powering to deliver the AC to power inserters located farther down the system, as well as possibly another fiber-optic node. Express power feeder cable should be kept as short as possible and should not be designed to exceed a voltage drop greater than 30 volts. At this point, the 90 VAC power design upgrade is back to ground zero with the existing 60 VAC design, canceling the benefits of an increase in available voltage. Power express cables will also add to the cost of centralized powering. There is the initial cost of the cable plus the labor for installation that will vary depending on the length and type of cable.

The RF equipment AC power passing capabilities is a very important factor to note when designing centralized powering. The AC current-passing capabilities of both the active and passive RF equipment must be considered. The AC current limit of RF equipment is the primary reason for using a power feeder express cable. These AC current limitations vary between vendors and will greatly influence the power design. Generally speaking, power inserters pass 15 amperes through the input port and 10 amperes through each output port. However, there are vendors currently offering equipment with 20 amperes per input and 15 amperes per output port. The average current-passing capability for RF actives is 15 amperes; 10 to 15 amperes for RF passive splitters and couplers, and 10 amperes for power passing taps is 10 amperes. The taps' power-passing limitations did not pose a problem in any of the models we studied because power was never inserted directly into the tapped distribution feeder.

The power supply efficiency rating also will effect the cost-effectiveness of the power design. Systems that are considering upgrades or rebuilds that require additional equipment loading going forward (such as changes due to cable phone) should consider better performance types of power supplies. Load variations have not been a concern with our traditional cable systems. Traditional 60 VAC and 90 VAC power supplies with standard ferro type designs are more load-dependent. These power supplies run at about 85% efficiency with a load of 50% load to 90%.

Powering strategies

Powering has taken on a greater role as we upgrade and rebuild our networks because of the increased cost of powering, more sophisticated wider bandwidth HFC, full service networks (FSNs) and the need for improved reliability. Network powering can no longer be viewed as just the final step in system design.

Today's power design must be planned to fit the needs of the network today and capable of fitting the needs of the network in the future. We have identified three basic power design strategies: maintaining distributed 60 volt powering, migrate to higher voltage and centralized powering over time, or move to 90 volt centralized powering. Based on this study we have established the following guidelines for the powering design:

Equipment and installation labor for powering scenarios

	Urban Scenario (100 homes/mile) Cost per home passed	Rural Scenario (35 homes/mile) Cost per mile	Cost per home passed	Cost per mile
60 VAC distributed Typical battery standby	$9	$809	$19	$801
90 VAC distributed Typical battery standby	$11	$949	$22	$924
90 VAC centralized Typical battery standby	$9	$810	$17	$709
90 VAC distributed Typical battery standby provisioned for generator	$22	$1,920	$45	$1,866
90 VAC centralized Typical battery standby provisioned for generator	$14	$1,231	$32	$1,309
90 VAC centralized Designed for cable phone Battery standbywith generator	$40	$3,536	$72	$2,971

- If there are not plans to upgrade or rebuild a system, continue to use 60 volt powering. However, install 90 volt capable power supplies with standby battery backup and operate at 60 volts that will prepare you for powering upgrades.
- Consider using 75 VAC (centralized or distributed drop-in) or 90 VAC centralized powering when upgrading a 300/330 MHz network to 550 MHz and when upgrading a 400/450 MHz network to 550/750 MHz.
- Design 90 volt centralized powering when rebuilding any network to 750 MHz.
- Design 90 volt centralized powering with provisions to install generators if cable phone is going to be deployed.

Conclusions

After completing this study we have come to a number of conclusions with respect to the advantages and disadvantages of using 90 volt powering. However, the study also raised a number of operational and safety questions that we are working through. This is because of the uniqueness of each system's existing architecture and services provided.

Our study yielded several advantages and disadvantages of 90 volt centralized powering that you can apply to your own specific applications. (See the sidebars on page 166.) CT

Craig Beesley is network design analyst at Jones Intercable.

By Jim Williams

Design Your Headend Step-By-Step

Headends are becoming more complex with narrowcasting, redundancy, additional video channels, additional services and system and headend consolidations. Faced with these headend challenges at Jones Intercable, we have come up with an approach that can be applied to any headend design. This article will help you design today's headend while planning for the future. It will provide a step-by-step approach to designing a headend by directing you to consider, in sequence, equipment, space, electrical and air-conditioning requirements.

BOTTOM LINE

One Step at a Time

It is most effective to use a **step-by-step** approach when you undertake the design of your headend. Remember to consider, in sequence, the equipment, space, electrical and air-conditioning requirements.

First, use simple worksheets to create a **channel lineup**, then a **racking schedule**, **component list** and **rack facials**.

The rack schedule is the most important worksheet in your headend design and plan. It contains information for the architects, mechanical engineers and electrical engineers.

The approach starts with a channel lineup. It then takes into account each of the following: compiling a racking schedule, component list, test equipment list, creating rack facials and a floor plan. Over-the-air signals, satellite signals, cable types, labels, access flooring, grounding, uninteruptable power supplies (UPSs), generator, surge protection, fire protection, headend controls, and alarms are all taken into consideration.

Getting started

Start with the proposed channel lineup. The first step is to create a spreadsheet on which you will list the channels and their frequency assignment followed by the equipment necessary for that channel. The equipment should include modulators, demodulators, descramblers, scramblers, stereo encoders, satellite receivers, etc. If commercial insertion, cross-channel promotion, FM or any other channel or frequency specific equipment is required, list it on this spreadsheet. When receiving signals direct via microwave or fiber consider if you need a backup processor or demodulator.

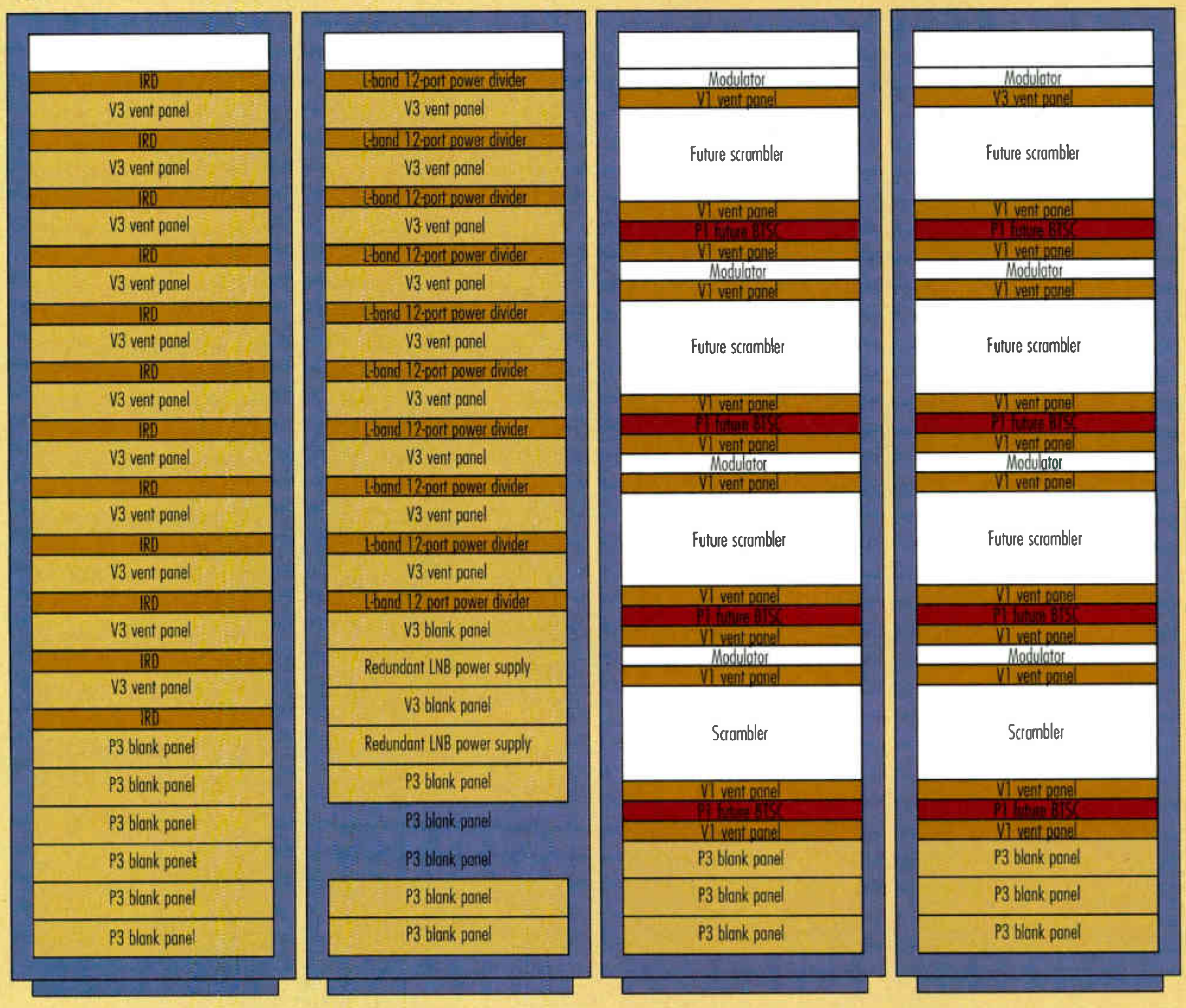
If a channel lineup is not available when you start, list the quantity of channels you think you'll be dealing with. Start the spreadsheet, leaving the program source blank and list modulators, etc. You will need a finalized channel lineup to complete your equipment list.

Racking schedule

Next, you'll want to create a racking schedule spreadsheet. This is the most critical stage. It will provide information for the architects, mechanical and electrical engineers. On this spreadsheet list each rack and the contents. Also, list the electrical requirements in volt amps (VA) for all the equipment in each rack. The equations that follow are used to calculate UPS size, generator size and air-conditioning requirements based on the electrical requirements for each rack. The average rack in a headend consumes 25 square feet of floor space, so additionally list and compile 25 square feet per rack on the racking schedule spreadsheet.

Rack 1 should be the first rack from the standpoint of signal flow in the headend. Begin by listing satellite receiver and demodulator racks. Continue listing the remaining racks with equipment just as signals would flow in your headend: FM equipment, (analog and digital) commercial insertion, modulators, combiners, fiber-optic transmitters and fiber management hardware. Don't forget test equipment, audio video router (if used) and patch panels. I install a patch for the output of each source and locate all patch panels near the test equipment. If you plan to use an access floor, also list the size of the cut out required for wiring and air flow below each rack.

Figure 1: Rack facials



Do some calculations for estimated electrical and air-conditioning requirements. Calculate the UPS size required for the headend racks. Divide the total VA (44,400) by 1,000, to convert to KVA. It is common practice that the UPS be sized 1.5 times the total KVA requirement. (See Table 1 on page 172.)

VA/1,000 x 1.5 = UPS requirement (KVA)

44,400 VA/1,000 x 1.5 = 67 KVA

Use the total KVA to calculate air-conditioning requirements. KVA times 3.412 divided by 1,000 equals kilo British thermal unit (KBTU) which is a measure of heat. Divide KBTU by 12 and you have the air-conditioning requirement in tons.

Total KVA x 3.412 = KBTU/12 = Air-conditioning requirement (tons)

44 KVA x 3.412/1,000 = 151 KBTU/12 = 13 tons

Consider some redundancy for air-conditioning. In a recent headend we installed three units. Two will handle the requirements, so we have 50% redundancy. Additionally, consider actual air flow within the headend. The best approach is to distribute conditioned air above the racks with ducting, use an access floor for the return air. Work with the electrical engineer to size the generator. It should power the racks/UPS, air-conditioning, lights, etc. Consider future growth requirements to decide what you should install today. You also should consider fuel requirements, the type of fuel and duration of generator run without refueling.

Component list

On this component worksheet, list all antennas, racks, electronic equipment and contract labor required to assemble the headend. (excluding labor and materials for the facility: building, electrical and air-conditioning equipment). List unit cost, quantity required, total cost per item and grand total. Be sure to include an estimate for tax and shipping. It's a good idea to include a small contingency (5%); some project managers believe in as much as 20%. However, the better you plan the less contingency you'll need. Create another worksheet similar to the component list if you plan to add or replace test equipment. I like to keep the test equipment costs separate from the actual headend costs.

Rack facials

Based on the racking schedule create rack facials, to represent what each rack will look like. This can be done in a computer-aided drafting (CAD) program, or graph paper to sketch the rack facials. (See Figure 1 on page 169.) Use the standard rack units of 1.75 inch. While creating the rack facials begin thinking about how the headend might change in the future.

Leave enough space for obvious changes. For example, leave space for the largest satellite receiver you will use. You may want to leave space for a scrambler and BTSC encoder for each channel.

Using tall racks will save floor space. I use eight foot racks for most headends, which have 55 rack units of space available. Be sure to leave spacers between each piece of equipment for cooling and working space.

Floor plan

Now you need to plan how the racks will be arranged within the space. You should have a good idea what the room size will be based on the total square footage from the racking schedule. Keep in mind cable lengths when laying out the floor plan. Good engineering practices dictate you should keep RF, video, and audio cable lengths under 100 feet inside the headend.

> "When receiving signals direct via microwave or fiber consider if you need a back-up processor or demodulator."

Again, either graph paper or a CAD program will work to lay out the racks on the floor plan. I usually work closely with the architect who is building or remodeling the headend at this point. The architect must show air handlers, lights, electrical equipment, racks, workbench, storage and any other requirements. This is another area that you can plan for the future by leaving some well-placed racks vacant. If possible, leave space for one to four racks at the end of each bay or row. (See Figure 2 on page 171.)

In building a recent headend, we used a different approach for the overhead lighting. Normally lighting is installed above and between each row of racks. We installed it diagonally several feet above the racks. This provided very good lighting without causing shadows or dark areas.

Over-the-air signals

After verifying signals with a field survey (done yourself or by a professional service) use another worksheet to calculate losses from the antenna location on the tower to equipment in the headend. This will help you determine cable size and if pre-amps are needed for any channels. Consider installing a broadband VHF/UHF antenna on a rotor as a spare. (See Table 2 on page 172.)

Satellite signals

A professional service can be used to survey the satellite receive location. They will calculate the minimum dish size required. At this point you should create another worksheet for calculating total losses from the antenna's low-noise block (LNB) to the receivers.

This needs to include splitters, jumpers, power inserters and cable. Vary the cable size to stay within the loss budget allowed. 20 dB of total loss from LNB to receiver is a good rule of thumb. This will provide an acceptable intermediate frequency (IF) carrier-to-noise (C/N) of 15 dB and a video signal-to-noise (S/N) of 54 dB.

Consider installing an extra dish—one that is on a remote controlled polar mount that can be used for special feeds or as a spare antenna. Also consider installing an AC power outlet near the antennas for testing and general maintenance. Consider de-icing for the antennas.

Cables and labels

The best advice for cables and labeling is to keep it simple. Do not create a complex paper wire list that must be updated each time a wire is added, deleted or moved. Color-code all the wiring; blue for video, black for RF, orange for IF, etc. Use good quality drop cable and connectors for RF. We use quad shield and compression F-connectors. Use video cable for all the video wiring. For audio use red and white for right and left and use red only for monaural signals.

Table 3 on page 172 shows a complete listing of the cables we use:

Label wire ends for the equipment and connector they are attached to. We utilize a four-digit sequence with the first two digits indicating the patch panel number, and the last two digits indicating the patch number within that panel. Number the modulator outputs with two digits representing the actual channel number.

> "Consider installing an extra dish — on a remote controlled polar mount for special feeds or as a spare antenna."

Access floor

An access floor will provide space for all wiring and keep everything neat and orderly. When using an access floor, use the space under the rear of each row of racks to run coax and audio wiring. This is where most of your work in the future will occur, so keep it uncluttered. Use the space under the front of the racks for electrical and ground connections.

If you do not have the space for an access floor, use good quality wire ladders. They are available at electrical supply houses. You should mount them directly above each row of racks with laterals connecting them to adjacent rows. Also mount the electrical and ground buss on the rear of each. Ensure that you consider weight loading when sizing wire ladders for ceiling attachment.

Grounding

A building ground should be established and tested with a Megger to be less than 5 ohms. Tie all grounds together: building, electrical, tower, dishes, racks and even the outside fence if it is metal. ➤

Figure 2: Floor plan

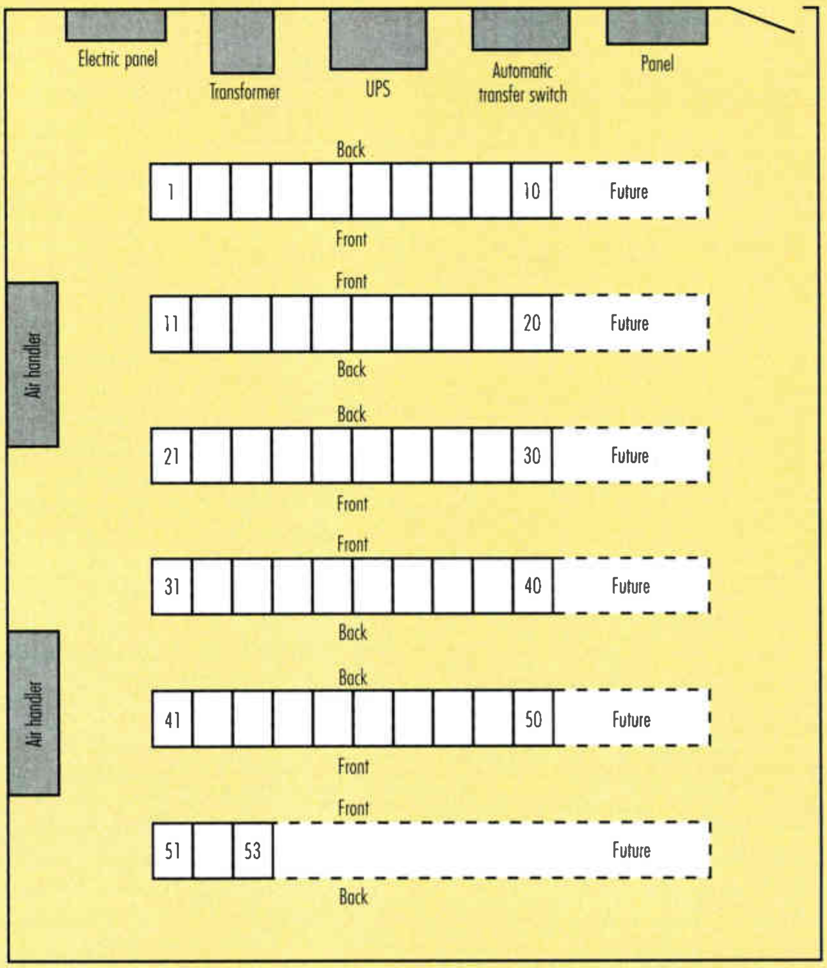


Table 1: Sample electrical/air-conditioning requirements

Racks = 53
Space = 1,325 SF
Power = 44 KVA (VA/1,000)
PWR (PF.85) = 38 KW (VA*.85)
UPS Size = 67 KVA (KVA*1.5)
Air-conditioning = 151 KBTU (KVA*3.412/1,000)
Air-conditioning = 13 tons (KBTU/12)

Table 2: Loss calculation samples

Channel Level	Frequency (MHz) Gain required	Level	100-foot loss
2	55.25	4.9	0.44
4.5	0		
6	83.25	7.9	0.58
7.3	0		
9	187.25	19.6	0.90
18.7	0		
24	223.25	12.6	1.58
11	0		

Table 3: Headend cables used by Jones

RF	Quad RG-6, Black
IF	Quad RG-6, Orange
Phaselock	Quad RG-6, White
Video	Belden 1505A, Light Blue
Commercial insertion	Belden 1505A, Yellow
Composite and/or 4.5	Belden 1505A, Gray
EAS	Belden 1505A, Red
Right audio	Gepco 61801, Red
Left audio	Gepco 61801, White
Control and/or data	Gepco 61801, Green
Power	14-gauge, Red

I have the electrician install a ground buss under the floor or on the overhead wire ladder and ground each rack to it individually. For low-maintenance have the electrician exothermic-weld all copper ground connections. I also have the electrician install a copper bulkhead to terminate all outdoor metallic cable. The bulkhead also is used to transition from outdoor coaxial cable to indoor cable. Consider lightning protection if you are in a high-lightning area.

Surge protection

Install surge protection on the incoming electrical service and the generator. Size the UPS to handle all electronic racks. I also install a generator so the UPS only need last until the generator starts or about 15 minutes. The air-conditioning should be fed from the generator, not the UPS.

Fire protection

Halon, the typical fire protection system used in many headends, is no longer considered safe. However, there are some replacements for it that are now available. The last two headends we built use a "dry system" combined with an early warning smoke detection system.

This type of system requires both smoke and heat to set it off. Water will be dispersed only where the heat has been detected in conjunction with the presence of smoke detection in the space.

Controls and alarms

Consider what you need alarmed and who will be notified by what means. Install at least minimum alarms for air-conditioning, security/intrusion, fire/smoke, UPS, generator and transfer switch.

Conclusions

Headends are becoming more complex and increasingly difficult to accommodate changes and additions. The approach just described has been successful.

With good planning, you can build a headend today that will accommodate changes in the future. The key is following the step-by-step approach: use simple worksheets, begin with a channel lineup, move through a racking schedule, component list and rack facials. Finalize electrical, air-conditioning and space requirements with suggestions relating to the use of hired architects and designers.

The author would like to thank John Lineberger, John Coons and Pam Nobles for their contributions to the Jones Intercable headend specification and to this article. CT

Jim Williams is the manager of product evaluation for Jones Intercable.

Five Considerations for Advanced Product Vendors

By S. Michael Johnson

This article focuses on five technical challenges and potential solutions that manufacturers should emphasize while designing products for advanced communications networks.

This article focuses on five technical challenges and potential solutions that manufacturers should emphasize while designing products for advanced communications networks.

1) Interoperability

The issue of interoperability has been addressed over the past few years through numerous standards groups, but many factors still remain up in the air. Vendors not only need to address interoperability between manufacturers, but interoperability within their own systems.

In a cable headend, there are generally multiple, independently created systems for monitoring the network. There may be numerous management systems in use depending on the number of vendors chosen for set-tops, digital music services, premium security, and so on. Another monitoring factor to throw into the pot is the fact that some systems interface pay-per-view (PPV) requests directly to the billing and accounting system. Operations has yet another monitoring system with information about the physical plant.

Each of these systems was initially created to function independently, and most of the system integration issues have been inadequately addressed. Manufacturers need to look at providing a complete interoperable solution, especially in network monitoring areas.

The solution should incorporate the ability to provide an easy, if not a common, interface for addressing set-tops from various manufacturers. These should interface with the customer service system for ease in aiding customers with service problems.

2) Reliability

Advanced communication systems require a high degree of reliability. To provide this reliability and ease of installation, manufacturers should look at providing some built-in diagnostic tools to aid in balancing and aligning the network.

Historically, status monitoring has transmitted information about voltages, currents and signal levels at given points in the network. Alarms would sound if any of these parameters fell out of tolerant ranges. Reliability in the future needs to evolve to a more complete telemetry system with a comprehensive quality of service (QOS) measurement throughout the network. With networks upgraded to perform QOS analysis, devices should be monitored not only to identify failed components, but to identify conditions where services are degrading. For example, if a real-time analysis indicates the carrier-to-noise ratio (C/N) is decreasing, the monitoring system should flag the nearest trunk amps for further polling and analysis because a nearby trunk amp may be degrading.

To aid reliability efforts in a global economy, equipment must be able to withstand environmental pressures that are not as common in North America. Throughout European countries, many devices are housed in controlled environments, and the additional expense of rugged housings required in North America are not as marketable in these countries. Some areas, such as Southeast Asia, will require additional protection for devices against heat and humidity. Some nations also may require additional protection against customer tampering, and the potential for additional alarms may become necessary in these areas.

BOTTOM LINE

Manufacture Products For the Real World

Manufacturers of next-generation cable telecommunications products must consider five important points as they research, develop and funnel products into the engineering real world:

1) Interoperability. Will the product work in harmony with other vendors' products—especially on the network monitoring frontier?
2) Reliability. Does the product provide or allow for built-in diagnostic and monitoring capabilities?
3) Dynamic range. Does the product provide a migration path toward new modulation schemes?
4) Powering. Does the product work toward the goal of 99.99% system availability?
5) Technical documentation. Is there sufficient documentation and training provided for product use (both in the United States and internationally)?

3) Dynamic range

The dynamic range of components and how that relates to system dynamic range is essential to the initial deployment of these systems. The modulation technique used for analog video is AM-VSB (vestigial sideband) and allows the engineer to predict the optimal transmission characteristics of each device. As new services are added to the spectrum, bandwidth is only one of several considerations that must be factored in to account for advanced services.

Amplifiers and optical equipment may be required to support different levels of subcarrier multiplexing, which makes it difficult to determine the required linearity of the devices a priori. Devices manufactured for these networks must be designed to provide allowances within the operational range for services that may be multiplexed onto the network. Manufacturers must be made aware of these issues and need to provide a migration path from the AM-VSB to the newer modulation schemes.

4) Powering

Powering has been a hot issue since the first hybrid fiber/coax (HFC) networks considered delivering telephony years ago. Providing telephony—a lifeline service—means shooting for 99.99% availability, a goal which cannot be achieved without backup power. Also, if active electronics are placed at customers' premises, then they must still be powered even when commercial power outages occur.

There are several strategies that address these challenges. The first is by powering through a coaxial drop or along separate wiring of a composite drop to the active components. Although there are a number of liability issues that must be thought out with legal departments, this solution will probably become the most common initially. Relatively few changes will need to occur to implement this design and thus will increase its time-to-market.

5) Technical documentation

Finally, adequate technical documentation is not the strong suit of some manufacturers. This must change. As they look to providing products for communication networks in a global society, manufacturers must communicate more technical information about their products both in this country and abroad. The Society of Cable Telecommunications Engineers, the National Cable Television Association, and the National Cable Television Institute have been excellent in promoting technical training but this has lulled some U.S. manufacturers into assuming that most everyone knows all common installation and test procedures. This is not always the case.

> "Adequate technical documentation is not the strong suit of some manufacturers. This must change."

Another education factor that manufacturers must consider is that technicians in foreign countries may not have the same training opportunities as those in the United States do. Training through professional organizations is rapidly becoming available outside the United States, but manufacturers should take a stronger lead in assisting foreign operators during the construction and installation of their advanced networks.

The author would like to thank Lamar West of Scientific-Atlanta for his research assistance and feedback on this article. CT

Michael Johnson is an application engineer specializing in advanced communication systems with Byers Engineering Co. He may be reached via e-mail at mike.johnson@byers.com.

Power System

A small power system was developed by ETPS Inc., the Watchdog Expandable power system. The system is designed for the majority of medium to large applications in the telecommunications market. Features include a modular monitor and control system with 34 visual and 200 fault event alarms (local and remote), temperature compensation, four low voltage disconnect controls, binary and/or analog operation, multiple auxiliary alarms; high power density; and can accommodate up to three 100 amp, 24 volt rectifiers.

This modular controller can monitor plant voltage and current, accomplish float/equalize settings and monitor eight alarm conditions. A second module can be added to the controller to provide four levels of low-voltage disconnect; a third module can detect up to 14 group or individual circuit breaker or fuse failures, phase failures or brownout conditions; a fourth module can provide RS-232 and remote modem communication.

Reader service #312

Vertical Racks

Winsted Corp. added a new line of heavy-duty, vertical racks named the VRx series. The all-welded units are 78.75 inches (45 U) and are performance designed with front and rear rack rails that adjust front to back to accommodate electronics of any depth. These rails are tapped (10-32) for equipment mounting. Both the top and bottom of the rack are open for cable management and venting.

Other features include independent lift-off side panels, large corner uprights for cable management, conduit knock-outs top and bottom, two grounding lugs, and mounting holes in top for eye-bolts. Overall size of the VRx series is 86 x 30 inches.

Reader service #311

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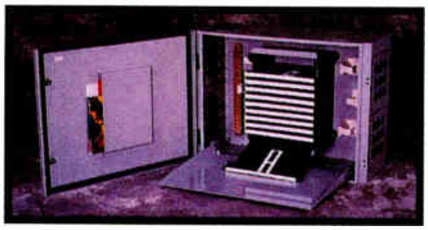
Electronics Enclosure

Channell Commercial Corp. has introduced its new SPH1432 broadband electronics enclosure with the 600 series HDC cover providing heat dissipation performance and featuring a new base designed for strength, cable storage and access.

Channell uses its Self-Lock system that provides a self-latching mechanism and offers multiple lock head options and is constructed with polyethylene thermoplastic. The SPH1432 houses line extenders and tap/splitter combinations with easy access to cables and interior electronics.

Reader service #309

Fiber Splice Vault



The new, high-capacity fiber-optic splice vault from Telect Inc. fits all industry-standard applications and comes with the following standard features: a functional modular design for network expansion; each vault holds 12 slide-out trays, which fasten up to 24 fibers; and vaults can be stacked for unlimited expansion by removing the plates at the top of the enclosure and threading cable between vaults.

Inside the vault, Telect's Post & Gate cable management system routes fiber and maintains its critical bend radius. Cable clamping provides additional fiber protection. Other features include multiple ports to hold several different cable sizes and variations, an internal grounding bus bar for metallic cables and a reversible door with two locks. Tray options include bare fusion, mechanical, heat-shrink fusion, or ribbon.

Reader service #310

Scope Adapter

The Fiber Optic Source Co. has added an 8° scope adapter to its line of manufactured products. The adapter is for use on the AMP fiber-optic microscope when inspecting angled connectors. The user can view 8° angled FC style connectors.

Reader service #303

Fiber-Optic Tracking

Molex Fiber Optics Inc. developed software support for end-to-end optic fiber tracking of all cable TV networks, traditional telephony networks and broadband applications. The Pathseeker fiber-optic database platform software package uses a Windows 95 operating platform, stores fiber data and allows users to track fiber routings by setting up network locations and identifying splicing or termination points.

The software provides fiber tracking and frame administration for fiber interconnect systems, cable and location routings for documenting outside plant cable routes and data base management for optical time domain reflectometer (OTDR) traces. Pathseeker also features fiber administration for frame graphics and an intelligent jumper running between frames. Equipment and system test data also can be stored in the software.

Reader service #308

Headend System

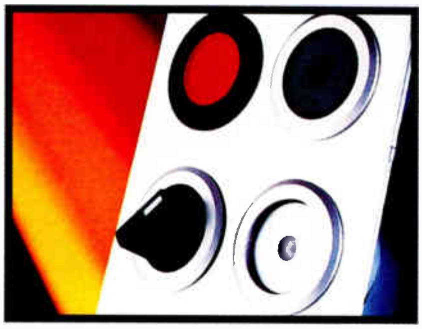
Olson Technology has introduced a compact, modular, frequency agile 12-channel remote control video headend system. The Olson OT-1200 series system features a 5.25- x 19-inch rack-mount housing that contains a power supply and can be configured with any combination of video/audio modulator or demodulator cards. The system operates at frequencies from 54 to 550 MHz and permits local tuning or remote control of each card via a serial data link.

Reader service #302

Bias Control

Ramar Corp. introduced the BC-10 modulator bias control accessory for use with lithium niobate modulators in fiber-optic systems. The BC-10 actively tracks the linear operating (quadrature) point of the modulator and adjusts the bias voltage to compensate for any environmental variations. The modulator features toggle switch operation, a manual bias adjustment knob (when not locked), adjustable bias correction slope to 0.1 V/ms, and is compact in size.

Reader service #305



Mounted Switches

The EAO flush panel mounted switches can be assembled into modern, smooth, easy-to-clean panels. The switches can be sized to handle loads from signal level to high power. The mounted switches assemble using standard components, for example, the series 04 switches handle up to 10 amps at 250 VAC. Other models are designed for low and moderate loads.

Reader service #307

The following is a listing of some of the 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.

• *CLI Ninjas II: The Sequel*—John Wong of the Federal Communications Commission's Cable TV Branch and Les Read provide a view of how one MSO is dealing with the cumlative leakage index (CLI) issue. They also cover important topics such as the chances of being targeted for an FCC inspection, what inspectors look for and the new role of the Emergency Alert System and how it affects cable operators. (1 hr.) Order #T-1104, $35.

•*Anatomy of Professionalism*—Produced by the SCTE in association with NCTA and funded by CableLabs, this outstanding program serves as an effective tutorial for BCT/E Category VII, "Engineering Management and Professionalism." Even for those who are not pursuing BCT/E certification, this professionally produced tape offers an in-depth evaluation of case studies relating directly to cable industry operations. (1 hr.) Order #T-1110, $18.

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

Shipping: Videotapes are shipped UPS. No P.O. boxes, please. SCTE pays surface shipping charges within the continental U.S. only. Orders to Canada or Mexico: Please add $5 (U.S.) for each videotape. Orders to Europe, Africa, Asia or South America: SCTE will invoice the recipient for additional air or surface shipping charges (please specify). "Rush" orders: a $15 surcharge will be collected on all such orders. The surcharge and air shipping cost can be charged to a Visa or MasterCard.

To order: All orders must be prepaid. Shipping and handling costs are included in the continental U.S. All prices are in U.S. dollars. SCTE accepts MasterCard and Visa. To qualify for SCTE member prices, a valid SCTE identification number is required, or a complete membership application with dues payment must accompany your order. Orders without full and proper payment will be returned. Send orders to: SCTE, 140 Philips Rd., Exton, PA 19341-1318 or fax with credit card information to (610) 363-5898. CT

Reader Service Number 152

CALENDAR

June

1-5: Supercomm '97, New Orleans. Contact David Swanston, (703) 734-3300.

2-6: ADC Telecommunications' broadband systems analysis and design course, Minneapolis. Contact Annette Biederman, (612) 946-3086.

4-7: Cable-Tec Expo '97, Orlando, FL. Contact SCTE special projects department, (610) 363-6888.

9-13: International Conference on Consumer Electronics, Chicago. Contact Diane Williams, (716) 392-3862.

10-13: The Light Brigade training course for installers, maintenance personnel and engineer designers, "Fiber Optics 1-2-3: Installation, Design & Maintenance," Phoenix. Contact Lisa Johnson, (800) 451-7128.

11: SCTE Mid-South Chapter meeting, Installer Certification exams to be administered, Memphis, TN. Contact Kathy Andrews, (901) 365-1770, ext. 4110.

11: SCTE Miss-Lou Chapter meeting, BCT/E and Installer Certification exams to be administered. Contact Austin Matthews, (601) 374-5904.

12: Society of Cable Telecommunications Engineers Satellite Tele-Seminar program, "Digital Technology," Galaxy 1R, Transponder 14, 2:30-3:30 p.m. ET. Contact Janene Martin, (610) 363-6888, ext. 220.

12: SCTE New England Chapter meeting, Boxborough, MA. Contact Tom Garcia, (508) 562-1675.

18: SCTE Smokey Mountain Chapter seminar, installation practices; meter and leakage detection, Johnson City, TN. Contact Roy Tester, (615) 878-5502.

19: SCTE Shasta/Rogue Chapter seminar, installation training, Yreka, CA. Contact Mike Smith, (541) 779-1814.

23-24: Society of Cable Telecommunications Engineers regional training seminar, "Introduction to Telephony," Chattanooga, TN. Contact SCTE national headquarters, (610) 363-6888. ➤

Planning Ahead

Sept. 15-17: ICSPAT/DSP World 1997, International Conference on Signal Processing Applications and Technology, San Diego. Contact Jennifer Call, (415) 278-5239.

Sept. 21-26: ISS '97: World Telecommunications Congress, "Global Network Evolution: Convergence or Collision?" Toronto, Canada. Contact Victoria Lord, (416) 588-2420.

Oct. 14-16: Mid-America Cable Show, Kansas City. Contact (913) 841-9241.

Oct. 20-22: Eastern Cable Show, Atlanta. Contact Southern Cable Television Association, (404) 255-1608.

Dec. 2-4: Converging Technologies Expo & Conference, Los Angeles. Contact John Golicz, (203) 256-4700, ext. 121.

Dec. 10-12: The Western Show, Anaheim, CA. Contact the California Cable Television Association, (510) 428-2225.

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24-26: CES Habitech: The Event for Integrated Home & Building Systems, Dallas. Contact Jonathan Thompson, (703) 907-7664.

25-27: Society of Cable Telecommunications Engineers regional training seminar, "Technology for Technicians II," Chattanooga, TN. Contact SCTE National Headquarters, (610) 363-6888.

July

9: SCTE Great Plains Chapter seminar, HSD/wireline telephony, Bellevue, NE. Contact Randy Parker, (402) 292-4049.

9: SCTE Mid-South Chapter meeting, BCT/E and Installer Certification exams to be administered, Memphis, TN. Contact Kathy Andrews, (901) 365-1770, ext. 4110.

10: Society of Cable Telecommunications Engineers Satellite Tele-Seminar program, "In-premises wiring issues," Galaxy 1R, Transponder 14, 2:30-3:30 p.m. ET. Contact Janene Martin, (610) 363-6888, ext. 220.

14: Career Fair Coordinators' high tech career fair, Denver. Contact Ceilia Smith, (972) 462-8807.

14-16: Institute for International Research conference, "Optimizing the Functionality and Cost of Set-Top Boxes," San Francisco. Contact (800) 999-3123.

16: SCTE Piedmont Chapter seminar, interactive services and the how and why of Certification, and BCT/E Certification exams to be administered; speakers to be announced. Contact Tod Dean, Chapter Voice Mail, (919) 220-3889.

17: SCTE Chesapeake Chapter seminar, safety, and BCT/E and Installer Certification exams to be administered, Bowie, MD. Contact Bruce Weintraub, (301) 294-7607.

25: SCTE Wheat State Chapter meeting, BCT/E Certification exams to be administered, Great Bend, KS. Contact Vicki Marts, (316) 262-4270.

August

6: SCTE Ark-La-Tex Chapter annual golf tournament. Contact Terry Temple, (318) 631-3322.

14: Society of Cable Telecommunications Engineers Satellite Tele-Seminar program, "Video transport (part one)," Galaxy 1R, Transponder 14, 2:30-3:30 p.m. ET. Contact Janene Martin, (610) 363-6888, ext. 220.

15: SCTE Oklahoma Chapter meeting, BCT/E Certification exams to be administered. Contact Doug Huston, (405) 348-4225.

18-20: 1997 Great Lakes Cable Expo, Indianapolis. Contact show management, (317) 845-8100.

21: SCTE Gateway Chapter meeting, BCT/E and Installer Certification exams to be administered. Contact Chris Kramer, (314) 579-4627.

21: SCTE New England Chapter annual vendors' days, speakers to be announced, Boxborough, MA. Contact Tom Garcia, (508) 562-1675.

29-30: National Association of Broadcasters' 1997 Service to Children Television Awards and Symposium, Washington. Contact Victoria Cullen, (202) 429-5368. CT

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	14-18	New Orleans, LA	Designing Telecom Distribution Systems
	16-18	Atlanta, GA	Design and Installation of Ethernet and Token Ring LANs
	21-22	Atlanta, GA	Introduction To Internetwork Design
	23-25	Atlanta, GA	High-Speed Campus Backbone Design
AUG	4-5	St. Paul, MN	Intro to LANs and LAN Cabling Systems
	6-8	St. Paul, MN	Design and Installation of Ethernet and Token Ring LANs
	11-12	St. Paul, MN	Introduction to Internetwork Design
	11-15	St. Paul, MN	Designing Telecom Distribution Systems
	11-15	Boston, MA	Designing Telecom Distribution Systems
	13-15	St. Paul, MN	High-Speed Campus Backbone Design
	18-22	Washington, DC	Designing Telecom Distribution Systems

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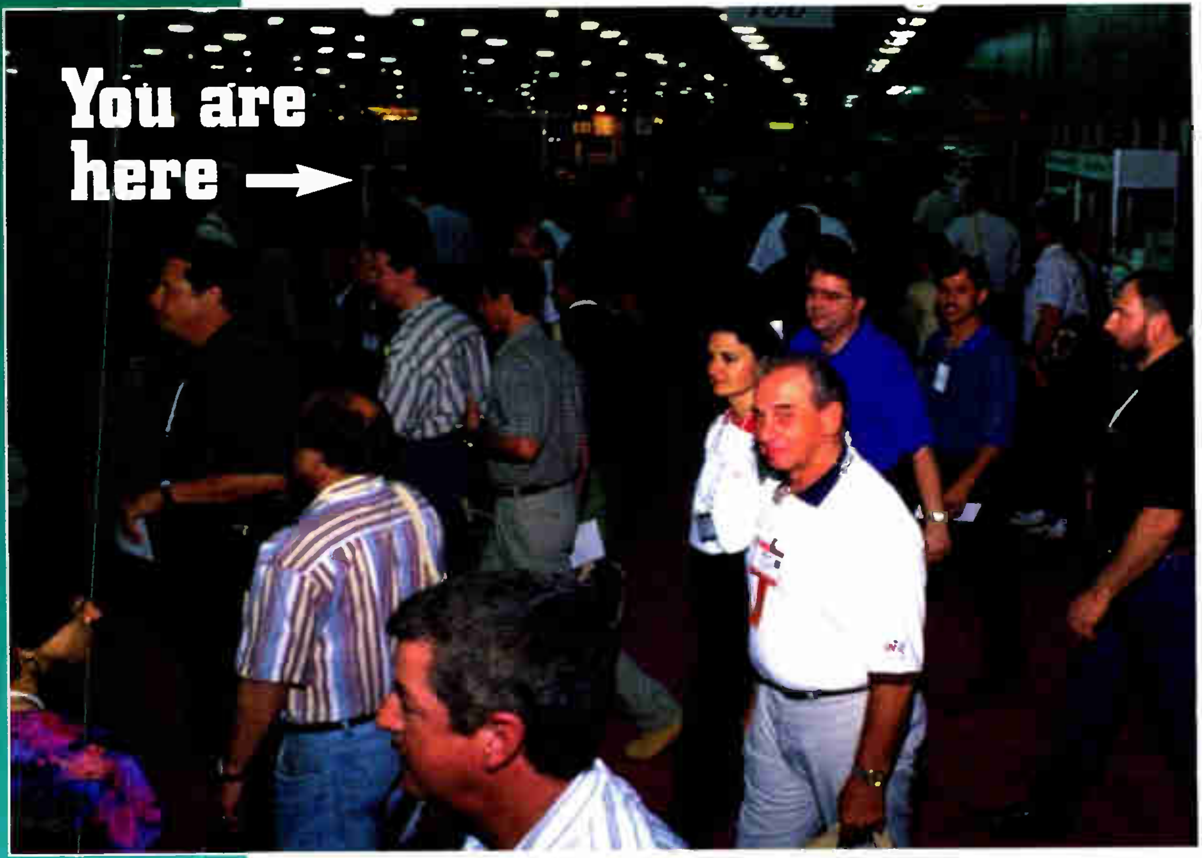
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CABLE TRIVIA

Our historical guru (aka Editor Rex Porter) has provided us with these trivia questions on the cable industry. Answers to the last set of questions appear first. (The last "Cable Trivia" ran on page 106 of the May issue.) Look for answers to this month's questions in a future issue (along with a new set of questions). The person supplying the most correct answers will be awarded a special Trivia T-shirt. You may only win once per calendar year.

To be in the running for a prize, your answers need to be postmarked or faxed to us by the 20th of the month of the issue date that the specific trivia test appears in. The first person who sends in the most correct answers will be the award winner. Good luck! Your answers need to be sent to: The Trivia Judge, e-mail: tvrex@earthlink.net; mail to *Communications Technology*, 1900 Grant St., Suite 720, Denver, CO 80203; or fax: (303) 839-1564.

Trivia #14 answers

1) J.E. Belknap & Associates in Popular Bluff, MO
2) Pottsville, PA
3) 419,000
4) Watch This Channel Grow
5) Narrowcasting
6) Storer, ATC, Sammons and Daniels

Trivia #15

For those of you who have expressed interest in joining the Loyal Order of The 704, the following questions are presented. If you can score at least 50% and have 20 or more years as a cable engineer, you should qualify. So, attend the meeting at the 1997 Cable-Tec Expo in Orlando, FL.

1) Jim Davidson ran a company out of Batesville, AR, providing Entron Line Amplifers and system construction. Its name was:
   A) Davco Electronics
   B) Blackburn & Co
   C) Westbury CATV Corp.
   D) Columbia Wire & Supply

2) The Jerrold Channel Commander Model COM*:
   A) Was the first transistorized headend equipment
   B) Was a low-band headend product
   C) Could be used as a spare headend for any VHF channel
   D) Was a fixed-frequency headend for a specific channel

3) If you ordered a model ATM-20C-HS line extender from its manufacturer, you were ordering from:
   A) Ameco
   B) Jerrold
   C) Entron
   D) Vikoa

4) A "star-mount," referred to as such because of its Star Of David pattern:
   A) Is an analog output representation
   B) Is a digital output presentation
   C) Is placed toward the top of towers
   D) Is the diagram of early signal mixers

5) "FOAMFLEX" was an early semi-flexible, aluminum sheathed, foam polyethylene dielectric coax cable marketed by:
   A) Times Wire & Cable Co.
   B) Superior Cable
   C) Amphenol Cable
   D) Phelps Dodge

6) Teflon, used widely in the cable equipment and cables, was introduced by:
   A) Westinghouse
   B) Dupont
   C) Ampex Corp.
   D) Bell Laboratories

And the winner is...

The winner for Cable Trivia #14 (which ran in the May issue) is **Jim Brown** of Comcast, who picked the most correct answers. Congratulations Jim! CT

Return signals in bridger amps: Part 2

This month continues the series on the return amplifier module in 450-550 MHz trunk/bridger amps. Is excerpted from a lesson in NCTI's System Technician Course. The hands-on training suggestions are modeled after NCTI's facilitator training courses for administering hands-on labs. © NCTI.

The controls for the return amplifier are typically located on the amplifier module, while the attenuator and equalizer are typically located inside the return amplifier module. In the C-COR return amplifier modules, the slope and gain controls are on the output side of the return amplifier. In the Jerrold return amplifier, the gain control is on the input side of the second push-pull amplifier stage. Positioning controls on the output allows balancing the reverse system on an amplifier-span basis when there are splits in the trunk system.

Attenuator pad

The attenuator pad may be on the input and/or output side of the reverse amplifier to reduce the input and output levels of the reverse amplifier as needed. This attenuator is the same type used in both the trunk and bridger amplifier modules.

Equalizer

The equalizer compensates for the output cable's loss at the return frequencies (5-30 MHz). This equalizer may be located on the input or output of the return amplifier. Figure 1 shows the actual location of the EQ and pad on the output of a Scientific-Atlanta return amp.

Slope control

Some return amplifier modules have a slope control (Figure 2) for obtaining the designed slope of the return signal. The slope control typically has a range of 6 dB. In some instances, an automatic slope control is employed, which operates similar to the trunk amplifier's ASC.

Gain control

The gain control is typically located on the front of the return amplifier module (Figure 3). This control permits adjusting the output levels of the return amplifier by 0-9 dB to match the input requirements of the next return amplifier. The return amplifier typically has a manual control or thermal-compensated gain control to compensate for changes in return signal level due to temperature variations. AGC is not normally used.

Next month's installment will cover the test points and specifications for 450-550 MHz trunk/bridger amplifiers.

Figure 1: Location of equalizer and attenuator pad in S-A reverse amplifier module

Hands-on performance training

Proficiency objectives: Locate the reverse amplifier passives and controls on your system's trunk/bridger amplifier(s) and their functions.

- Provide each student with a block diagram of your system's trunk/bridger amplifier(s).
- Use the block diagram to show the location of the reverse amplifier passives and controls while describing what each does and how it affects the signals in the amplifier's return path.
- Then, using the actual equipment, have students locate the reverse amplifier passives and controls.
- Verify that students can locate the return amplifier passives and controls on your system's trunk/bridger amplifier(s) and can describe their functions. CT

Figure 2: Magnavox return amplifier manual slope control location

Figure 3: Location of Jerrold return amplifier manual gain control

By William W. Riker

What's New on the Horizon?

The Society has long been exploring new frontiers that will help keep our members on the cutting edge of the ever-changing broadband industry. In response to member requests over recent years, the Society is completing the development of two new certification programs, as well as new materials to enhance our already extensive technical training curriculum.

A few years ago, the SCTE Training Committee assembled to discuss the question, "What do Society members really need?" After much research, time and many questions, the Committee determined that certification at the "Service Technician" and "Telephony" levels were of great interest to the membership.

Alan Babcock, SCTE's new director of training development, is aggressively working to implement our Service Technician and Telephony Certification Programs, which will officially be made available to members this fall. The Society recognized a need to also make support training available in both of these areas, so the SCTE Training Committee is developing programs that will satisfy that need.

The Service Technician Certification Program was designed to bridge the gap between the Installer and Broadband Communications Technician (BCT) certification levels. This program will focus on the specific functions of someone who may need to troubleshoot the distribution system at, for example, a customer's drop, or the output of a bridger. It will define what a typical service technician is, and will be of particular interest to service, maintenance and sweep technicians.

The program consists of two categories. The first level will focus on troubleshooting, particularly the half-split, or "divide and conquer," method of locating distribution problems. The second area is a reinforcement of installation skills and the overall knowledge that a service technician should possess. This program tests a candidate's overall comprehension of the materials presented. This exam will be closed-book.

Cognitive testing

Unlike BCT/E and Installer Certification exams, which test an individual's knowledge, these new programs will test cognitive thought processes. For example, rather than memorizing question-and-answer-style facts, test takers will be asked to resolve a hypothetical situation based on information they have learned from the courses. They may be presented with a subscriber's problem. Looking at a map of a cable system, certification candidates must decide what steps to take to correct the problem.

Similarly, the first level of the Telephony Certification Program will confirm a candidate's comprehension of this field. With several large cable companies currently making plans to enter the telephone business, SCTE has recognized a need for quality training in this area. This technical program was developed to address the growing collaboration between the telephone and broadband cable industries. Since a formal technical training and certification program for telephony is not available anywhere else this offering is unique and exclusive to our industry.

Certification levels

Candidates will be able to be certified at two levels in telephony. The first area of study, Associate Certification, is somewhat like a "Basic Phone 101" that confirms an individual's knowledge and understanding of telephone technology. This exam also will be closed-book.

The second level is Master's Certification. To become certified at this level, a candidate must first successfully complete the Associate level. Individuals may opt to participate in one or all six specialty areas, including customer premise equipment, access, network, transmission, switching and powering. Each of these topics are significantly detailed areas of study, and the exam will be open-book.

A sampling of exam questions will be available at Cable-Tec Expo this month. Attendees will have multiple opportunities to answer random questions very similar to what actual certification candidates will find on the exams this fall. SCTE is seeking volunteers to answer experimental questions. Participants will be asked to fill out a survey that will enable us to ascertain our target audience for the certification program.

A preview of SCTE's newest certification programs will be presented during the Pre-Conference Sessions on June 3. Babcock, Region 2 Director Dennis Quinter of Time Warner Cable, At-Large Director Andy Scott of NCTA and Gary Selwitz of Raystay will offer tips and information on how to prepare for these new certification levels.

We are currently working to increase the scope of other training tools. Society members have requested specific training that will not only help them earn BCT/E Certification, but also support all of SCTE's programs. Tentative plans include designing training in alternative learning styles, such as through the World Wide Web, CD-ROMs and computer-based training (CBT).

In the future, Babcock will focus on developing student workbooks and leader guides to support the Society's BCT/E Program. For more information, contact SCTE at (610) 363-6888, fax at (610) 363-7133, or visit the SCTE Website at http//:www.scte.org. CT

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

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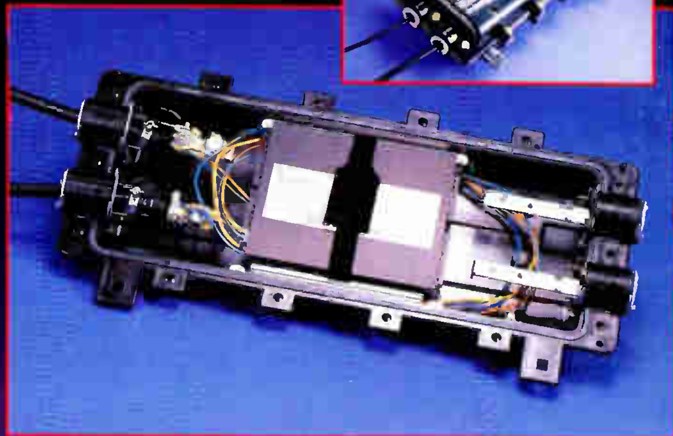

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