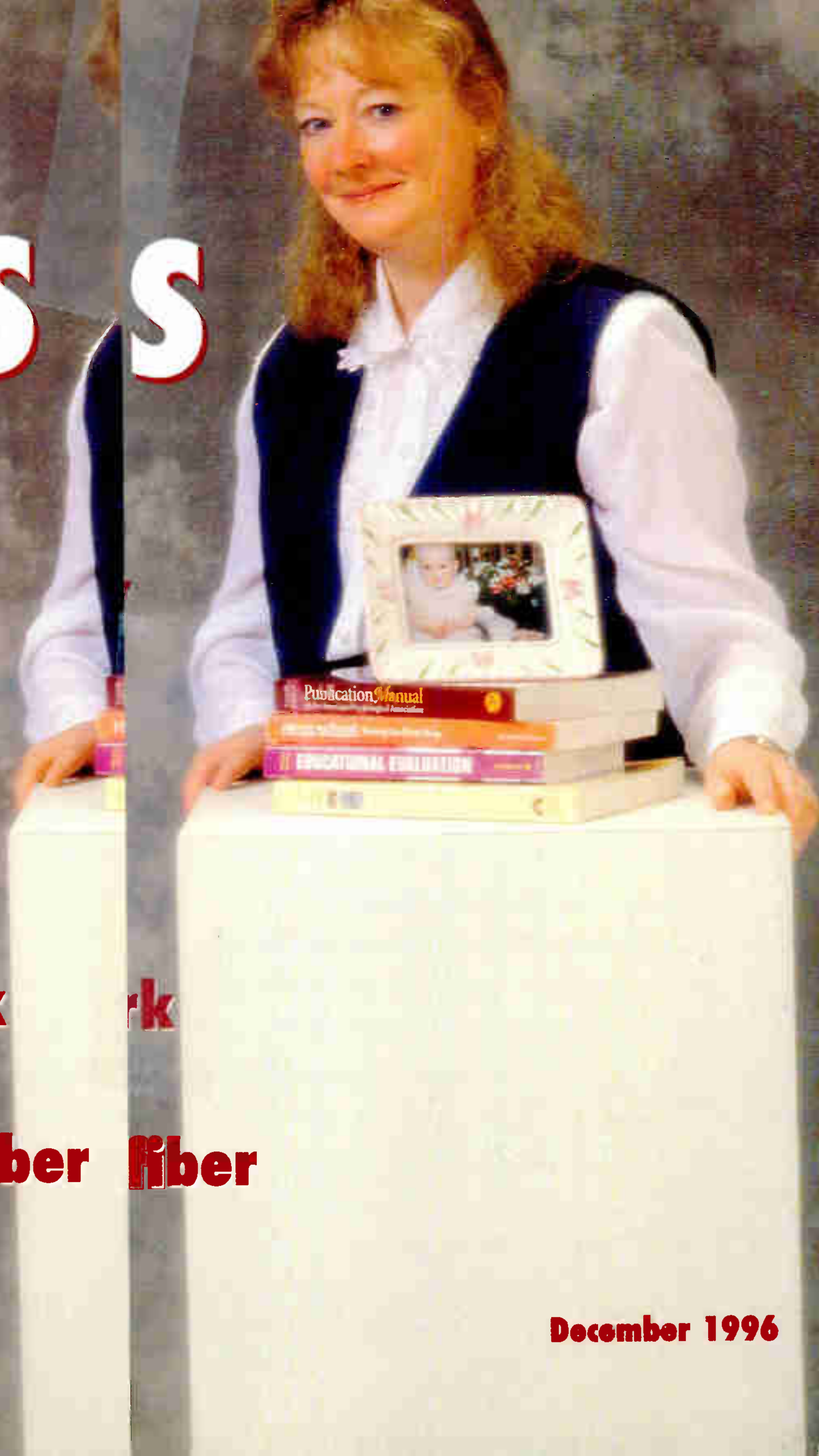
COMMUNICATIONS TECHNOLOGY

Official trade journal of the Society of Cable Telecommunications Engineers



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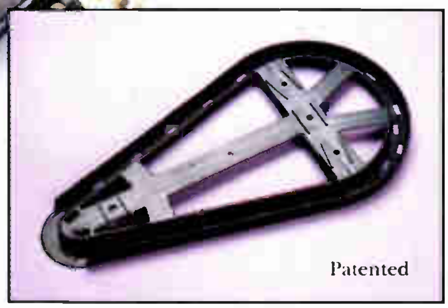

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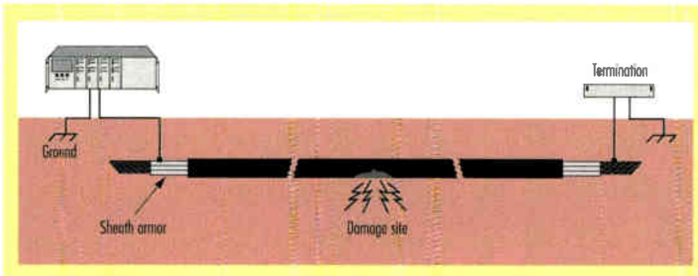

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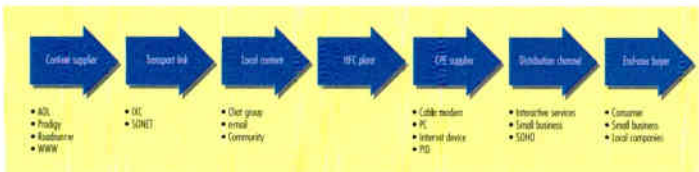

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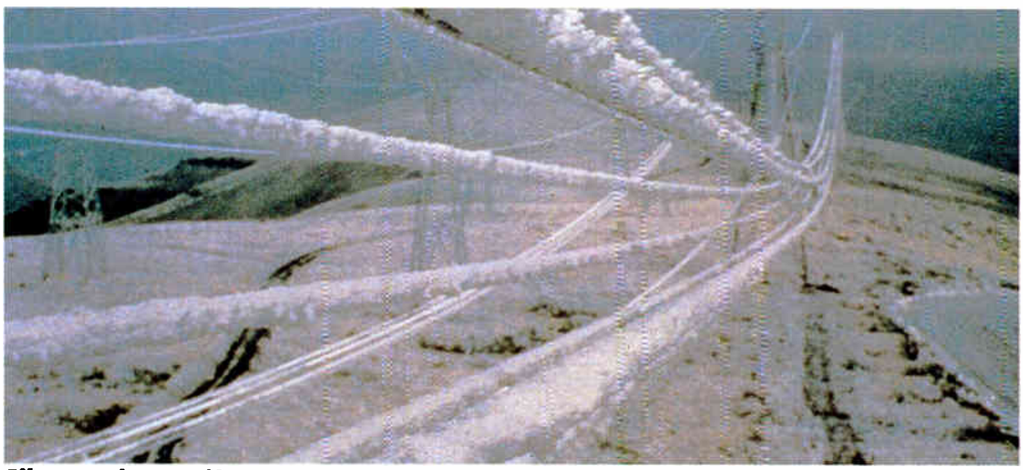

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Pam Nobles of Jones Intercable not only balances work, masters degree studies and motherhood, but hauls in this year's Women in Technology Award. Photo by Bob Sullivan.

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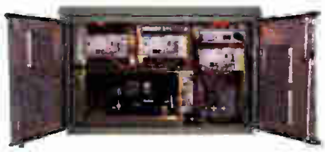

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Rating your magazine

Recently, *Communications Technology* hosted a gathering of its advisory board. (Members are listed on our masthead on page 8.) Earlier this year, they provided themes and editorial content for the 1997 editorial calendar that will shape what you read in the pages of this magazine in the coming year. As 1996 nears its end, I want to thank each member of the advisory board for continuing support of the Society of Cable Telecommunications Engineers and its official trade journal. We look forward to working with their suggestions on how we can improve this magazine for members of the SCTE and other readers.

Write to us

It's you readers we'd like to turn to now for comments on how you feel about your magazine each month. Hopefully, we can begin publishing a "Letters To The Editor" column more regularly, but this will depend on your feedback. We want to provide the best technical journal in the industry, and not just for the cable TV side of communications but for the telephony and computer sides also.

Communications Technology should be a forum for engineering ideas and programs from all segments of the industry. Your daily work involves more than amplifiers and cable. Your career requires training in cable, fiber, lasers, multiplexers and interface with telephony equipment, computer hardware/software and standards. We have tried to present a mix of engineering information in a format with which you can understand the changing technology.

Some of the best ideas I've heard for the magazine have come from discussions in meetings with system technicians and engineers, especially at seminars and conferences such as SCTE's Emerging Technologies Conference and Cable-Tec Expo. But it's hard to meet with everyone who reads the magazine. And perhaps you cannot make some of the meetings.

As editor, I assure you that we need your feedback. Perhaps there are problems in a certain technology that you want help with. There might even be solutions you have found and would like to share your success with fellow technicians and engineers. We may have already covered questions that you have in an earlier issue, and if this is the case, we can direct you to that information immediately.

I recall many times when information from the field led manufacturers to modify products to overcome problems everyone was having. The technicians talked among themselves but not much was done until an article was written. The introduction of T-connectors, flooding compounds for cables, and better grounding products are only a few examples of improvements that were brought on by talk backed up by the written word. As this industry continues to change, our readers will be our best bellwethers.

I get lots of calls and I'm pleased when many of the them express such satisfaction with our editorial content. But, like everyone else, I smile a lot broader when I get to see comments about this magazine in writing. And, if they are negative, I promise to still smile a little, as we try to be even better.

So, tell us what you think at: "Letters to the Editor," *Communications Technology*, 1900 Grant St., Suite 720, Denver, CO 80203; (303) 839-1564 (fax); CTmagazine@aol.com (e-mail). We look forward to getting your input.

Rex Porter
Editor

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East Coast Regional Sales Manager, Tim Hermes, (301) 340-7788, ext. 2004
Account Executives
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CT Publications Corp.
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CT Sales and Editorial Offices
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Corporate Offices
Phillips Business Information Inc.
1201 Seven Locks Road, Suite 300, Potomac, MD 20854
(301) 340-1520 Fax (301) 340-0542

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CableLabs announces digital specification

Cable Television Laboratories and its members agreed upon major elements of an interoperable digital cable systems specification for North America. This spec establishes the basic building blocks of digital services, allowing set-top terminals and data modems built by different manufacturers to work together (interoperate) on the same cable system. CableLabs expects many of its members will purchase equipment that complies with this specification.

The spec covers how cable TV systems will transport digital video and data in standard 6 MHz cable channels. In the specified digital transmission systems, the payload data rate will be between 27 and 40 megabits per second.

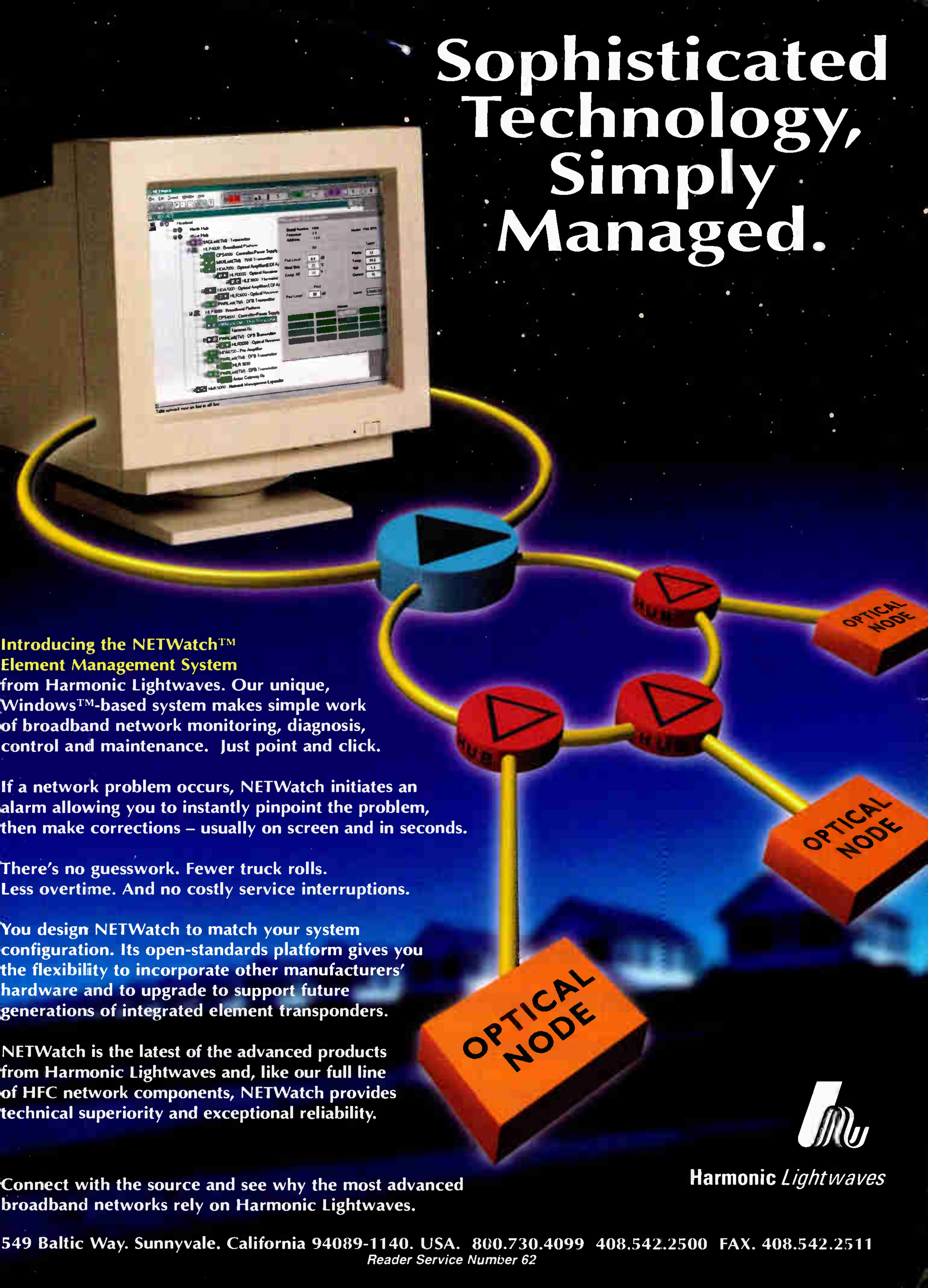
Among the basic areas covered in this specification are: the system will conform to MPEG-2 (Motion Picture Experts Group) main profile at main level parameters; the specification transport multiplex also will be MPEG-2; and the audio element will be the Dolby Audio AC-3 system. The service information tables for this spec will incorporated the Advanced Television Systems Committee specification.

Downstream digital modulation will conform to the International Telecommunications Union standard ITU-T J.83 Annex B that calls for 64- and 256-QAM (quadrature amplitude modulation) with concatenated trellis coded modulation, plus enhancements such as variable interleaving depth for low-latency in delay sensitive applications such as data and voice.

Richard Green, president of CableLabs, praised key suppliers General Instrument and Scientific-Atlanta for their willingness to work with CableLabs to establish this specification. "Scientific-Atlanta and GI are working toward an agreement that will include a royalty free cross-licensing arrangement for core encryption, modulation and forward error correction technology, and they are willing to license other manufacturers," Green said. "This is a tremendous precedent and we would like to see it expand into other areas," he added.

GI, Rogers tout 256-QAM success

General Instrument announced it has successfully completed what is being called the industry's first successful field test of advanced 256-QAM transmission over an hybrid fiber/coax (HFC) network. The testing was performed at 21 locations served by five different Rogers Cablesystems headend sites located



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in Toronto, Newmarket, St. Thomas and Woodstock in Ontario, Canada.

Equipment used included GI's 256-QAM modulator, 256 (ITU-831) FEC, TDM fiber link, C6M RF upconverter and new 64/256 QAM Demod. Systems tested consisted of fiber-optic links up to 55 km in length and cascades of up to 38 amplifiers. Tests during 15-minute gating periods at all locations resulted in error-free performance. Overnight tests averaged 99.9% error-free performance with worst-case performance of 99.6%.

256-QAM transmission provides more efficient bandwidth, which expands cable operators channel capacity by 44%.

Trillion-bit ATM switching tested

One day will it be possible to surf 100,000 channels? It very well could be, according to a team of Bell Labs researchers that demonstrated a trillion-bit asynchronous transfer mode (ATM) switching technology recently.

If a next-generation communications network can handle a trillion bits of information at once, that's equivalent to allowing a user to surf 100,000 TV channels simultaneously or responding to computer clicks from 10 million Internet users at the same time. Today's highest capacity systems can switch up to 20 gigabits (billion bits) of digitized information per second, the equivalent of 200,000 simultaneous two-way voice conversations.

The experimental switching technology is based on Lucent Technologies GlobeView 2000 20 gigabit per second asynchronous transfer mode (ATM) switch.

Superior, GI join for net reliability

Superior Electronics and General Instrument joined forces to develop and market status monitoring products. According to the companies, their primary objective is to ensure that industry deployment of broadband communications equipment and network management technologies supports the operations, administration, maintenance and provisioning (OAM&P) in an open systems, standards-based environment.

GI and Superior will be interfacing Superior's Cheetah status monitoring system with the distribution products of GI's transmission network systems (TNS) business unit.

Tek, Sarnoff team in picture quality

Tektronix and the David Sarnoff Research Center said they will work together to commercialize a reliable, objective assessment method to quantify the unique picture quality impairments associated with compressed video applications. The methodology is Sarnoff's Just Noticeable Difference (JND).

Since JND "views" pictures much like humans do, it is said to be more sensitive to a variety of defects and works over a broader range of picture quality than do alternate methods employing less elaborate techniques.→

NOTES

• A definitive agreement for **Thomas & Betts** to acquire **Augat** in an exchange of stock was announced recently. At Thomas & Betts' current stock price, the value of the transaction would approximate $550 million.

• **Siecor** relocated its fiber-optic test equipment operations from its corporate headquarters on 800 17th St. N.W. in Hickory, N.C., to 1978 8th Ave. N.W. The new location also houses the operations' marketing, and service and repair departments.

• **ADC Telecommunications** combined its Access Platforms Division and its ADC Video Systems subsidiary to create the Broadband Communications Division.

• In October, *Fortune* named **Superior Electronics** #20 and **C-COR Electronics** #68 in the magazine's "The Top 100 of America's Fastest Growing Companies." Superior touts a whopping 5, 506% growth over the past five years.

• **Motorola Multimedia Group** announced an agreement to provide cable modems to **Marubeni Corp.**, the Tokyo-based general trading company backing what will be Japan's largest broadband network. Motorola will provide 1,000 of its CyberSURFR cable modems by the first quarter of 1997, which will be deployed mid-year as the first installation of a phased roll-out of cable modem service in Japan.

• A new Integration Services division was established by **AM Communications** to support its OmniStat status monitoring and element management system.

• Western Kentucky University installed high-speed cable modems in four residence halls and announced plans to expand that number. The units being used are **Zenith Electronics** HomeWorks Universal cable modems. Charles Anderson, vice president of information technology at the Bowling Green campus said the modems were chosen because they were "readily available and at the right price."

• **Philips Broadband Networks** appointed John Caezza as vice president of engineering and Carl Buesking as vice president of sales. Both are long-time members of the **Society of Cable Telecommunications Engineers.**

• Chris Plonsky was named director of engineering at **Superior Electronics.** Most recently he was with **Sensormatic Electronics**.

• The **National Cable Television Center and Museum** recently designated two Industry Fellows: Rex Porter and Dave Willis. Porter, editor of *Communications Technology*, has been in the cable telecommunications industry for 30 years. Willis has been active in the industry for over 40 years, including 21 of them as director of engineering for TCI.

• Lawrence Lockwood of **TeleResources**, a cable telecommunications veteran and long-time contributor of technical papers and articles to the industry, is presently recuperating from a fall in his home. He can be contacted at (703) 920-3795.

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ET '97: Program announced

The Society of Cable Telecommunications Engineers announced its technical program for the 1997 Conference on Emerging Technologies, which will be held January 8-10, 1997 at the Opryland Hotel Convention Center in Nashville, TN.

On Wednesday, Jan. 8, optional preconference tutorials will be held. These are designed to give attendees detailed background information on several of the technologies that will be discussed during the next two days.

The overall theme of this year's conference is data, so accordingly Thursday, Jan. 9 will offer two data-oriented sessions. The first session, "Data Services Over Cable—The Technology," explores the enabling emerging technologies to allow efficient data transfer across the cable system. Security, distribution, trafficking, asynchronous transfer mode (ATM) and fast Ethernet also will be discussed.

The conference's second session, "Data Services Over Cable—Applications," will explore applications that represent a variety of future business opportunities for cable operators. Some of the ways in which Internet technology may evolve allowing time-sensitive traffic such as voice and video will be presented. Also discussed will be the strategies of two major groups of system operators for the roll-out of consumer services. Finally, insight will be gained into the systems integration challenge behind the deployment of high-speed data services.

On Friday, Jan. 10, the conference will offer three additional technical sessions. The first, "New Science Applied to Current Issues," will examine the fact that as hybrid fiber/coax (HFC) networks rapidly deploy new services, operators are experiencing operational and engineering issues. This session is dedicated to providing quantitative field data relating to these issues as well as procedural and technological solutions from subject matter experts.

The second session presented on Friday will be "Empirical Data and Field Experiences." It deals with the launching of a network application after all the research and product development is completed. In this session, attendees will hear about real-life deployments of data networks, including work-at-home applications, technical requirements of the network, business requirements and security issues of a widely-dispersed network.

The third session, "Over the Horizon," addresses today's exponentially growing requirements for mass storage, retrieval and distribution of data. This session will present a panel of industry experts to explore over-the-horizon technologies that may well be used to create the super servers and fiber-optic transport components that will be so vital to the success of the telecommunications industry.

For further information or to register, visit SCTE's Web site at http://www.scte.org, or call SCTE national headquarters at (610) 363-6888.

Tech seminars at new building

The SCTE recently held two regional seminars during the week of Sept. 16 at its national headquarters in Exton, PA. A total of 46 attendees came to the headquarters building to attend the "Introduction to Data Communications" and "Technology for Technicians II" seminars, with some attendees traveling from as far as California and Missouri.

These seminars marked the second instance of training being conducted on the premises of the Society's new national headquarters building, which opened in February of this year. SCTE first offered seminars in the new building's training room in March.

"Introduction to Data Communications," SCTE's newest two-day seminar, provides an historical look at telecommunications through the use of the telephony model. SCTE Vice President of Technical Programs Marvin Nelson conducted the program, which includes a discussion on T1 circuits and the North American Digital Hierarchy, as well as information on X.25, frame relay and cell relay, such as ATM.

The seminar also features a discussion of how the telecommunications industry will utilize digital technology, which will require telecommunications engineers to become proficient in both data communications and digital in order to succeed. This course benefits attendees by building a foundation for the learning of advanced digital technology.

Audience response was favorable, with attendees commenting that "the speaker was well organized and articulate" and "the materials and information provided were very informative." One attendee elaborated, stating, "It provided me with a clearer concept and understanding of data communications. [Marvin Nelson was a] very competent instructor and expressed the subject material well."

"Technology for Technicians II" is an advanced three-day program designed for broadband industry maintenance technicians and chief technicians. As conducted by SCTE Director of Training Ralph Haimowitz, this second-level program provided information on basic system design theory and the use of broadband test equipment. In addition to the comprehensive technical theory that the course offers, it creates ample opportunities for hands-on training. Upon passing the course exam, attendees will receive 2.2 continuing education units (CEUs) from Empire State College in New York.

The program focuses on professionals who work with cable TV plant, both trunk and feeder, and the solving of problems with a current cable system or the coaxial feeder in HFC cable systems. It stresses mathematics to foster a greater understanding of and the ability to work with various formulas that apply to such system operations as unity gain, proof-of-performance (POP) testing, common cable system problems and their cures, system operating equipment, the Federal Communications Commission cumulative leakage index (CLI) calculations and the use of the TV set and signal level meters as diagnostic tools.

HFC '96 pack available

The Society has maded available the proceedings manual and audio transcripts from HFC '96, which was held in Tucson, AZ, in September. It was the first-ever technical workshop jointly sponsored by the SCTE and the IEEE Communications Society.

For information on ordering, contact SCTE national headquarters at (610) 363-6888.

By Ron Hranac

Doom and gloom?

"Gloom, despair, and agony on me
Deep dark depression, excessive misery
If it weren't for bad luck
I'd have no luck at all
Gloom, despair, and agony on me"
—Song from some of the comedy skits on the 1970s syndicated TV program "Hee Haw."

If you've been reading the popular media recently, you might get the impression that the cable industry probably should adopt the above as its theme song. Consider a few recent examples:

• Oct. 4, *USA Today*: Time Warner Cable Chairman Gerald Levin was quoted as saying he is no longer interested in the information superhighway or providing telephone service via cable. Further, he was said to be considering getting out of the cable system operating business altogether. Doom and gloom.

• Oct. 14, *Business Week*: An article titled "Cable TV: A Crisis Looms" painted a dismal picture of an industry on the defensive because of new rivals. Stocks are down, subscriber growth is slowing, monthly bills are rising, operating results are weak, debt is high, new technology deployment has been delayed, competition is here, and cable telephony uptake is low. Doom and gloom.

Oct. 24, *Rocky Mountain News* (a similar story also appeared in the *Wall Street Journal*): An article in the Denver newspaper's business section noted that TCI has suspended existing purchase orders with major vendors while it examines internal inventories and gets a better grip on capital spending. As a result, the vendor community has seen its stock prices take a nosedive. Doom and gloom.

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

• Questionable telephony results: I can't remember the name of the publication, but a recent article I read said that in Time Warner's Rochester, NY, telephony project, a large percentage of customers who take TW's telephone-via-cable service go back to the original provider at the end of the two-month free trial period. As well, the previously mentioned *Business Week* article stated that after 11 months, Jones Intercable's Alexandria, VA, system had only 247 telephone subscribers. Doom and gloom.

I haven't seen so much bad cable press since the negative publicity we got from the folks at *Consumer Reports* in 1991 (*"Consumer Reports* Readers: Satisfaction with Cable TV Lowest in Survey History," *Consumers Union Newsletter*, August 21, 1991). Cable's naysayers appear to be having a heyday. Doom and gloom. Is it really as bad as some in the media make it out to be? For the most part I doubt it. There's no question that we re no longer the darlings of Wall Street. Industry stock prices are definitely on the down side. Even so, cable is a $26 billion per year business, and two out of three TV households subscribe to our service. That's certainly nothing to grumble about. True, growth has slowed, but we're still growing, despite competition from direct broadcast satellite (DBS), multichannel multipoint distribution service (MMDS) and others. If anything, the marketing campaigns of our competitors have for now been beneficial to both them and us, by increasing overall public awareness.

Competition, especially from DBS, is something that we absolutely have to take more seriously. When DirecTv and USSB launched a couple years ago, a few very senior cable industry executives dismissed DBS as a temporary phenomenon that would not be a long-term threat. Wrong. There are now five DBS providers—AlphaStar, DirecTv, EchoStar, PrimeStar and USSB—and their cumulative subscriber count is expected to reach 5 million by the end of this month. Some analysts predict the U.S. DBS industry will hit 20 million subs by the year 2000. A good sized chunk of that 20 million could, and probably will, come from our own subscriber base. We need to pay more attention to good customer service, positive marketing efforts, reasonable rates, quality and reliability, and program content. This latter item may mean the need to provide more services (a la pay-per-view and near-video-on-demand) via digital compression, a technology now being used by DBS. The bright side here is that we get to learn from the mistakes and problems of others before we deploy compression on a wide-scale basis.

It should be no surprise that Time Warner's Gerald Levin has made the statements attributed to him in *USA Today*. Programming is one thing his company does very well, and the recent merger with Turner Broadcasting makes that even more so. The cable side of Time Warner is saddled with huge debt, so why not consider spinning off the cable assets and concentrate on programming? Cable systems have been bought and sold before.

Time Warner's involvement in the so-called information superhighway has actually been an asset to the entire industry. We've learned much from that company's Quantum project (the 1 GHz system in Queens, NY), as well as the Full Service Network in Orlando, FL. Technology has advanced because of these and similar projects, and we have improved our understanding of what consumers want and

are willing to pay for. Time Warner is enjoying success with its cable modem activities, having just rolled out the Road Runner service in two Ohio cities. More are planned. Word is that initial customer feedback is very positive. Yes, there have been a few stumbling blocks with reverse path activation and operation (no surprise there), but the problems are manageable and the modems are working.

Cable modems haven't hit the streets in large numbers yet (only 40,000 or so have been installed), due to a number of reasons. One reason that is holding back some companies is a lack of standards and interoperability among modem manufacturers. That should be hopefully sorted out by the time you read this. CableLabs is anticipating a 1996 year-end completion of detailed cable modem specifications. Those specifications are intended to provide product interoperability, so that, in theory at least, cable modems ultimately will be able to be sold in retail outlets such as Circuit City. Consumers will be able to go to their favorite store, buy a cable modem, hook it up at home, and subscribe to the local operator's cable modem service, regardless of who the operator is or what company manufactured the modem. Modems that meet the proposed specifications should be available by the end of 1997.

As for telephony via cable, the success in the United Kingdom has been a major inspiration for operators in this country. While we may not see the 30%+ penetration that cable telephony operators are enjoying across the pond, I think it's still too early to pass judgment on cable telephony. In the case of the U.K., keep in mind that British Telecom is not held in the highest esteem by the subscribing public. While the U.K.'s cable industry is getting itself established as a provider of cable and telephony services, British Telecom is prohibited from providing competitive cable service. Telephony competition should naturally be expected to do well in that kind of environment.

The U.S. regulatory environment is much different than that in the U.K., and for the most part, the phone companies do a decent job here. We will have to work harder to get a piece of this country's telephony market. We also have an image problem to overcome as we attempt to convince our subscribers that we can provide reliable telephone service. Some studies have suggested that joint ventures with well-known names such as AT&T, MCI, Sprint and others may help us to be more successful with telephony compared to trying to do it ourselves. Time will tell.

When you look at the big picture, I don't think the cable industry is in the bad shape portrayed by the popular press. For the 24 years I've been in this business, there have always been up and down cycles. Cable is a big industry now, and we're watched a lot more closely than ever before. Maybe the real lesson to be learned here is how well other industries manage the popular press. That's the real doom and gloom. **CT**

By Justin J. Junkus

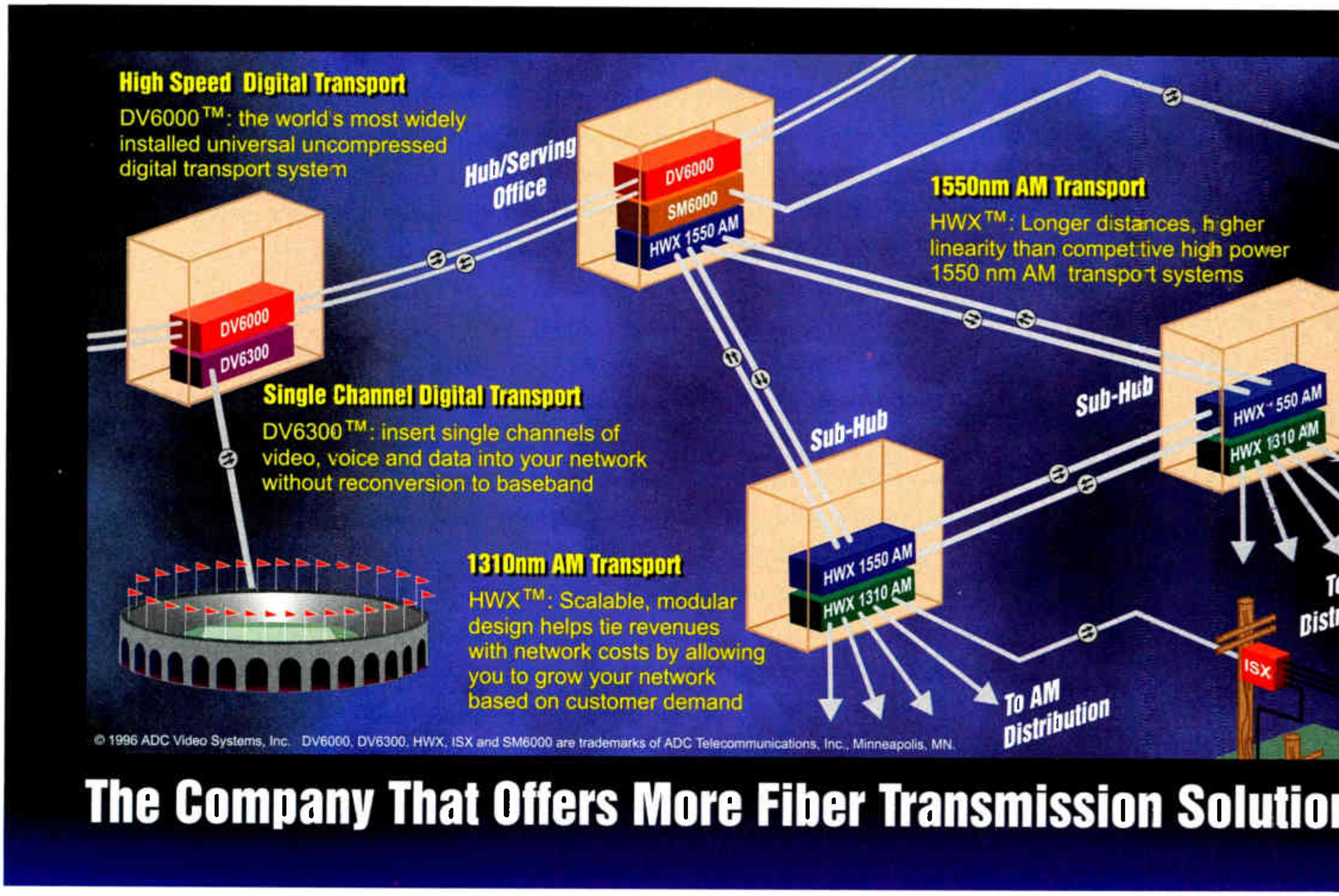
Business telephony systems

Up to this point, much of this column has mainly concentrated on network and residential applications of telecommunications. This month, we are going to look at systems owned by businesses. This is an area that cable operators will be examining as they expand offerings to business parks or multiuse buildings passed by cable routes.

Justin Junkus has over 25 years experience in the telecommunications industry. Previously the AT&T cable TV market manager for the 5ESS switch, he is currently president of KnowledgeLink Inc., a telecommunications training and consulting firm. If you want to contact him, he may be reached at his e-mail address, JJunkus@aol.com.

Business telecommunications needs will vary, based on business size. Small business customers are similar to residential customers in many ways. For example, the business needs to decide which service provider will provide local access to the public switched network. In addition, like a residential customer, a business must choose its interexchange carrier to handle long distance calls. These are the choices that will determine if it will be the cable company or the traditional phone company that will provide communications access for the business.

After the business makes the choice of access providers, it must make other communications decisions. These other choices could mean additional revenue for the service provider, if the service provider carries the product needed by the business. For a single line, business customers need to order basic phone services just like the residential customer. They need to specify features and choose telephone sets. In addition, they need to provide wiring from the telephone sets to the point where the line from the service provider enters the business, called the demarc, or point of demarcation. After setting up for initial service, the small business will find that



managing the phone system requires little more than reviewing the bill each month, and maybe unplugging a telephone set to move it when needed.

Advertising in the Yellow Pages is an important consideration for businesses, apart from the hardware and line features they order. Since Yellow Pages and local service access both belonged solely to the telephone company up to about a year ago, advertising in the business section of the phone book was automatic. Now, both the MSO entering the telephony market and the business customer buying access from the MSO have to be sure this important area is still covered for the business.

As a business becomes larger, it must make still more telecommunications choices. For operations requiring more than one line, the business needs to decide if the service provider should continue to provide separate lines to each location where phone service is required. Its alternative is to concentrate lines from phone users to the facilities offered by the service provider. Individual lines can provide a better chance of always getting access to the telephone network (known as grade of service), but this alternative can be more expensive. As the number of lines increase, it is not the most efficient method. The logic is the same as not giving every phone user a permanent connection to every other phone user in the public switched network. Usually, not everyone will be using the phone at the same time, so some concentration is both feasible and more economical than private lines. One possible exception to this rule is Centrex service, which we will discuss later.

Key systems

Key systems are the low size end of business systems that concentrate station lines to lines going to a service provider. A key system consists of business station sets with keys (or buttons) that are pressed to connect to an outside line, and a control device called a key service unit (KSU). One side of the KSU connects to the business station sets. The other side of the KSU connects to lines from the service provider's headend or central office telephony switch. At the service provider's switch, the line terminates on a line circuit. To dial an outside call from a key system, a station user depresses the key corresponding to the outside line, and dials the phone number the same as from an individual line. For internal calls, the key system provides an intercom feature, which allows the user to call between station sets without using an outside line.

Key systems have evolved from the very simple 1A1 Key System introduced by the Bell System in the 1930s to today's systems that include a myriad of features in addition to concentration. Some examples of these features are automatic dialing, call announcing, conferencing, automatic restriction of calls outside of the local area (toll restriction), music on hold, and different ringing for different parties or stations (distinctive ringing). With digital key systems, one of the system stations may be designated as an attendant console, and all incoming calls arrive at that station first. The attendant station will then have a number of features of its own, such as monitoring of the entire system for busy station conditions and the ability to transfer calls. Key systems typically serve 3 to 50 station sets.

Private branch exchange

The next step up in size of business systems is a private branch exchange (PBX). A typical range for the number of station set lines in a PBX is between 50 and 20,000. In addition to handling more station sets on the user side of the PBX, the PBX incorporates trunks instead of lines to connect to the service provider. A typical ratio of station set lines to service provider trunks in a PBX is 10:1.

Depending on the type of trunk, the difference between a line and a trunk can be small. The physical connection is still one or two pair of wires. One distinction is that the trunks are connected to trunk circuits at the PBX rather than to a KSU or directly to station sets. Depending on the type of trunk, these circuits provide special functions, such as signaling, ringing or multiplexing (another form of concentration). At the service provider's telephony switch, the termination of a trunk also is called a trunk circuit. Some types of trunks and the corresponding trunk circuit are loop, E&M, T-1, and ISDN primary rate.

"More and more, improved software and processors are blurring the distinctions between key systems and PBXs."

PBXs tend to have more features than key systems. While an attendant position is optional in a key system, a PBX typically includes this feature as standard. More user features are provided, such as grouping of users by organization for conferencing or call coverage, and data communications interfaces called modem pools. The PBX can provide automatic route selection capability, so that calls are always sent through the public switched telephone network using the least costly service provider. Additionally, management features are available to help administrators review system and station traffic, change station features, track costs by station user or group, and generally keep track of total system configuration.

What determines the functionality of key systems or PBXs is the amount of control and programmability within the system. All modern business systems are essentially digital machines consisting of three major components: peripheral interfaces, switch matrix and processor. The peripheral interfaces and the switch matrix are relatively simple components that provide points of connection for wires to and from the business system, and an electrical path through it. The processor, on the other hand, is a special purpose computer complete with hardware and software. It is largely the software that determines the system functionality. Like the personal computer on your desk, a business system can be upgraded by changing the software to a new release that provides more features and functions.

More and more, improved software and processors are blurring the distinctions between key systems and PBXs. There is, in fact, a category of business systems known as hybrids that combine the functions of key systems and PBX. The Federal Communications Commission determination of whether a system is a key system or a hybrid is based on whether a single line station can access only a single line to a service provider (key system), or a pool of lines (hybrid).

Centrex

To close this month's column, we need to discuss Centrex service as a business system, for this is where an important revenue opportunity exists for the cable company that owns a telephony switch. Centrex is the service provider's way of offering a business user a "virtual" PBX, by dedicating part of the service provider's headend or central office switch to a particular business customer. Most of the features of a premises-based PBX or key system mentioned earlier can be provided by a Centrex service. This includes attendant service and four or five digit station-to-station calling. In addition, all of the management reporting features are available to the business owner, along with several adjunct features, such as enhanced voice messaging and automatic call distribution (ACD).

From a business owner's perspective, the advantage of Centrex is that it is not necessary to tie up capital dollars, floor space, personnel and support systems to provide telephone service to the business. These responsibilities and any need to grow communications systems as the business grows are offloaded to the communications service provider, for the appropriate fees. For the cable company, providing Centrex services to businesses offers the ability to operate their digital switch closer to its capacity, and share the costs of the switch investment with another business opportunity. **CT**

Women in Technology Award

Congratulations Pam Nobles

By Laura K. Hamilton

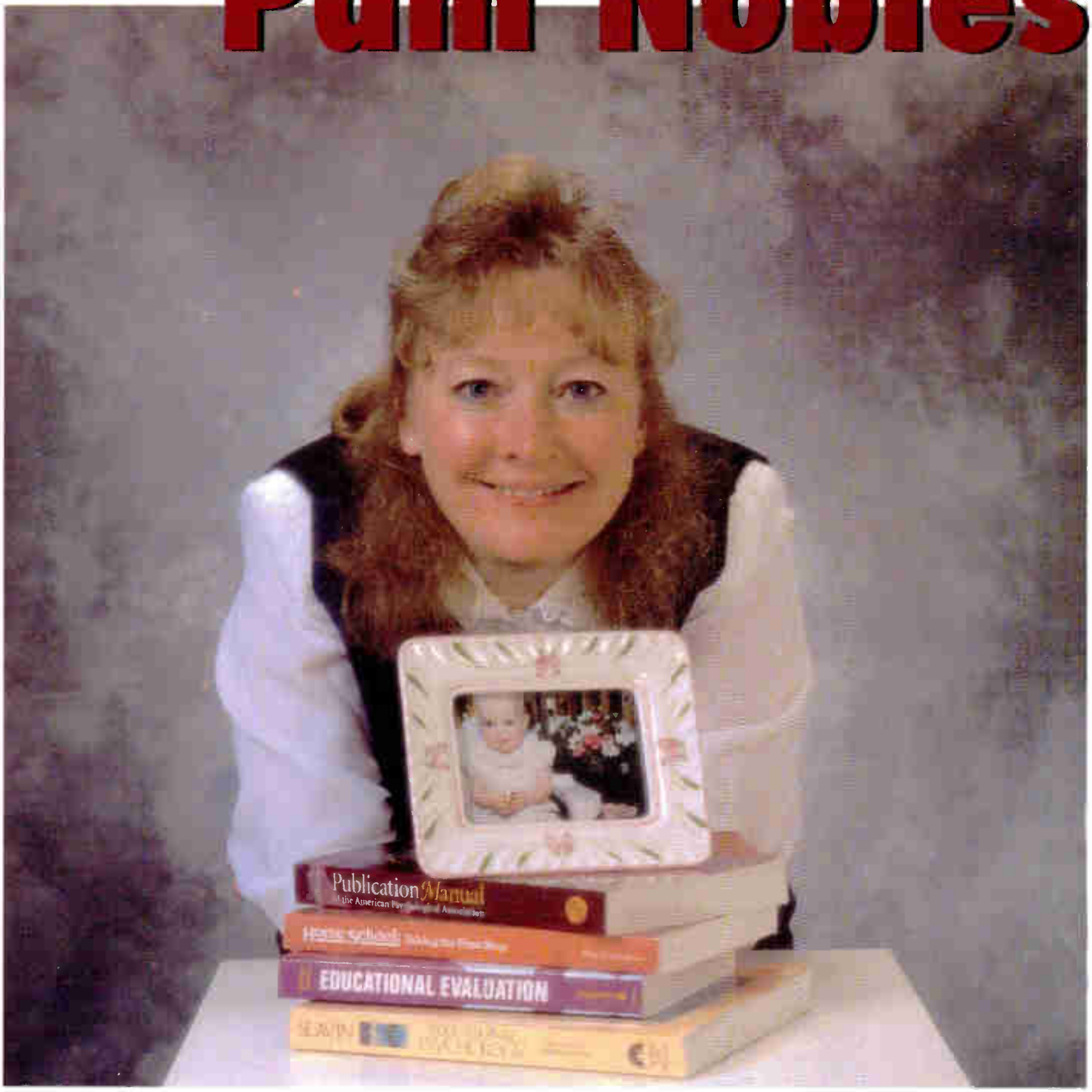


Photo by Bob Sullivan

Pam Nobles, this year's winner of the Women in Technology Award, balances many roles: technical training curriculum developer for Jones Intercable, masters degree candidate in curriculum and instruction, and mother of Eliza Catherine who was born in 1995.

CONGRATULATIONS

Scientific Atlanta

To Pam Nobles,

recipient of the 1996

Women in Technology Award,

in recognition of your

valuable contributions

to the cable industry

in technical training

and education.

Does this sound vaguely familiar? "If the cable telecommunications industry is going to successfully implement (put your favorite hot technology topic here) and compete with other communications providers, it must actively pursue the goal of cultivating a highly trained engineering/technical work force."

Well, if over the past few years you've been to many cable conventions, read the trades or even had a cursory conversation about the industry's technical challenges, you've probably heard (if not said) something close to those words.

Much in the training arena has changed and is still changing, but you don't have to be an industry visionary to recognize one of the most obvious transformations: Today's technical community isn't going to find it as easy as it might have in the past to avoid some sort of formalized training to keep technology from turning into a confusing maelstrom of acronyms and technical formulae.

Laura Hamilton is senior editor of "Communications Technology."

Pam Nobles is a "change agent" when it comes to training and has been for quite a while in the industry. And although "change agent" may be one of those pop business-speak terms you might have heard tossed about, it's a good way to describe her. Nobles is one of those people who helped transform—and are still changing—the way the cable telecommunications community thinks about training its technical people.

The winner of this year's Women in Technology Award (sponsored by the Society of Cable Telecommunications Engineers, Women in Cable & Telecommunications and *Communications Technology*), Nobles is a familiar face on the technical side of the cable telecommunications industry. You might have seen her speak at the Society of Cable Telecommunications Engineers' Cable-Tec Expo, attended one of her lively workshops or seen her name attached behind the chairman title of the SCTE's Training Committee, Cable Games Subcommittee and Service Technician Certification working group. (See the sidebar on page 30 for more details on Nobles' involvement with the SCTE.)

She seems particularly proud of some of the work she's done with the SCTE Scholarship Committee.

"In the past we have done 'success stories' about scholarship recipients, who because of their scholarship and the visibility it brings, have received promotions or new jobs," Nobles said. "These people have a lot of drive and commitment and would probably achieve that education anyway, but there is satisfaction in knowing that SCTE, and in a small way, I had a part in that person's success."

And if you look at Nobles' own drive and commitment and the importance she's placed on training herself as she's worked her way up at Jones, you can see why she's so passionate about training others to succeed in technology as well.

Photo by Bob Sullivan

Here at SCTE's Cable-Tec Expo in 1991, Nobles donned stripes, stopwatch and whistle to referee the very popular National Cable-Tec Games where technicians from around the country compete for bragging rights.

Let the Games begin

Pam Nobles has been a big part of the ongoing success of the Society of Cable Telecommunications Engineers Cable-Tec Games at state, regional and national conventions. She seemed to honestly enjoy her role as chairman of the Cable Games Subcommittee and could usually be spotted easily by her referee stripes when the fun of the Games began.

"I think the Cable-Tec Games give installers, technicians and even technical supervisors an opportunity to show off in a good-natured way, and getting a medal for an event generates a lot of excitement," Nobles said.

If you've enjoyed the thrill of victory at the Cable Games and toted home one of those gold, silver or bronze medals, and if you happen to spot Pam Nobles in the near future, you might want to thank her for all the work she put into helping to make the Games the success they are today.

"The" draftsman

Nobles started in the cable industry in 1982 as a draftsman—actually "the" draftsman—for Jones Intercable in Denver. Early in her career at Jones she became involved with the Society of Cable Telecommunications Engineers and was among the initial start-up group of the Society's Rocky Mountain Chapter.

Jones was growing rapidly when she first started. In 1983 her department expanded and she was promoted to design and drafting department supervisor, where she continued for four years.

"During this time, I saw a great need for training and education," Nobles said, "Our associates were asking for training specifically in the cable design area, but in other technical areas as well. I began developing and giving technical classes on an as-requested basis."

She also saw an avenue to educate herself at the same time. Taking advantage of Jones' support in educating its associates, she returned to

school for a degree in electrical engineering. In 1987, she took advantage of an opportunity to move into technical training and development, and with the completion of her bachelor of science degree in electrical engineering technology from Metropolitan State College in Denver in 1989, she was promoted to senior staff engineer at Jones with an emphasis still on technical training.

Slowing down?

Today Nobles is pursuing a masters degree in curriculum and instruction from Colorado Christian University while still developing technical training curriculum for Jones and spending time with her young daughter, Eliza Catherine. Nobles is taking a sabbatical from her heavy involvement with the SCTE until she finishes the accelerated masters program in May 1997.

Although it sounds like she has a lot on her plate right now, Nobles is keeping it all in perspective with a little help from Eliza and her husband, Keith. "With the birth of my daughter in 1995, a whole new world has opened up for me. I'm still a busy person—always have been a busy person. But Eliza has helped me slow down," Nobles said. **CT**

SCTE committee and board work

The following list includes some of the various positions Pam Nobles has volunteered her time for the Society of Cable Telecommunications Engineers since 1992:

- National Region 2 director; Western Region vice chairman (1993-1995)
- Training Committee chairman
- Cable Games subcommittee chairman
- Service Technician Certification working group chairman
- Scholarship Committee member
- Health and Safety Subcommittee member
- Installer Certification Manual Subcommittee member

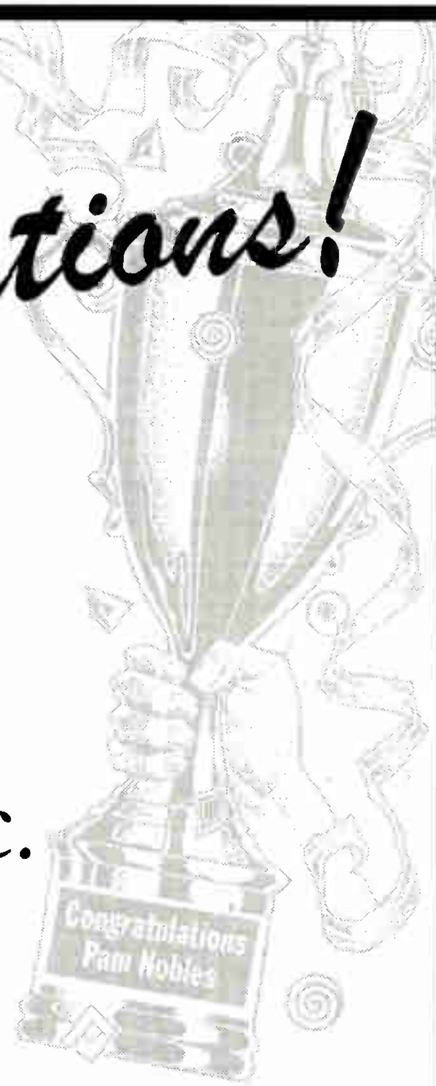
In January 1994, she also was a member of a Walter Kaitz Ad Hoc Advisor Group to create a technical development program for ethnic minorities in the telecommunications industry.

Nobles also refined the *Facilitator's Guide for CableLabs' Outage Reduction Program*, including a pilot for implementation at SCTE chapters.

Photo by Bob Sullivan

Here Nobles conducts a training workshop at SCTE Cable-Tec Expo '94.

Congratulations!



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By Gaylord A. Hart

Deploying ATM in advanced HFC networks

Historically, CATV systems have been characterized by a high degree of transmission asymmetry (virtually all content flowed to the subscriber) and a point-to-multipoint architecture (all subscribers received the same content in a broadcast fashion). For entertainment services such as television and music, this is an extremely efficient and cost-effective network.

However, voice and data applications place new requirements on the network. Bidirectional transmission and point-to-point transport are necessary, in essence requiring more bandwidth per subscriber. Modern hybrid fiber/coax (HFC) architectures readily provide extra bandwidth by segregating traffic onto individual optical nodes serving a small number of homes. This bandwidth may be increased as often as needed (and economically justified) simply by subdividing existing optical nodes into two or more smaller nodes, each fed with its own fiber.

In a competitive environment, however, it makes better economic sense where possible to make more efficient use of the existing network infrastructure rather than to upgrade or add nodes. Packet switched digital transport technologies, which use statistical multiplexing in the transport path, can greatly increase transmission bandwidth efficiency for voice, data and video-on-demand (VOD) services. The efficiencies to be gained thereby will only increase as these services become more prevalent on HFC networks. Fast-packet transmission also provides the benefit of bandwidth on demand to the subscriber without any network re-engineering, which gives the overall network much greater flexibility for providing new services and evolving gracefully.

"It makes better economic sense where possible to make more efficient use of the existing network infrastructure rather than to upgrade or add nodes."

Two other trends provide even more compelling reason to migrate toward fast-packet transmission: the migration of analog signals to digital transport and the increasing need for integrated delivery of voice, video and data services throughout the network using a common transport mechanism. TV signals are now the primary analog signals carried on an HFC network, but over the next few years these signals will be displaced increasingly by compressed digital NTSC signals. Once these analog signals disappear from the network, it makes little sense to transport their digital representations separately from other digital traffic on the network. An advanced digital network must somehow provide enough built-in flexibility to provide the unique transport requirements of voice, video and data while at the same time using a common transport mechanism for all. Ideally, a single digital pipe to the home should provide all these services.

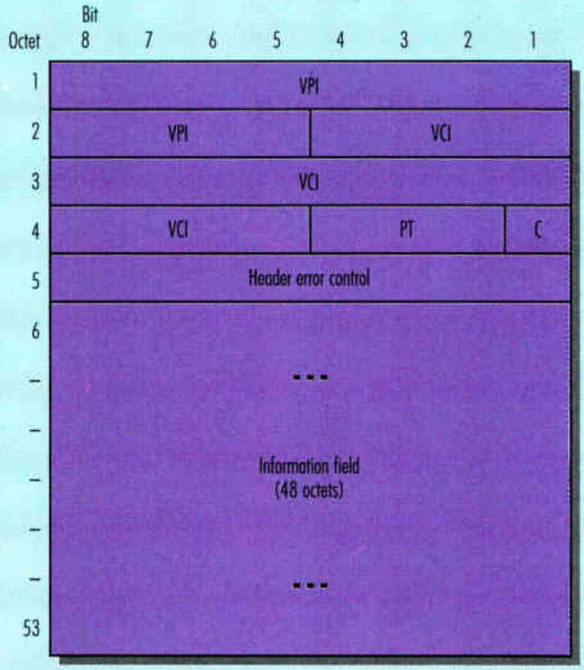
Carrying voice, video and data on the same network through the same digital pipes is not an easy task, however. Each of these signals has unique transmission requirements. Data transmission tends to be bursty, but transmission delays can usually be tolerated. Television requires a lot of bandwidth to the home, but little or none back to the headend. Telephony requires symmetrical transmission, but will not tolerate long transmission delays. Data is somewhat tolerant of transmission errors because errored packets can be retransmitted, but TV signals do not allow retransmission of errored packets because another video frame is already on the way. A purely digital network must provide the mechanisms and flexibility to meet each of these unique transmission requirements. Packet switched networks are more suitable for this purpose than circuit switched networks, and of the common packet technologies available today, only ATM (asynchronous transfer mode) will ultimately provide the flexibility, efficiency and low cost necessary to accomplish these objectives.

ATM cell structure

ATM is representative of a new family of packet protocols (called fast-packet protocols) that have been developed to eliminate most of the transport overhead and error processing in the transmission path itself, thus allowing higher transmission throughput. These fast-packet protocols have been developed to take advantage of the virtually

Gaylord A. Hart is director, advanced technologies with XEL Communications.

Figure 1: ATM cell structure



Basic ATM NNI cell key:
VPI: Virtual path ID
VCI: Virtual channel ID
PT: Payload type
C: Cell loss priority
HEC: Header checksum

error-free transmission of today's networks and the use of low-cost, intelligent terminals at the network endpoints. Error detection and processing must of course still take place, but these functions are primarily carried out now by the end terminals rather than the transmission path equipment.

Packet switched networks further increase throughput by statistically multiplexing several users' digital information onto a single transport channel. This information may consist of voice, video or data services, or a combination of these. Unused channel capacity from one user is then allocated to another user on a real-time basis, thus taking advantage of the dynamic nature of channel capacity requirements. Fewer transport channels are now required in the network since each individual channel is more fully utilized. This results in more efficient use of network resources and lower transport costs.

Multiplexing is carried out by partitioning each user's data into small packets, or cells, for transport. Each ATM cell has a strictly defined structure consisting of a 48-octet payload field and a 5-octet header, for a total of 53 octets. *(Editor's note: An octet is a byte.)* The header is used for routing the cell through the network and performs four critical transport functions: 1) packet boundary delineation, 2) packet routing to the intended destination, 3) congestion control and 4) error detection. The header represents transport overhead and is kept to a minimum since it consumes transport capacity. For an ATM cell, the maximum transport efficiency is 90.6% (48/53). Keeping the cell short provides greater flexibility in allocating network bandwidth; keeping the cell fixed in length allows simplified and faster switching with minimal buffering. Because fixed size cells also allow greater control and predictability of transmission timing and delays, ATM is well suited for low-delay, low-jitter applications such as voice and video.

Figure 1 shows the basic structure of the ATM cell (a slightly different structure is used at the interface between the network and the end user). The virtual path ID (VPI) and virtual channel ID (VCI) comprise two routing hierarchies and together form a 28 bit routing address used at each node to determine the next receiving node. The payload type field identifies whether this is user or network management cell, whether the cell encountered congestion in transit through the network, and other functions. The cell loss priority (CLP) bit is used to mitigate network congestion by prioritizing each cell. Should congestion occur, a cell with its CLP bit set will be discarded by the network before a cell with its CLP bit clears. The header error control (HEC) field is used to determine if errors have occurred in the header itself and to delineate ce boundaries. This 8-bit field also allows single bit error correction in th header itself. Cells containing unrepairable header errors are discarded within the network.

One of the great advantages of ATM is that it was designed from the beginning to support the unique transmission requirements of several types of services, including voice, video and data. This is accomplished by embedding another structure called an ATM adaptation layer (AAL), unique to each transport service type, within the 48-octet information field. The AAL is responsible for providing such functions as cell sequencing and information field error detection. Within the AAL structure itself is a smaller payload field containing the end-user or

ATM adaptation layer types

AAL type	Type 1	Type 2	Type 3/4, Type 5	Type 3/4	N/A
Service class	A	B	C	D	X
Bit rate	Constant	Variable			User-defined
Connection mode	Connection-oriented			Connectionless	User-defined
Source & destination timing relation	Required		Not required		User-defined

- Impact resistant for protection during reburial
- Eliminates craft application sensitivity common with tapes and heat shrink methods
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Twisted pair and hybrid closures meet requirements of Bellcore TR-NWT-000251

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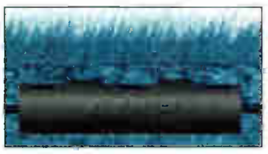
Volume Resistivity	1×10^{12} ohm/cm per ASTM D 257
Copper Corrosion	1B rating per ASTM D 4048
Slump Resistance	≤ 5 mm after 24 hrs. at 80°C per ASTM D 2202
Coax Closures:	
Thermal Shock	-40°C to +60°C
Impact Resistance	5 pounds at 12 inches
Water Immersion	1 foot water head



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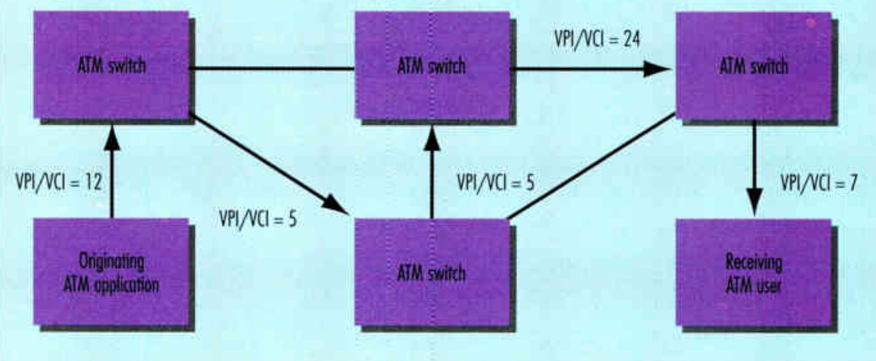
application information.

AAL types have been defined for each major service class. The accompanying table on page 36 shows the various AAL types currently defined and the service class each supports. (For technical reasons, AAL Types 3 and 4 were combined into a single AAL type.) AAL 1 cells are used to transport voice and video services using a constant bandwidth. AAL 2 cells are used to transport voice and video services where the bandwidth requirements may vary with time. AAL 3/4 and 5 cells are used for data transport where bandwidth varies with time and transport delays are tolerable. Class X service is provided for raw cell service to allow proprietary AAL types to be defined by network equipment vendors.

Figure 2: ATM packet switching



ATM cell transport

ATM is a connection-oriented packet transmission protocol. As the name implies, connection-oriented networks require that a logical connection be established between two endpoints before data may be transferred between them. These connections are made via virtual circuits and require setup operations to establish each connection and its routing path. Virtual circuits use a predefined routing path for all packets traveling between two network endpoints. These routing paths are defined by logical and physical paths through the network from one endpoint to the other and are maintained by routing tables set up at each switch when the connection is initially established. Since all cells follow the same path through the network, they also arrive at the end node in the same sequence as originally transmitted (providing no packets have been discarded due to errors).

The term "virtual circuit" simply means such a channel appears to the end user just as a real circuit provided by a switched circuit network. Unlike switched circuit networks, however, several virtual circuits (and their cells) can share the same physical channel between any two nodes internal to the network. Virtual circuits may be further characterized as switched virtual circuits (SVCs) or permanent virtual circuits (PVCs). SVCs are analogous to dial-up connections in that the setup and teardown of the connection are done on a demand basis in real time. PVCs are analogous to leased line connections and must similarly be provisioned to establish the connection.

Unlike other packet technologies, ATM supports reserving network resources and defining a quality of service (QOS) for a virtual circuit when the connection is initially established. This is critical for delivering a diverse set of applications with a wide range of transmission requirements, and this is another major reason why ATM is the best packet technology for delivering voice, video and data over the same network. Reserving network resources guarantees adequate bandwidth will be provided by the network to transport the service intended for the link. In defining the QOS for a link, the network transport requirements are tailored specifically for the application to be transported. Not all services require that the same QOS parameters be defined. For example, end-to-end transmission delay may be critical for voice transport, but unimportant for data. Typical QOS parameters include cell error rate (CER), cell loss ratio (CLR), cell transfer delay (CTD) and cell delay variation (CDV).

Figure 2 shows a simplified ATM network with a single application serving a single user over a virtual circuit that has already been established. The originating application could be a movie or an e-mail being sent to the receiving user. The originating application formats its data into ATM cells that are buffered locally and then time-division multiplexed into the network when transport capacity becomes available. Cells are transported and routed within the network as indivisible units. At each switching node, the 28-bit VPI/VCI address in the cell header is examined and compared with a routing table maintained at the ATM switch to determine the next receiving node. If necessary, cells are buffered at each switch while awaiting transport capacity.

Several possible paths may exist for transporting a cell through the network. A virtual circuit connection is defined at each switch in the network by a routing table that associates a switch port with a VPI/VCI address. The routing tables maintained at each switch guarantee that for a given virtual circuit all cells will take the same path through the network. Note that the VPI/VCI address has local significance only and that a new address may be assigned to a cell at each switch. These addresses also are predefined and stored as part of the routing tables at each switch when the initial connection is established. Since these addresses have local significance only, different virtual circuits may actually use the same VPI/VCI addresses simultaneously in the network providing they are not used simultaneously on the same physical path.

At the receiving end, the 5-octet cell overhead used to transport the cell through the network is stripped off, and the 48-octet information field is passed on for AAL processing. Here the final payload data bits are reassembled in the correct order before handing off to the end user or terminating application.

The nodes in a packet network are connected by fixed-size transmission pipes. Under normal conditions, the

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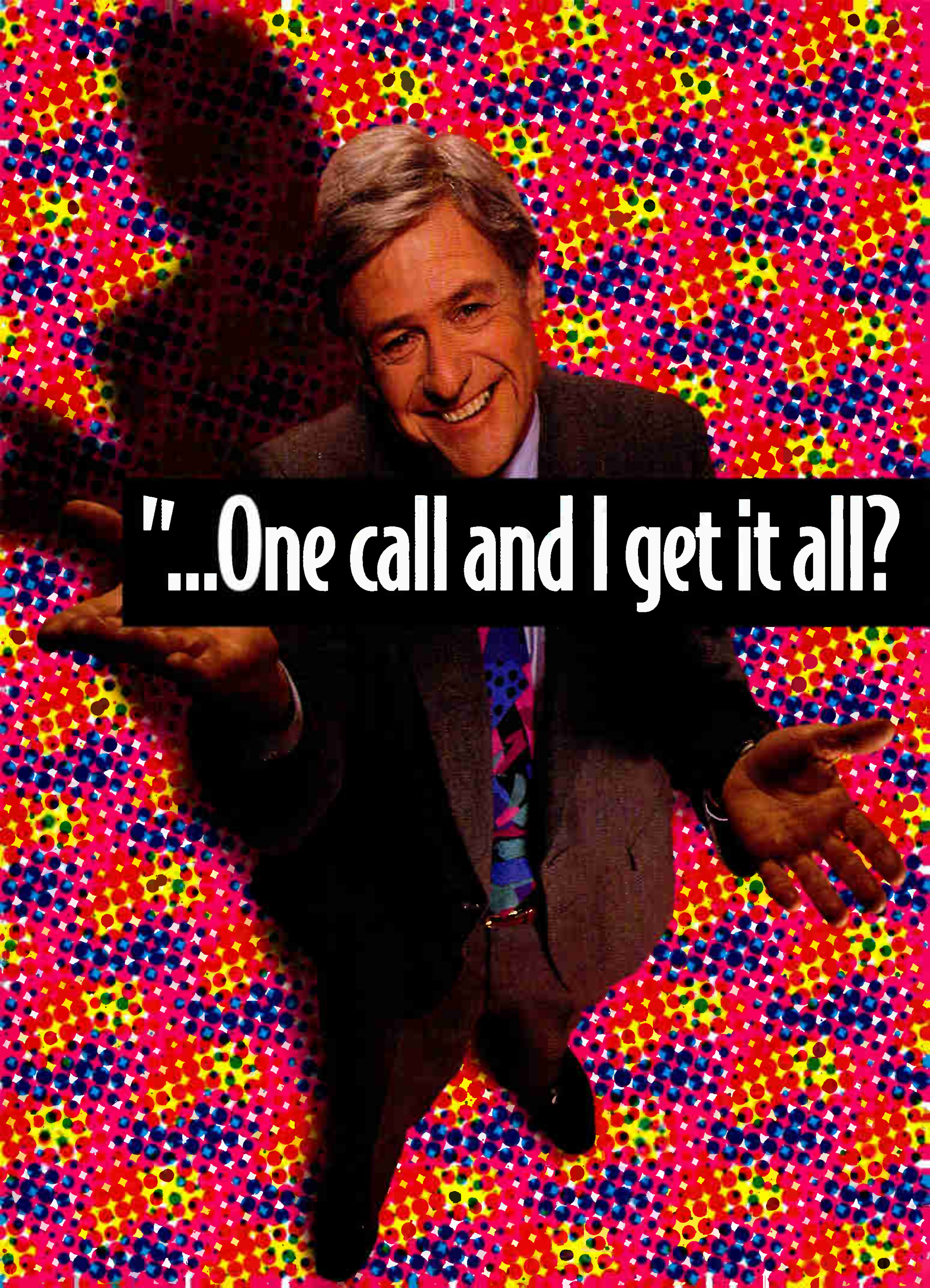
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number of cells entering one of these pipes is not enough to fill the pipe, and cells are allowed to enter the pipe as soon as they are available. Congestion occurs when more cells are trying to enter the pipe than the pipe has capacity for. When this occurs, cells must be buffered at each switching node while awaiting a slot in the pipe for transmission. The buffers thus serve to mitigate peak demand by spreading it out over a longer period of time. As the buffers begin to fill up with cells, the delay increases for each cell before transmission to the next node.

"It is no longer possible to operate systems as islands. Internetworking is essential."

Unlike traditional switched-circuit networks, which can have connections blocked while circuits are unavailable during heavy traffic loads, packet networks can still accept packets under heavy load conditions. When congestion occurs, a packet network will simply experience greater transmission delay. However, the buffers are also finite in size. If the network experiences extreme congestion (i.e., the cell buffers overflow), significant delays will result because those cells lost in the buffer overflows must now be transmitted again, thus adding more traffic when it is least desired. Once congestion begins to occur in a packet network, performance tends to degrade rapidly. Careful traffic engineering is needed to avoid these situations.

HFC ATM network architectures

Historically, CATV systems have existed as isolated islands receiving signals via satellite and other over-the-air antennas. It has not been uncommon for a large metropolitan area to be served by several MSOs, each operating a system providing service to a particular geographic region. Because of the broadcast nature of traditional CATV services, little need existed for building large interconnected CATV networks between these systems. Even within systems, individual headends typically only needed to be connected for local distribution of video signals. This was accomplished with AML microwave links or, more recently, with fiber.

Competition to provide new services, ongoing deregulation of the telecommunications industry, competitive threats to existing services, migration from analog to digital signal delivery, and rapid growth of the Internet and data services have changed all this. CATV systems must in the near future provide a combination of analog TV, compressed digital TV, HDTV, telephony, data services, Internet access, and numerous other interactive and multimedia services. Many of these services require connection to a larger universe of networks, both national and international. It is no longer possible to operate systems as islands. Internetworking is essential.

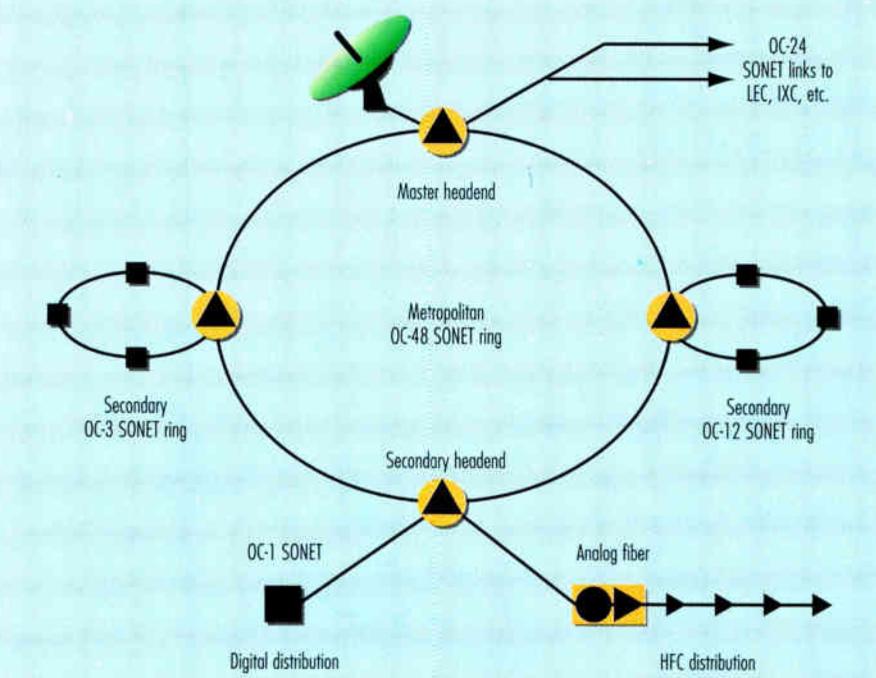
At the same time, there is an increasing economic incentive to integrate service delivery within the network itself, and ultimately to the subscriber. An integrated delivery system reduces maintenance and installation costs as well as capital equipment expenditures by transporting all services through common channels and equipment. At some point, it will no longer make sense to offer disparate services that share the HFC transport path but that essentially operate independently and use different headend and customer premise equipment, transmission formats and signaling schemes.

Digital signals are ideally suited for integrated delivery of voice, video and data services, and ATM is ideally suited for meeting the unique transmission requirements of each of these services while integrating overall network transport. In the end, an integrated network should be capable of delivering all these services to each home over a single data stream with unique content and virtual connections for each service. However, for both technical and economic reasons such a network is still a future prospect. ATM will be deployed incrementally in the network, and services will be integrated on an evolutionary basis as hardware becomes available and economic factors allow.

HFC metropolitan area network

Figure 3 shows a large metropolitan area HFC network consisting of a master headend for gathering

Figure 3: HFC metropolitan area network



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and processing signals, and several secondary headends connected by a SONET ring that transports digital signals between the headends. Secondary SONET rings also may radiate from each headend for local transport of digital signals to businesses or secondary hubs attached to each headend. Each headend in turn has several HFC nodes supporting local distribution of services to residential and small business subscribers. Point-to-point SONET links also may be used to distribute digital signals to individual businesses or other sites. The overall metropolitan network has additional SONET links that connect to the larger network universe: LECs, IXCs, and other CATV systems. Though not ubiquitous, networks of this type already have been built.

From a functional standpoint, the SONET ring shown in Figure 3 is used today to distribute digital TV and audio signals from one headend to another and for local ad insertion and distribution. The ring also is sometimes used to support parallel alternate access telephony and data transport services, though these have typically been operated separately from the CATV network itself. More recently, some operators have installed telephony switches in headends to accommodate switched access telephony services as well, and these switches use the SONET ring for connecting to customers and other carriers.

In most cases these networks are characterized by multiplexers and switches using traditional switched-circuit technologies. The various services are multiplexed onto and off of the SONET ring using dedicated channels. As these networks evolve toward ATM-based transmission, the overall metropolitan architecture will not change, but more of the SONET transport capacity will be used as the physical transport layer to carry ATM cells between switching nodes. In the beginning of this evolution, the fundamental changes will take place at the switching nodes: the regional headends and other hubs where signal distribution takes place. Here, ATM switches will be installed after the SONET multiplexers to route cells onto and off of the SONET ring, thus forming a metropolitan ATM backbone. Such backbones already are common in the public switched network to transport internet traffic and other data services such as frame relay.

The HFC ATM backbone most likely will be used initially to carry data traffic such as Internet access, but distribution of video and audio services between headends will migrate toward cell transport through virtual circuits in this ATM backbone. This will become increasingly more likely as more services on the HFC network are distributed as digital rather than analog signals and as services become more specifically targeted to demographic areas or individual subscribers. One of ATM's great strengths is its ability to simultaneously switch voice, video and data traffic. Switched services such as VOD are ideal for ATM delivery. Eventually, telephony services will migrate onto the backbone as well, and at some point all services likely will reside there.

HFC headend with ATM signal

For the short term, TV and audio signals will likely continue to be delivered from the headend to subscribers over the existing HFC directly to subscribers, nor will distribution or subscriber hardware need to be changed. After being multiplexed off the SONET ring at each headend, the ATM transported signals will be switched to appropriate devices where they will be converted back into native analog or digital signals. These signals will then be modulated onto standard RF carriers for transport to subscribers just as they currently are. The one initial exception to this may likely be iInternet traffic, which by its very nature is already packet based.

Figure 4 (page 46) is a simplified block diagram of an ATM headend and its distribution nodes in the HFC metropolitan area network. The SONET, ATM and HFC transport components are shown. The SONET multiplexer used to interconnect this headend with other headends and secondary sites in the ATM network is shown on the left.

> **"ATM's switching capability opens up many possibilities for economically delivering local ad inserts or VOD services from a single, centralized video file server center."**

This add/drop multiplexer allows ATM signals on the SONET ring to be dropped off at this headend and ATM signals originating from this headend to be added onto the ring for transport to other network destinations. This multiplexer also can be used to transport traditional switched circuit services such as telephony at the same time, but this application is not shown here.

In this evolutionary snapshot, most of the ATM traffic originates at a master headend that feeds over the SONET ring this headend with all its video and audio signals and provides Internet connectivity as well. The SONET multiplexer in turn is connected to a port on a local ATM switch that has additional ports connected to a local file server and all other service distribution equipment in the headend. This switch will examine every ATM cell entering one of its ports and route each cell out of the appropriate port towards its final destination, which also will include putting ATM traffic back onto the SONET ring for routing to other locations. For ATM cells arriving at this headend for service distribution, this will typically be the last switch the cell sees in the network. For cells being routed back onto the SONET ring, this may be one of many ATM switches the cell will pass through before reaching its final destination. The ATM file server shown in Figure 4 might support any one of a number of applications, but in all likelihood will actually be several file servers, each specialized for a particular function: local ad insertion, Internet access, VOD, CD audio or some other application.

Several ports on the ATM switch are shown serving format converters. These simply convert the ATM digital streams back into their native format for modulation onto the HFC distribution network, and this is where the ATM transport stops in this example. The outputs of these converters are digital in the case of compressed digital NTSC and digital audio services and analog in the case of standard NTSC video and audio services. These native format converters then feed standard

Figure 4: HFC headend with ATM signal sources

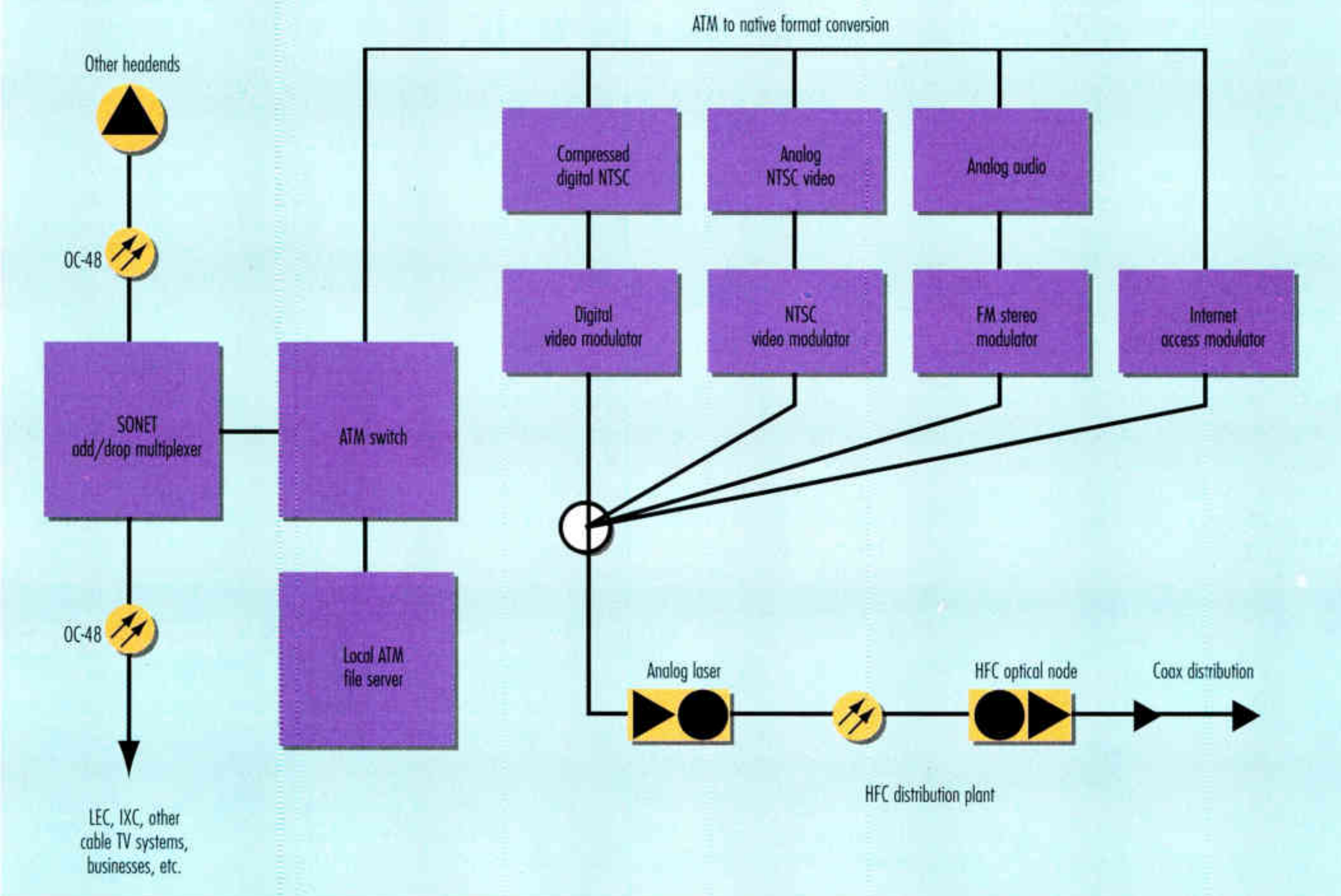

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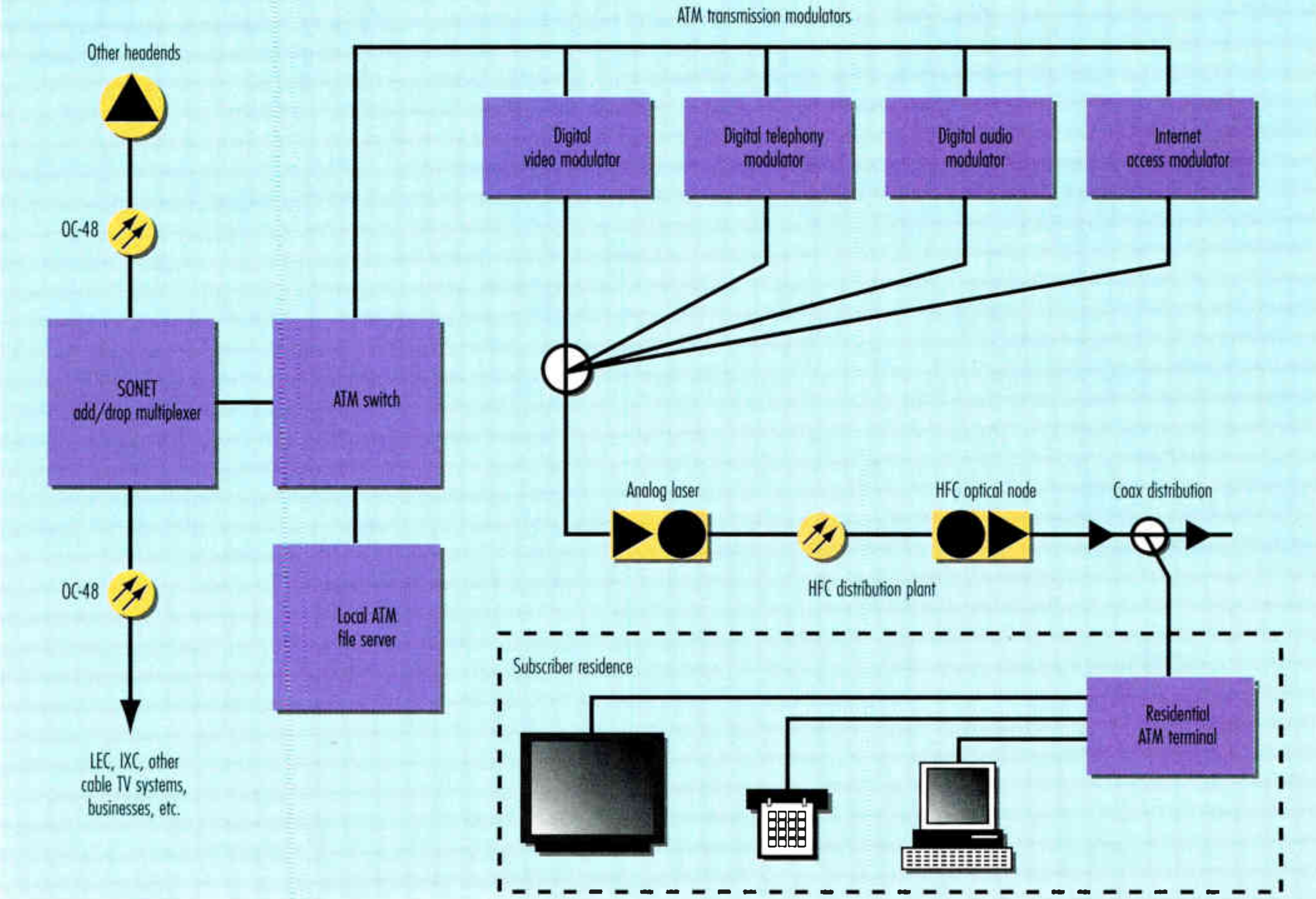
Figure 5: HFC node with ATM distribution to subscriber



headend modulators, and from this point forward the distribution network looks just as it does today. The one exception shown here is the Internet access modulator, which transports ATM cells directly to subscribers' RF data modems.

HFC node with ATM distribution

New services also will be made possible or economical by ATM technology, and these too will be integrated into the network as it evolves. ATM's switching capability opens up many possibilities for economically delivering local ad inserts or VOD services from a single, centralized video file server center. As the ATM switching capability extends to individual subscribers, TV ads may literally be targeted to individual homes—in fact, you may be able to choose your own ads! Some day all television viewing may be video-on-demand operating over virtual channels, but this will be transparent to the subscriber, who only knows that he can watch whatever he wants whenever he wants. Other services such as basic telephony also will at some time be carried by the ATM network.

As the evolution of the ATM HFC network proceeds, more services will begin to be delivered to the subscriber as ATM cells, thus opening the door to the full switching and statistical multiplexing capabilities of ATM. This will likely occur on a service-by-service basis, possibly requiring unique subscriber ATM interface devices (sort of an ATM set-top converter) for each service. In the long view, however, the ATM interfaces will likely migrate into the application device being served, whether it be a computer, telephone or TV set, and no outboard boxes will be needed. Another possibility, however, is to provide a single integrated residential ATM terminal on the side of the house. This terminal would then provide standard interface connections for each of the home's voice, video and data devices, and also may provide local switching functions that could support LAN interconnectivity in the home between telephones, computers and TV sets.

Figure 5 shows a simplified block diagram of the previously shown headend of Figure 4, but at the evolutionary stage where all services are now delivered directly to the residence as ATM traffic. The architecture of the SONET ring, ATM switch and local file server has not changed, though these components may have been upgraded by this point to handle increased traffic. The nature of the ATM traffic itself has changed, however. Services other than entertainment are increasingly carried over the network, including telephony, and more switched traffic such as VOD is being handled. More traffic is now originating from subscribers homes, as well.

Unlike the example in Figure 4, however, ATM converters are no longer used in this headend. All services are now transported digitally in the network and delivered to the home as ATM cells. (Return traffic for such services as telephony and internet access also is via ATM, but for simplicity the details of the return

path are not shown here.) The digital modulators accept ATM cells directly and modulate these onto RF carriers for distribution over the HFC plant. For switched services such as telephony, independent ATM modulators will likely be required for each HFC node and will be connected to unique ports on the ATM switch. For services that are broadcast in nature (basic TV service, for example), a single ATM modulator may be used for several or all nodes, taking advantage of ATM's point-to-multipoint transport capability.

Figure 5 shows service specific modulators, but it also is possible (and at some point may even be desirable) to provide subscriber specific modulators. In this latter case, an ATM modulator might accept voice, video and data traffic from the ATM switch and put all this traffic on a single RF channel intended for a single subscriber or group of subscribers.

Once the digital signals have been modulated for HFC RF transport, they are combined and distributed on the HFC plant just as signals are today. A point to note here is that no changes are required in the distribution plant itself to deploy ATM to the home (providing the plant already has enough bandwidth and return transmission capability). The primary changes required at this stage of evolution are in the headend (ATM modulators) and subscriber home (ATM terminal). Of course, network management becomes much more critical in this system for operations, administration, maintenance and provisioning, and extensive software support systems must be deployed in parallel with the ATM transport hardware.

The residential delivery system also is shown in Figure 5. Of course, this residential delivery system can take many forms and often poses some of the most daunting challenges: equipment powering trade-offs, internal wiring issues and interfacing with existing consumer equipment. In the example shown here, a single ATM terminal interfaces with the subscriber drop. This terminal then demodulates the digital streams and accepts only those ATM cells intended for this particular home. (Once again, the opposite function takes place for upstream signals, but for simplicity this is not shown here.) The terminal converts these ATM streams into signals that can be used directly by the subscriber's telephone, TV set and computer, and then these signals are distributed in the home via separate wiring for each. Numerous other residential distribution architectures exist as well, and the subscriber's residence may indeed be the hardest hurdle to overcome in taking ATM home.

Analog signals will continue to disappear from HFC networks as

> **"At some point, ATM cells may be delivered via a home LAN directly to the TV set, radio, computer and phone in the home."**

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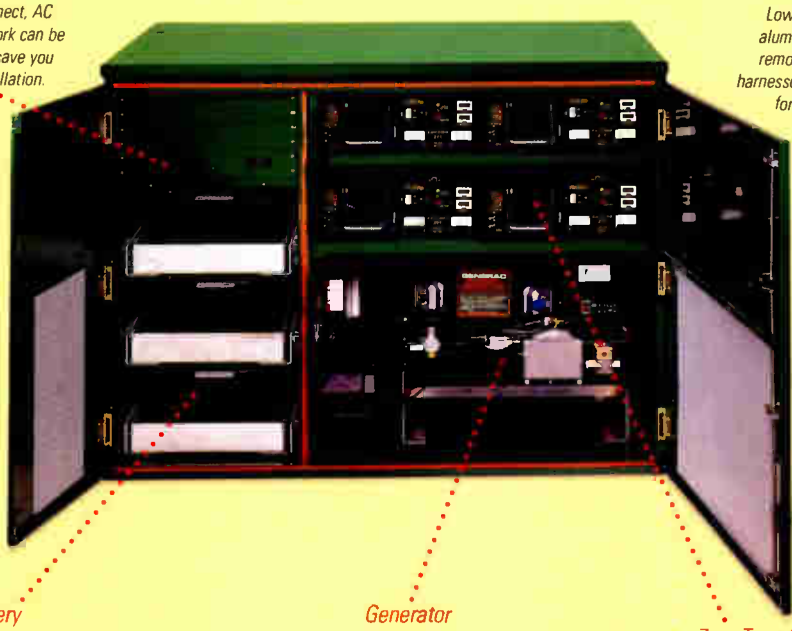

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By Kim Harrington and Bill Koerner

Supporting the complete cable service value chain

Traditional hybrid fiber/coax (HFC) networks are becoming capable of supporting interactive multimedia services. This position should enable cable companies to exploit and capture significant market share, especially early adopters. As we all know, cable modems/Internet access is currently a fast-growing market. IDC predicts that, in the United States alone, there will be over 81 million "Web cruisers" by the year 2000, growing from about 25 million in 1996.[1] Current users access the Internet and online services via telecommunication networks. The data rates (28.8 kbs) are acceptable, and the telephone network is very reliable.

With the advent of cable modem services, the early adopters will quickly appreciate the higher data rates, up to 10 Mbs (and even higher). While the current growth is driven by the innovators and early adopters, they will evolve into a group of pragmatists called the "early majority."[2] The early majority will have different requirements and expectations than the early adopters. They will expect the same level of connectivity and reliability as currently provided by telecom companies. Essentially, the service level of quality rapidly becomes an issue. Pacific Bell Internet states that its customers want fast, reliable, easy-to-use and affordable service backed by world-class support;[3] thus, cable operators will compete with the established telecom market for subscriber base. As a result, cable operators will be confronted with reviewing the efficiency and capability of their corporate theory of operation, especially where services provided to the end user experience dynamic evolution as demanded by their subscribers.

Kim Harrington is a senior technical consultant with Hewlett-Packard's Telecom Industry Solution Center. He has over 10 years experience in implementing telecom management strategies. Bill Koerner is a business architect with Hewlett-Packard's Telecom Industry Solution Center. He is a registered professional engineer in Colorado, and has over six years experience with the broadband/cable TV industry.

Meeting/exceeding customer expectations

Cable operators intending to provide multimedia services, namely Internet access to the World Wide Web, have to develop a strategy that delivers quality services meeting or exceeding customer expectations. This strategy also must implement ever higher levels of service quality in phase with the expansion rate of the target market. Following are four examples of key strategic goals aimed at providing high levels of service quality:

1) Furnish customers the ability to access the desired service anytime. Perhaps an access guarantee of 85% or less than 20% connection blocking to a limited set of service and content;

2) Provide on-demand high-speed bandwidth availability rates to specific services with a 20% attenuation factor;

3) Construct service pricing structures that are flexible and appealing to various end-user classes; and

4) Make the service easy and enjoyable to use.

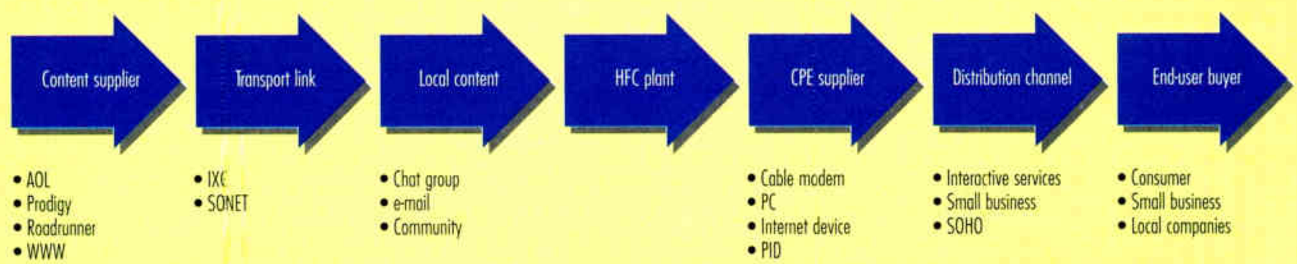
Therefore, cable operators must conduct strategic planning that specifically addresses the following three chief factors:

1) Value chain analysis;

2) Business processes (and the people involved) within and across the value chain; and

3) Information technology (IT) as related to network management. →

Figure 1: Cable service value chain



These three factors must be thoroughly considered along with the other important aspects of strategy development, namely defining what business you are in, what your core competencies are, who your customers are, where you will operate, and what your firm's mission is.

The value chain

Value chain analysis is diagnosing the firm's key strengths and weaknesses as they relate to providing quality Internet access and services to end-users, be they residential or small to intermediate size businesses. This often leads to Michael Porter's "value chain" analysis approach.[4] Simply put, "the value chain disaggregates a firm into its strategically important activities to understand the behavior of the firm's cost and the firm's existing or potential sources of differentiation."[5] A cable operator will gain competitive advantage by performing these strategically important activities understanding its logistic inputs, transactions and outputs (Figure 1 on page 54).

When looking at the value chain for Internet services, it is apparent that numerous business practices, services

> **"The cable operator offering Internet access and services will have to develop a strategy that includes a value chain encompassing multiple business partnerships."**

and capabilities are currently outside the cable operator's core competency. The operator will realize that the value chain will have to extend beyond its own limits, resulting in the development of a strategy aimed at identifying key business partners that will complement its ability. Essentially, it would be extremely cost-prohibitive for a cable operator to expand into new businesses that are highly competitive within well-established markets. The cable operator may partner with hardware and customer premise equipment (CPE) manufacturers, network and service providers, content providers, and various channel distributors.

Therefore, the cable operator offering Internet access and services will have to develop a strategy that includes a value chain encompassing multiple business partnerships. This extended value chain will be focused on, ensuring that every partner of the value chain will have common and open service quality measures and standards.

Business processes across the value chain

Strategic development also extends to each partner within the value chain, including their business processes. Every partner in the chain can be viewed as a collection of value activities that are performed to design, produce, market, deliver and support its products.[6] The uniting factors that empower a partner's activities flowing from one to another are its business processes. Business processes have controlling factors, inputs, outputs, resource mechanisms, and the subject and/or transaction activity.[7] These processes may have to be altered or re-engineered to support the value chain's service quality focus. This implies the input, output and transaction of the business processes between and within each partner will be geared or tuned toward delivering quality products to neighbor processes and partner, extending to the customer's keyboard.

Figure 2 on page 58 is a service management business process model, developed by the Network Management Forum. The model segregates key business functionality into four categories: 1) customer interface processes; 2) customer care processes; 3) service/provider development and maintenance processes and; 4) network and system management processes. Each of these four categories are interdependent and are implemented appropriately by each member firm within the value chain. Logically, all the business process categories are encompassed by the entire value chain. Realistically, only certain business processes will be realized by each member firm. The business processes identified by the model are those necessary to satisfy said strategy.

Why integrated network management?

The enabling agent that unites the value chain end-to-end, i.e., from content or service to end-user, is IT network management, commonly known in the telecommunication arena as operation support systems (OSS). Just as the product quality and performance extends the value chain, a common open and aligned network management set of systems and conventions must overarch the value chain.

Collectively, cable firms partnered with external businesses must capture the target market's customer base, sustain it, eliminate or minimize inroads, and continue expansion at acceptable rates. This is accomplished through a strategy that differentiates across the entire value chain. Only IT network management conventions and systems can realize this strategy. Network management systems and conventions have proven their capability in the telecommunication industry to integrate various business partners and their assets into a productive, profitable cohesive business. This capability should be leveraged in the cable industry. In addition, a cohesive network management system is necessary to facilitate the planning, organizing, monitoring, accounting and controlling of all related business activities and resources.[8]

Following is a list of network management functions that may be common to all cable business partners:

1) Distributed in-memory databases and computing; advanced intelligent network components, e.g., service control points; subscriber management systems

2) Billing systems; homepage hit aggregation,

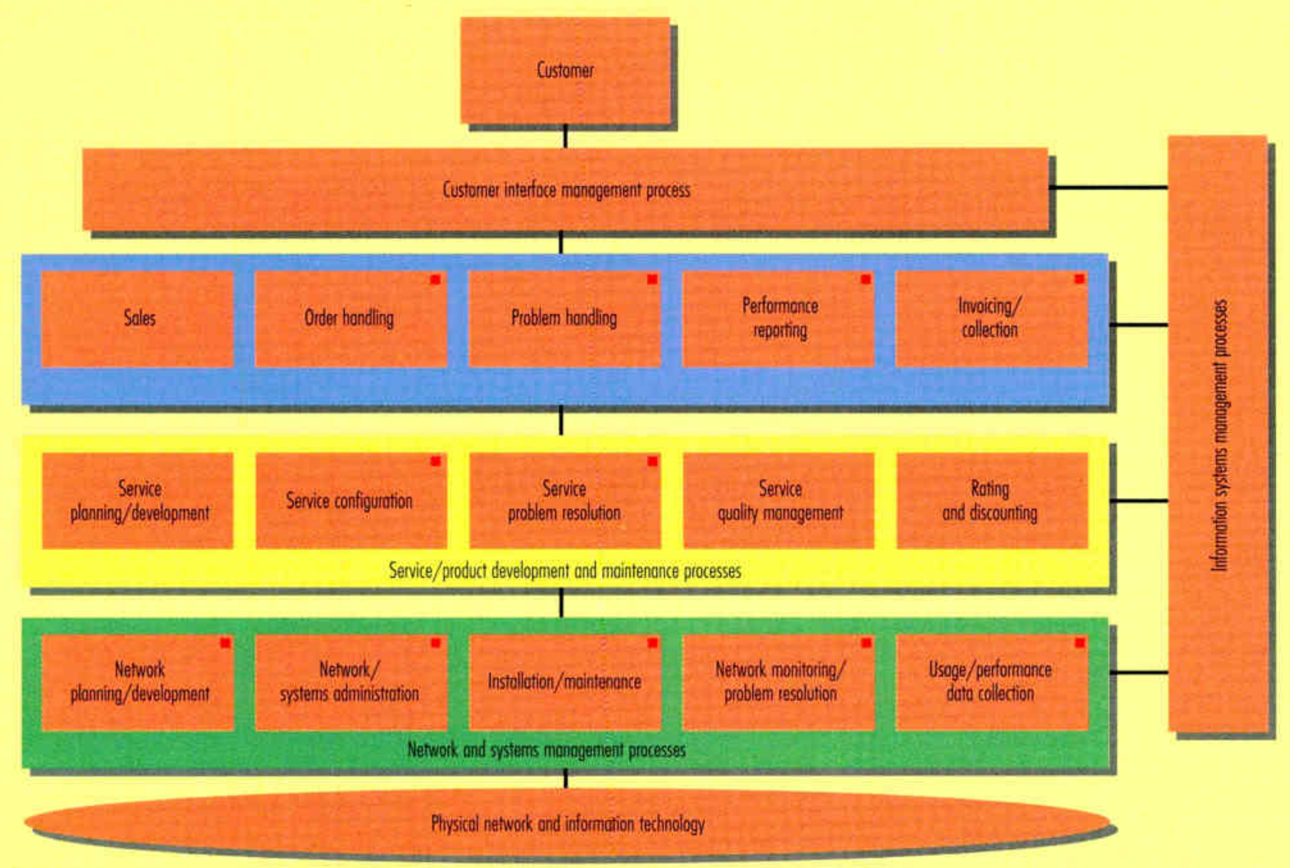


Figure 2: Service management business process model

Source: Network Management Forum, "A Service Management Business Process Model," Issue 1.0

connection details, pricing and rating

3) Customer care systems

4) SNMP and CMIP interconnection management protocols

5) Telecommunication management network (TMN) paradigm and Q3 interfaces

6) Mediation or proxy agents for interfacing to legacy systems to capitalize on existing assets across the value chain.

Upon closer examination of the service management business process model, one will quickly realize how well it lends itself to implementing a network management architecture. Each process category aligns with typical OSS functionality. For example, the first strategic goal mentioned earlier addresses providing either guaranteed access or blocking. Figure 3 on page 60 shows the service quality management process (expanded from Figure 2), and how it relates to other processes and partners in the value chain. Note that several of the inputs come from other partners/providers along with internal information. These inputs, specifically problem data, usage trends and problem trends are classical examples of the information available from an integrated network management system.

For example, to verify our customers' access to the service at least 85% of the time, we would want to look at the following information through the service quality management process:

1) Problem data: Could include data collected from status monitoring systems (fiber node or RF outages), broadband Internet access management systems (traffic flow through routers, traps collected from cable modems or traffic through fiber nodes), Internet backbone management systems (status of link), or other content providers (their server status, high-speed link to their servers); trouble tickets from other partners.

2) Usage trends: This could include data collected from broadband Internet access management systems (usage data by fiber node, usage data by customer), Internet backbone management systems (congestion of link, hot web sites), or other content providers (congestion of high speed link, usage profiles).

3) Problem trends: This could include data collected from status monitoring systems (number of outages per fiber node over time, variations in RF amplifier parameters over time), broadband Internet access management systems (number of log-ons per day, peak measures, number of failed log-on attempts, growth in access requests by fiber node), Internet backbone management systems (number of failed requests, traffic data rates over time). →

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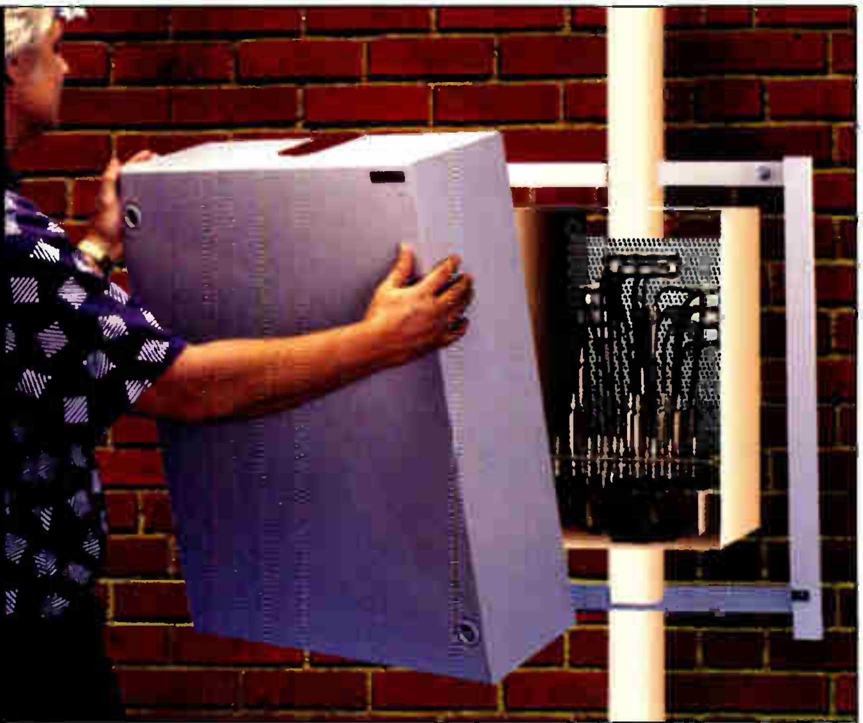

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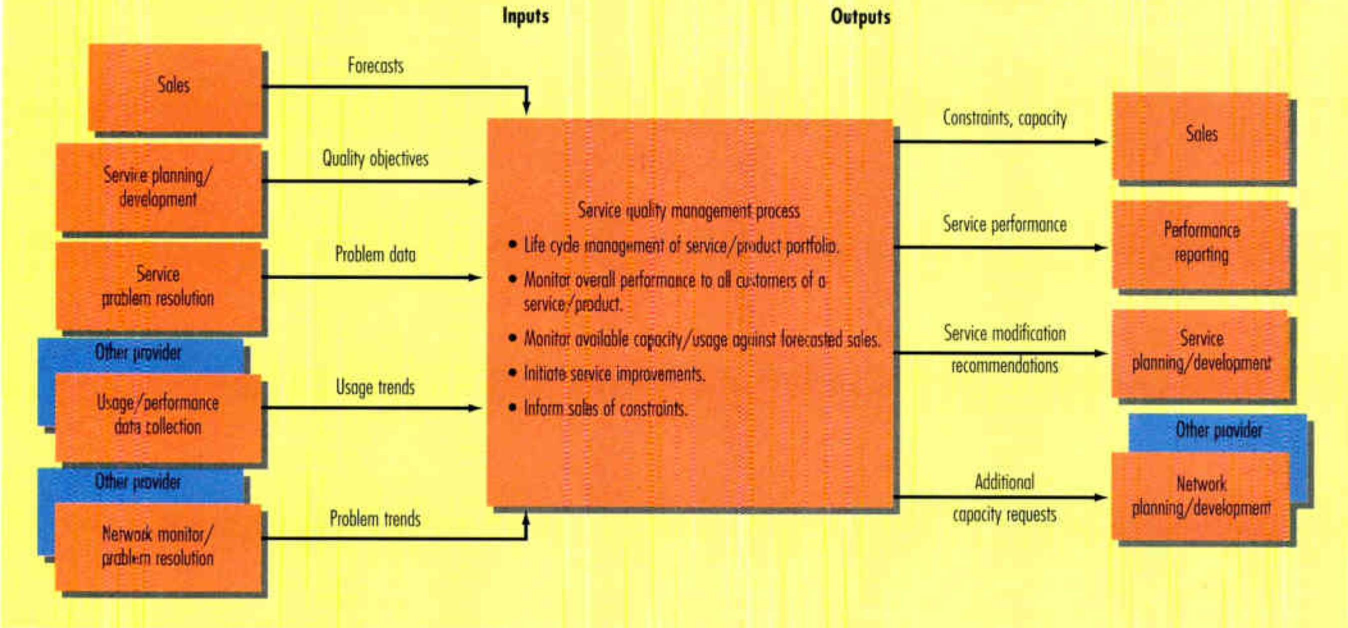
Figure 3: Service quality management process



A phased approach

The network management architecture should support the processes across the value chain since these processes align with the strategic goals of the value chain. Ideally, network management systems should be designed to meet a desirable return on assets (ROA), usually about 20%. ROA is the ratio of return on net operating income generated from providing high quality Internet services and products to end-users, to the total network assets used to provide those services and prod-

> **"Investment into the infrastructure for integrated network management should be designed in a phased approach."**

ucts. This is important because the more a cable operator and its partners earn per dollar of sales, and the more sales it makes per dollar invested in its operating assets, the higher the return per dollar invested.[9]

This would imply that any investment into the infrastructure for integrated network management should be designed in a phased approach to maximize the ROA. For example, status monitoring systems could be rolled out in the areas where the service will be offered first, and only those areas with the highest expected penetration. The next step might be to integrate the data provided by the status monitoring system with data from the broadband Internet access management system to provide congestion and outage information. Ultimately, the integrated solution will take data from all aspects of the value chain to provide the required information to support the business processes.

Strategy dictates market share, customer satisfaction, effective operation location and costs, and revenue generation. Business processes are the implementation activities that realize the strategy. Network management OSS systems enable business management control and feedback measures that support the business processes across the value chain. All three aspects must be understood and addressed during the strategy formulation process especially in light of today's extremely dynamic and competitive telecommunications market segment. **CT**

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By S. Michael Johnson

Integrating broadband design services into AM/FM/GIS

For years, utility companies have used AM/FM (automated mapping/facility management) software to track information about their distribution networks. Historically, AM/FM systems have been used to maintain accurate field records throughout the processes of field surveying, planning, engineering, construction and inspection. These records provided accurate information for field technicians performing routine and emergency maintenance, and support for numerous other downstream systems (billing, accounting, etc.). Polygon processing capabilities provide AM/FM systems with more GIS (geographic information system) functionality, which is critical to performing more advanced queries against the database. The industry must begin to utilize more GIS capabilities to support the automation of workflows, particularly the time intensive efforts of engineering and planning.

Since the advent of the programmable calculator in the 1970s, engineers have worked to develop methods to simplify redundant tasks, such as calculating attenuation along coax routes. Commercial spreadsheets made this process more efficient and, eventually, communications engineers had specific software packages available to design coaxial plant. Communications engineers have successfully used these tools for years, and companies discovered these software packages saved tens of thousands of dollars in engineering efforts annually over manual processes. The issue then becomes, why should an

S. Michael Johnson, E.I., is an applications engineer with Byers Engineering Co. and has specialized in advanced communications systems.

engineer have to take data from an AM/FM system for service locations, structures (poles, pedestals), backspan, enter the information manually to the design software, then re-enter completed designs back into the AM/FM system? Why can't we simplify this to a one-step process?

Over the past few years, HFC (hybrid fiber/coax) networks have received extensive publicity, touting the economic advantages of this architecture for delivering broadband services. Recently, FTTC/H (fiber-to-the-curb/home) networks have started to receive attention as costs for the curbside ONUs (optical network units) and other components of the FTTC network have decreased. As HFC and FTTC networks become the preferred method for delivering broadband services, engineers are again looking for ways to simplify the cumbersome design process.

A simpler process

An engineer performing a broadband design requires the following information: 1) physical layout of the area to be designed; 2) information about the service addresses and structures; 3) accurate backspan information (backspan defined as the distance between two structures); and 4) technical information about the RF components of the network (coax cable attenuations, device insertion losses, launch RF levels from ONUs and gains for amplifiers). The first three items in this list are usually stored in the AM/FM/GIS models. A potential exception would be that structures may not be accurately stored in the model, and a field survey may be necessary to validate accurate structure placement and backspan measurements. However, this has to be done anyway to use analysis routines.

The last item is the additional data that must be stored to perform RF signal calculations. Information about the RF components is obtained from manufacturer specifications. The manufacturer information needs to include attenuation and insertion loss characteristics at the frequencies at which the design needs to be calculated, as well as port level information so connectivity may be generated from feature to feature. (Feature is defined as coax devices, either RF active, RF passive; or optical.) If this information is available to the workstation, AM/FM/GIS data may be used to seamlessly automate the design of coaxial and fiber networks.

With an AM/FM/GIS system, tables are created for each of the features that are placed in the network. As features are placed, connectivity is created so the model knows how each feature is connected. Rules are established within the software to assure design integrity. For example, a coax may connect to an input port on an amplifier, but an input port of an amplifier may not connect to an input port of a tap. When features are placed, a database link must be established between the feature and the manufacturer data table. The link may be established through one common field, such as a material code, or made up of a composite key, such as manufacturer, plus item description, plus model number. Through this link, the AM/FM/GIS software has access to the vendor specific data.

Since AM/FM/GIS data contains connectivity for all features, the software may perform a trace along a coaxial route to determine how each element in the network is connected. As this trace is performed, an algorithm in the workstation retrieves the necessary design information from the manufacturer data tables based on the item passed in the trace. For example, in a network of a fiber node to coax to a tap, the software would first retrieve design information on the fiber node, pick up backspan and attenuation information for the coax, then insertion loss information for the tap. The software algorithm calculates the launch RF signal levels from the ONU, subtracts the span attenuation, based on the backspan length and the attenuation stored for the coax cable in the manufacturer data tables, then subtracts the insertion losses for the tap, again stored in the manufacturer data tables. Similar trace algorithms also may be performed to calculate

carrier-to-noise ratio, composite triple beat, composite second order and cross modulation.

Similar algorithms may be applied to FTTC/H designs, but designs in FTTC/H are usually not as critical due to the characteristic lower attenuation of optical fiber. Furthermore, since the architecture of most FTTC/H networks is generally passive from the HDT to the ONU, design of these systems is simplified. Since the ONU is the most expensive component of the FTTC network, the critical component for cost effective deployment of FTTC systems is ONU sharing—and your AM/FM/GIS model can help you in the design process! FTTC networks generally serve up to 12 subscribers per ONU. With assistance from the model data, software at the workstation level for the AM/FM/GIS system may be used to determine the best density overlay to eliminate redundant nodes in the service area.

After designs are completed, the design information from the network is stored in the instance tables for each of the features placed. This allows a field technician to quickly verify RF signal levels during installation or maintenance. Status monitoring devices also may contribute information to a corporate data warehouse. The powerful query capabilities enabled by the AM/FM/GIS software may compare the data between designed and current signal levels to allow proactive maintenance before lifeline services are affected.

As cable companies and telephone companies evolve to become communications companies, engineers will be forced to find more efficient methods to design broadband communications networks. AM/FM/GIS models provide the comprehensive information required by engineers to perform the design process. **CT**

"The powerful query capabilities enabled by the AM/FM/GIS software may compare the data between designed and current signal levels to allow proactive maintenance."

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From Concept to

By Anthony J. Wasilewski

Public key cryptography in broadband nets: Part 1

The broadband networks operated and deployed in the wake of the Telecommunications Act of 1996 need to offer both more expanded and more advanced services to their subscribers to compete with alternatives. Significant new revenue streams are possible with electronic commerce applications. However, consumer and merchant acceptance of these applications in broadband networks will be limited without suitable technologies to secure them. Contemporary conditional access systems using public key techniques have important advantages over their traditional counterparts.

The advent of widespread two-way communications in broadband and other networks will open up new possibilities for the support of electronic commerce. While current home shopping networks do provide commercial activities in existing systems, these services fall short of fully enabled electronic commerce in which subscribers can browse, select and complete transactions from the product and service offerings of a large selection of vendors with whom they have no previously established relationship.

Such services may arise through Internet connections via cable modem products. Or network operators may create their own "virtual shopping malls" in which they are the broker for "virtual merchants" and, like their physical shopping mall counterparts, take a percentage of each merchant's transactions as compensation.

Electronic commerce applications must be secure before merchants or consumers will have enough trust to use them. Authentication, identity and privacy concerns are magnified in the cyberworld of remote transactions and digital cash. Fortunately, the same kind of public key cryptography and protocols that enable the new, multiservice provider applications of the emerging digital broadband networks, also can serve well in providing the means for establishing effective electronic commerce transactions.

The need for advanced security and access systems has never been greater than at the present. In broadband networks, many video and data applications require robust security to gain market acceptance or become more profitable. Inadequate security has been one of the primary barriers to growth of electronic commerce over the Internet, which demands rapid and safe exchange of highly sensitive information.

Interactive networks in which private data is exchanged, such as credit card numbers, must allow for selective access to services based on validated authorization. Ensuring the confidentiality of subscriber

Anthony J. Wasilewski is principal engineer, digital video systems with Scientific-Atlanta.

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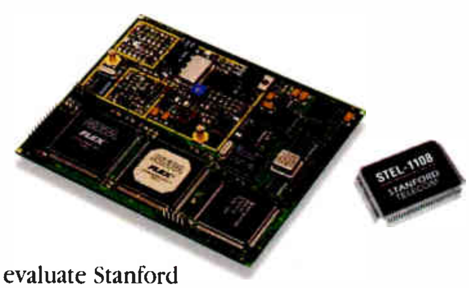

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information, such as service or product orders, will be an important requirement for fully enabled electronic commerce. Therefore, any network operator wishing to participate in electronic shopping, interactive communications, digital pay-per-view (PPV) and premium channels, or high-speed data communications needs a sophisticated security system in place.

Content providers, network operators and consumers alike are concerned with protecting messages, product orders, programming, software, databases and intellectual property from vandalism, theft or unauthorized access. Traditional conditional access and secure messaging systems make use of signal security measures, such as encryption, to prevent a signal or message from being received except by authorized users. Many aspects of the conventional approaches to conditional access are inadequate for the requirements of emerging digital networks. Due to the nature of the applications and services, an extremely robust public key cryptography system is necessary. Further, such a public key system also can provide the foundation for electronic commerce in broadband by enabling network users and service providers to exchange secret, protected messages without first having to exchange a secret, such as an encryption key.

"Inadequate security has been one of the primary barriers to growth of electronic commerce over the Internet."

Broadband security and conditional access systems have been deployed for more than 10 years. Why can't these systems, in their current form, support electronic commerce and the new digital applications? The following three cases will highlight the salient issues.

Case 1

The Internet provides a global communications network supporting a variety of applications from e-mail to the World Wide Web. The Internet of today grew from much smaller research projects in universities and labs that contributed work to the DARPA project on advanced, fault-tolerant networks. Basically, no attention was paid to security in the Internet infrastructure itself, presumably because that could be handled at the application layer, if needed. Unfortunately, most of the commercial applications and utilities that arose also did not consider security issues.

Thus, the current Internet has many weaknesses in security services, including the following:

• Most lower-layer protocols over which the Internet runs are "broadcast" type networks. Ethernet, for example, allows any machine on the

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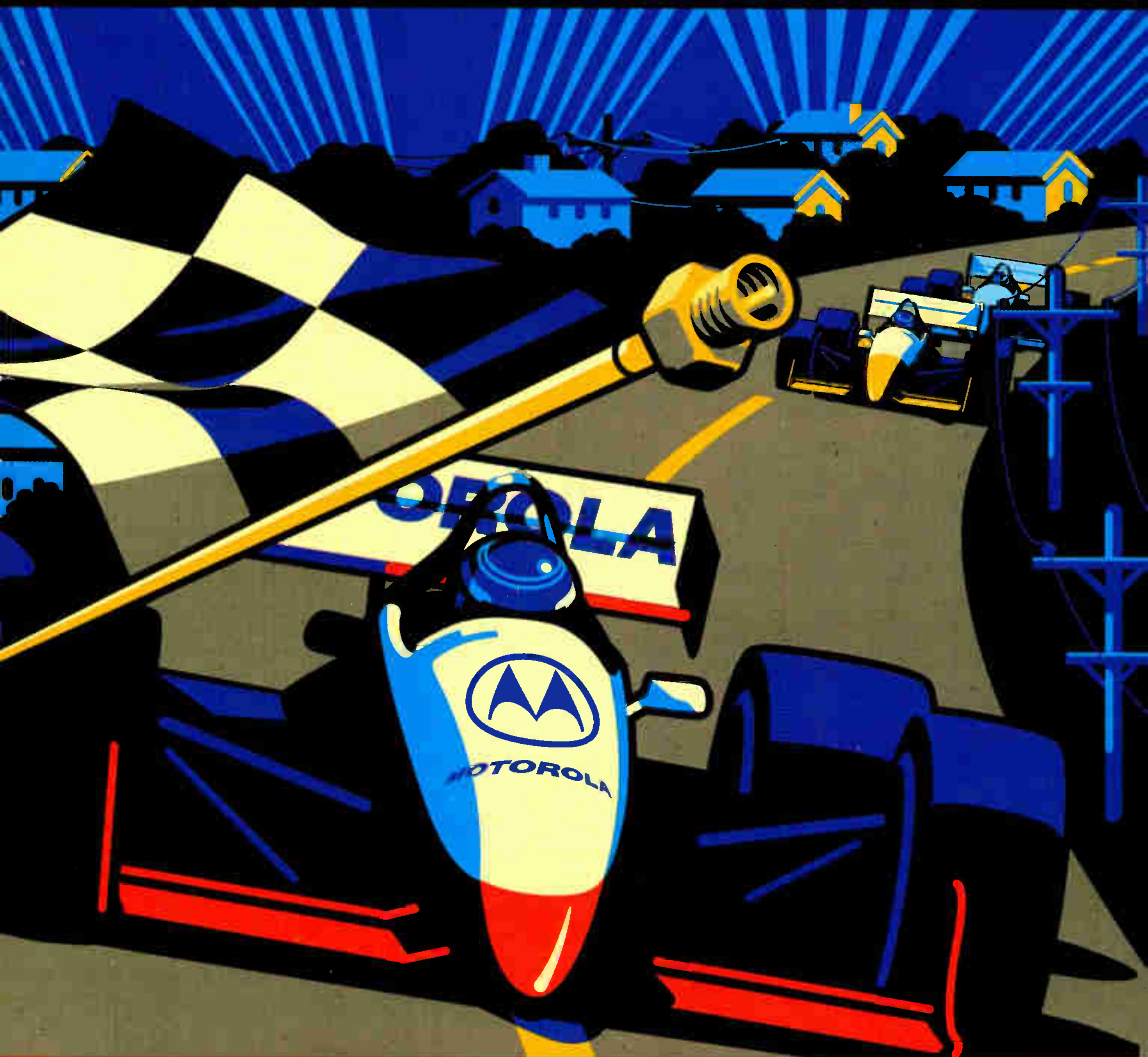

same LAN to eavesdrop on the passing traffic, even that not directed to it. This could lead to the stealing of passwords or other data content on the LAN. Thus, there is *an inherent lack of privacy*.

• Addressing schemes in the TCP/IP protocol suite include identification of both the source address and the destination address. Indeed, it is this "connectionless" addressing that allows the Internet to work as it does. Unfortunately, there is no way to be sure that these address fields have not been altered or "faked." Thus, there is *no basis for authentication of users* in the Internet. Perhaps, the least grievous violation this could lead to is simple spoofing attacks in which the hacker gains access to some information of modest value that the perpetrator should not have access to. At its worst, one could imagine criminal individuals posing as financial clearinghouses or transaction acquirers collecting payments and fees from unsuspecting consumers or merchants.

• Likewise, while there are simple checksums applied to the content of IP packets, these provide the most basic form of error detection and are easily circumvented by a determined hacker. Therefore, there is *no authentication of the content* of Internet messages.

Thus, broadband systems that plan to carry Internet-based services should carefully consider any liabilities that may be associated with lack of security and make inquiries to their vendors and service providers regarding providing solutions in this area.

Case 2

In current broadband or satellite systems, the network topologies and service offerings are simple and straightforward. BB Co. Inc. operates a conventional cable system with an unswitched, one-way network topology. At a central location, an authorization database is maintained for all subscribers, keyed to each headend. Addressing is "single wire" with no routing or networking issues. The only services offered requiring authorizations are subscription channels and PPV.

The subscription database maintains records of the serial numbers and secret keys of the set-tops of the subscribers. The secret keys are used to encrypt authorization messages to individual set-tops. This approach both maintains privacy and ensures that only the conditional access computer maintaining the secret keys can address authorizations to the set-tops. To send a secured message to a set-top, the sender must have a copy of its secret key.

Security weaknesses include:

1) The secret key database is vulnerable to "insider attacks" in which a BB Co. employee reads keys from the database and uses these to create clone set-tops.

2) Current methods of recovery from such an attack involve rekeying the set-tops, which is both time-consuming and logistically complex. It also assumes that the piracy is discovered.

3) When new shipments of set-tops arrive from the manufacturer, new secret keys must be loaded into the conditional access computer database. The keys are vulnerable to being stolen in transit or during loading. Even though precautions can be taken to protect the keys while in transit, these also depend on insider participation. Again, the recovery is complex if a breach occurs.

4) Having a secret key database effectively prevents the geographic distribution of the conditional access function because such distribution increases the opportunity for the database to be compromised. There also may be concerns about which entities within BB Co.'s operation are allowed access to the conditional access function.

5) For reverse channel applications, providing a scheme for private, secure messaging from the users to the service providers is difficult using only secret key methods. Distributing the service providers' secret keys to user terminals opens up the system to fraud and impersonation attacks.

6) In emerging networks, the topologies are inherently distributed, including full networking and routing in the addressing. The services include not only the traditional one-way subscriptions and PPV, but also near video on demand, video on demand, home shopping/banking and the like. Many of these services require significant reverse bandwidth

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and may involve transactions between users and service providers with which (unlike BB Co.) they have no previous relationship.

Case 3

John Doe is a managing consultant who often works at home. He requires high-speed data access to the Internet and to sensitive information in computer systems at his employer's offices. Furthermore, he must authorize official company documents from his home. Doe's employer is considering use of cable modems.

As in the BB Co. scenario, Doe's employer must maintain a database of secret encryption keys to allow authorized users to access its systems. Without stringent key management measures, the database is vulnerable to piracy. Doe's employer must have a secure way to distribute the secret keys and to encrypt information as it crosses the network. Neither Doe nor the employer can be fully confident that the content of exchanged messages are authentic. The employer has no way to be sure who is accessing sensitive files.

The security weaknesses, logistic complications and lack of needed encryption functions that traditional conditional access systems present are barriers to the deployment of electronic commerce in broadband networks. However, a combination of the traditional secret key methods of legacy systems with public key cryptography can result in a system that supports both the traditional subscription/PPV functions of the broadband system and the electronic commerce applications of the Internet.

Method comparison

What's different about public key methods that make them appropriate for e-commerce and the broadband systems of the next 10 years? This section will explore the issues.

Privacy protection by conventional means is relatively easy in small networks, requiring the exchange of secret encryption keys with each party. The sender uses a secret key to encrypt the message and the receiver must know the same key to decrypt the message.

As a network grows in size, using symmetric or secret encryption techniques, such as data encryption standard (DES), for addressed messaging makes security vulnerable and creates complicated logistics. (Note: DES can still be appropriate for protection of high-speed content, such as video encryption.) In practical implementations, secure communications using secret key methods can only occur when there is a prior relationship between the parties (for example, an employer and employee).

The secret key database used for messaging must be carefully guarded, because the discovery of even one of the secret messaging keys can lead to widespread system fraud through clone-type attacks. Furthermore, discovery of a subscriber's secret key (through database access or during shipment to the database site) could be used for

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service request message forgery.

To counter the disadvantages of secret key databases, many organizations are using the "public key" approach popularized by RSA Data Security Inc. Public keys present a method of exchanging authenticated secret messages without previously exchanging secrets. Instead of using the same key to encrypt and decrypt the data, the RSA algorithm uses a mathematically matched pair of keys for encryption and decryption. What one encrypts, only the other can decrypt. The public key of all network users may be openly published. Knowledge of the public key does not allow discovery of its private key partner.

Other advantages

Public key cryptography also offers the best method of providing authentication and digital signature, features necessary for secure multiservice provider and reverse path communications. Enabling a set-top terminal to accept messages from several legitimate service providers, but not from others, requires "digital signatures"—in essence, an electronic passport that only one entity can produce, but all others can verify with the sender's public key. Digital signatures provide an unambiguous confirmation of the identity of the sender of a message. With digital signatures, messages from unauthorized sources can be rejected and authorized messages cannot be repudiated by the sender.

For encryption of digital services such as compressed video, traditional secret key algorithms (such as DES) are still the superior choice because of their higher speed of operation. Public/private key and secret key cryptography are complementary and can be integrated into the same conditional access system.

In the United States, essentially all forms of public key cryptography are protected via U.S. patents. To deploy systems using public key methods, licenses must be obtained. In the case of the RSA algorithm, RSA Data Security Inc. is the licenser. For appropriate patents, Cylink Inc. is the licenser.

Digital certificates

A digital certificate is a nonforgettable, tamper-proof way of certifying the validity (and therefore protecting the integrity) of published public keys. A digital certificate serves to bind a public key with a user's name, an expiration date and other related data. Digital certificates are issued, verified and revoked by a certifying authority, which can be any trusted party for central administration.

A certificate authority is a trusted entity that issues, verifies and revokes digital certificates within a system. The certificate authority provides this service by applying its digital signature to each certificate and then by making its own public key available for use in verifying the certificates of the users of a system. Because there are relatively few certifying authorities, their public keys may be made widely available by common publishing means, such as the *Wall Street Journal*. **CT**

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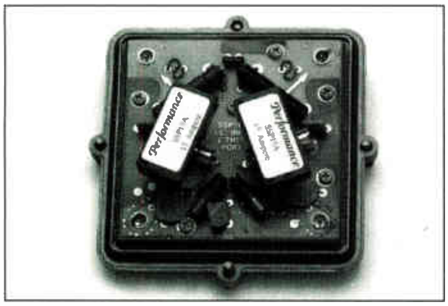

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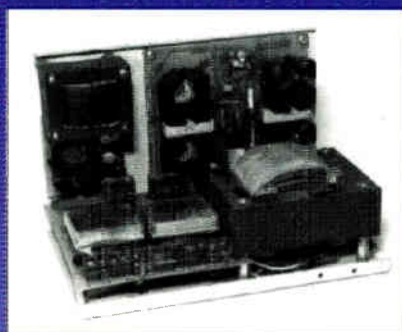
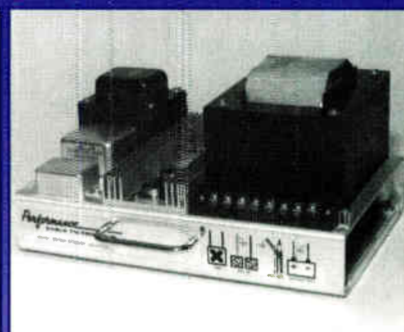


Replace this...



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Reader Service Number 124

Braving the great outdoors

By Dean Yamasaki

No single optical cable design is universally superior in all applications. Optical cables are designed to protect fibers from damage due to the rigors of installation and the demands of the environment in which it is placed.

The consequences of optimizing a cable design for outdoor use can prove counterproductive in meeting the requirements for indoor applications, and vice versa. For example, the most rugged cable jacket materials, ideal for outdoor use, will not pass flame resistance tests required for indoor placement.

In general, optical fiber cables installed outdoors are exposed to more severe mechanical and environmental conditions than in the protected, climate-controlled indoor environment. Outdoor installations, usually lashed aerially, pulled through duct or buried directly in the ground, are subjected to combinations of ultraviolet (UV) radiation, standing water, cable-gnawing rodents, temperature extremes and other hazards. As a result, it is important to install optical fiber cable that is designed and optimized for outside plant applications. Let's review each of these significant design considerations for outdoor cables.

Dean Yamasaki is an applications engineer at Siecor Corp.

Extreme temperatures

The primary materials in an optical fiber cable are silica glass and plastic polymers. The rate and magnitude of material expansion and contraction with temperature changes are different for the glass and plastic because each possesses different shrinkage characteristics. That is why it is important to use a cable design such as the loose tube cable (Figure 1) that establishes a strain-free environment for the fiber to mitigate the influences of external effects. Loose tube cable manufacturing processes ensure that the fiber-to-buffer tube length ratio is controlled so no fiber is compressed against the tube wall when the tube expands or contracts with temperature change. This strain-free environment compensates for movement in the cable structure without inducing mechanical forces on the fiber. This characteristic enhances the operating temperature range of the loose tube design.

The tight-buffered cable design (Figure 2), on the other hand, does not decouple the optical fibers from the effects of expansion and contraction of the cable's other components. The thermoplastic buffer, usually 900 µm in diameter, is directly coupled to the fiber. (Hence its name—tight buffer.) As a result, these cables will not isolate fibers from external forces. Therefore, temperature-related expansion and contraction effects applied to any cable component are directly translated to the optical fiber.

The tight-buffered cable is well-suited for indoor applications where requirements for fire retardancy and easy direct termination are required. However, these same design characteristics that make it ideal indoors, limit its performance outdoors. More sensitive to temperature extremes and mechanical disturbances than loose tube cables, tight-buffered cables experience increase in attenuation due to changes in temperature that may not be acceptable in meeting specifications of the cable system.

Ice crush effects

Ice crush hazards affect optical cables in environments where standing water and freezing temperatures coexist. In a confined space, significant tensile and compressive forces can be generated from the expansion of water as it begins to solidify in freezing conditions. This effect can occur in water-filled, outdoor conduits or within the cable core itself.

Both loose tube and tight-buffered cables are designed to withstand compressive forces applied from outside the cable jacket, but forces directly applied inside the cable core can degrade performance. Ice crystals can form if water migrates inside the cable's outer jacket to the core. This ice causes stress and strain very close to the optical fibers, which may increase attenuation to unacceptable levels, or even result in fiber breakage. Therefore, it is essential to prevent water from intruding to the cable core.

A loose tube cable provides maximum protection against water penetration and migration using a core waterblocking agent and buffer tube filling compound. To block water from reaching the core, the cable is surrounded by a water-insoluble gel and/or water-swellable material to stop the entry and migration of water should the cable's outer jacket be breached. These protective materials maintain the mechanical integrity of the cable by preventing ice crush, fungus growth or corrosion of metallic cable members if present.

A filling compound is placed in the buffer tubes with the fibers during the cable manufacturing process. (See Figure 3 on page 84.) An additional water barrier, this compound also provides a mechanical cushion for the fiber to allow it to float within the buffer tube in virtually a stress-free state.

Unlike loose tube cables, standard tight-buffered cables do not have filling compounds or waterblocking protection because these materials do not meet fire-retardancy requirements of the inside building environment. This makes tight-buffered cables susceptible to water penetration and migration damage when used outdoors. Bottom line, no plastic material is completely impervious to water, so a tight-buffer material alone cannot permanently isolate fibers from the influence of water. So, if water penetrates the cable jacket and subsequently freezes, individual fibers are subjected to microbending, increased attenuation or damage.

In addition, moisture can permeate the plastic tight-buffer coating. Once exposed to freezing temperatures, water molecules can crystallize on the fiber's surface and create a potential for increased attenuation or damage due to microbending.

Mechanical protection

As noted earlier, the loose tube cable design establishes a strain-free environment for optical fiber by reducing the influences of external effects, including a variety of mechanical forces. Installation practices and outdoor installed system conditions can subject cable to tensile, flexing, twisting, crush, impact and bending forces. By isolating fibers from these external forces, the loose tube cable ensures maximum cable life in an outdoor environment.

In addition, the cable should incorporate long-term, reliable optical and mechanical performance features to assure system performance and dependability. The outer cable jacket must be rugged enough to withstand initial installation forces as well as years of outdoor punishment. Rugged jacket material, such as medium density polyethylene (MDPE) used in loose tube cables, allow for a lower coefficient of friction and higher abrasion resistance for simplified installation.

Tight-buffered cables usually

Figure 1: Typical loose tube cable design

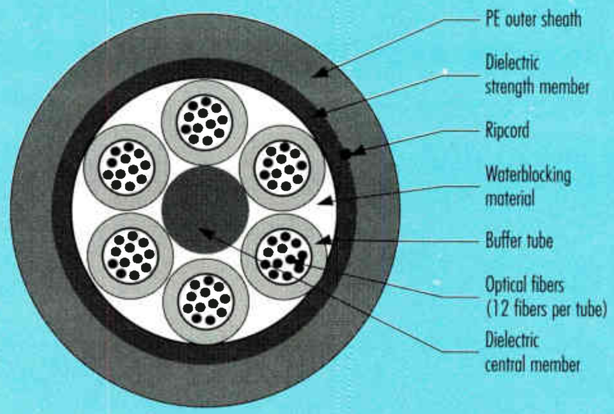


Figure 2: Typical tight buffered cable design

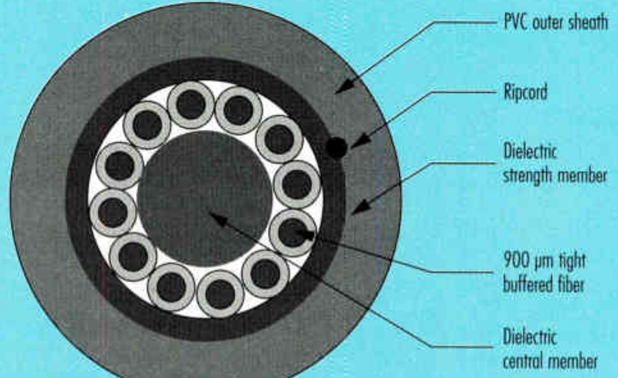
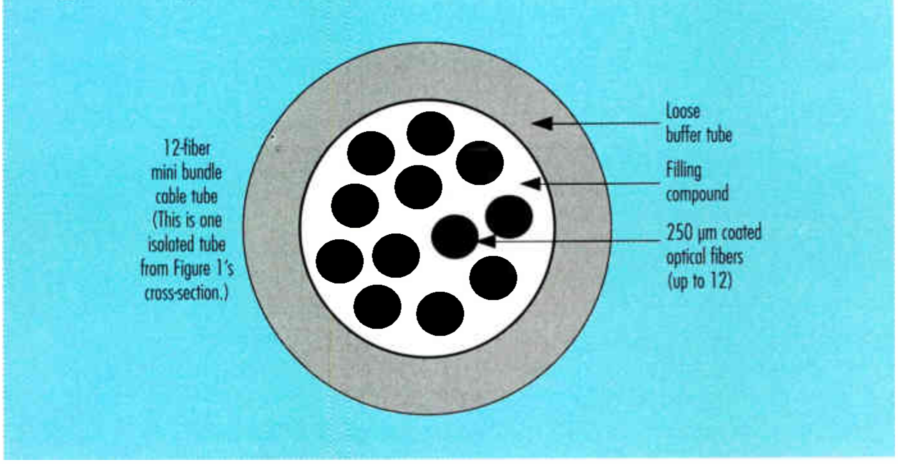


Figure 3: Typical buffer tube construction



employ polyvinylchloride (PVC) jackets that provide flame retardancy required for indoor applications. However, PVC materials are not as durable as MDPE in the outdoor environment.

UV protection

If an optical fiber cable is installed aerially, it must be able to withstand direct exposure to ultraviolet (UV) light. Light, heat and moisture combine to cause optical, mechanical and chemical changes in materials. The first line of protection in this environment is the cable jacket. Carbon black compounded into the MDPE to provide maximum ultraviolet protection is the best defense against UV degradation.

The PVC material used for the outer jacket of standard tight-buffered cables does not have carbon black compounded into the material. As a result, standard tight buffered cables should not be used in applications involving exposure to direct sunlight. However, carbon black can be compounded into PVC jacket material to create a UV-resistant jacket.

Industry specifications

The telecommunications industry and related organizations have developed standards to ensure cables used outdoors can withstand environmental hazards. The Electronic Industries Association/Telecommunications Industry Association has established procedures to test mechanical, environmental and optical characteristics needed for cable survival outdoors. In addition, outdoor cable requirements are defined by the U.S. Department of Agriculture Rural Utilities Service, 7 CFR 1755.900 (PE-90), which requires dedicated water-blocking protection; and by the Insulated Cable Engineers Association's Standard for Fiber Optic Outside Plant Communications Cable Publication S-87-640.

"The loose tube design has more than 20 years of successful use in harsh outside plant applications."

It's imperative to select an optical fiber cable that is most suited for its application. For outdoor applications, cables are required that can withstand temperature extremes, ice crush, a variety of mechanical forces and UV exposure with minimal performance degradation. The loose tube design has more than 20 years of successful use in harsh outside plant applications because of its reliable optical and mechanical performance. **CT**

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Reader Service Number 96

S E E   U S   A T   W E S T E R N   S H O W ,   B O O T H   #   3 7 0 6

By John Chamberlain

Locating cable ground faults: A preventive maintenance plan

Fiber-optic cable preventive maintenance can be effectively accomplished by monitoring the integrity of the cable armor and splice enclosures. Once an armor ground fault is detected there are a number of techniques available to locate the fault to repair the cable before the fault deteriorates, causing a service outage to occur.

Historically, telecommunications cable sheath monitoring has been deployed to maintain the outside plant and prevent costly outages. The first extensively deployed sheath monitoring systems were pressurization monitoring systems deployed in twisted pair networks. A pressurized outside plant consists of air core cable, pressurization equipment and extensive pressure monitoring. Splice enclosure and cable integrity is assured by monitoring the air pressure at designated points in the system. A system alarm sounds when a loss of sheath or splice integrity results in an air pressure change outside of preset parameters. The sheath or splice enclosure failure is located by correlating readings from specifically located pressure transducers in the field.

This indirect measurement of plant integrity requires a dedicated maintenance management organization to design and maintain the pressurization and alarming functions. However, the presence of an outside plant maintenance system pays for itself by eliminating outages, recovering loss revenue and maybe, most importantly, increasing the long-term reliability of the system.

New, more economic and automated electronic sheath and splice enclosure monitoring systems are currently being deployed on filled copper and fiber-optic cable outside plant. Monitoring fiber cable plant is especially of interest due to the density of telecommunications circuits and vulnerability of the cable.

"The presence of an outside plant maintenance system pays for itself."

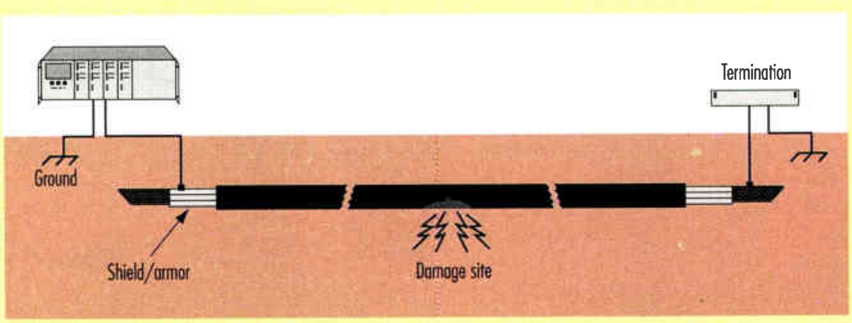
Electronic cable monitoring is accomplished by monitoring the metallic armor of the cable for ground faults. When the integrity of the plastic jacket is compromised, the metallic armor is exposed and some level of ground fault occurs. A loss of jacket integrity in a cable can result in a ground fault from a dead short to 1 mega-ohm. (See Figure 1.)

Once a sheath monitoring systems detects a ground fault on the cable armor, it must be located for repair. If not repaired, the damaged cable often degrades and can affect the fiber and, therefore, telecommunications traffic. Automated sheath monitoring systems are available that detect sheath faults, forward the alarms to designated locations, track the cable condition over time and give an indication of the general location of the fault.

To facilitate locating, it is very important to have access to the armor of the cable periodically along the cable route. If easy access is not available, location of sheath faults becomes very difficult. Either the splice enclosures must be opened to get access to the armor or very long sections of cable must be physically "walked out" with an A-frame fault locator.

The access point to the cable armor should be well protected, easily accessible and provide for lightning and grounding protection. A typical configuration is shown in Figure 2. These sheath access closures allow isolation of a particular section of cable armor, and can be used for ground fault location or the

Figure 1: Ground fault caused by jacket damage



John Chamberlain is general manager at Norscan.

"To facilitate locating, it is very important to have access to the armor of the cable periodically along the cable route."

application of direct local tones for cable tone location.

Once the sheath fault is located within a 60-mile length of cable, more accurate methods of sheath fault location can be employed. The best first step in determining the fault location is to use commercially available equipment such as the long range fault locators. These units are connected to the system at either end of the faulted cable and are capable of localizing a ground fault to within a few hundred feet. (See Figure 3 on page 88.)

After localizing a fault on a long section of cable (e.g., 60 miles), the closest splice located sheath access points on either side of the fault are identified. The long-range locators are then operated at these points, and locate the fault within as close as a few dozen meters.

After long-range fault locators have located the fault within a few hundred feet, an A-frame fault locator is used. A tone is applied at the closest sheath access point to the fault. Be sure to connect the tone transmitter only to the sheath that has been identified as being faulted. All other sheaths should be disconnected from the tone transmitter. A-frame fault location systems operate much better if the faulted sheath section is isolated from all other sections.

Once the tone is applied to the isolated section, the A-frame is used to pinpoint the ground fault. The A-frame is used by walking the path of the cable and periodically placing its ground pins into the earth along the length of the cable. This locator measures the direction of the ground

Figure 2: Sheath access unit

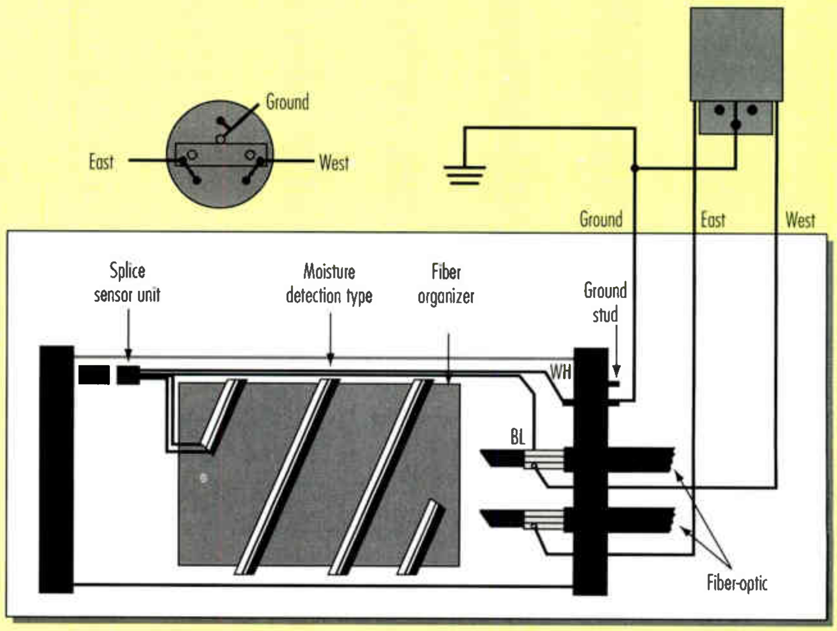


Figure 3: Locating a sheath fault with long-range fault locators

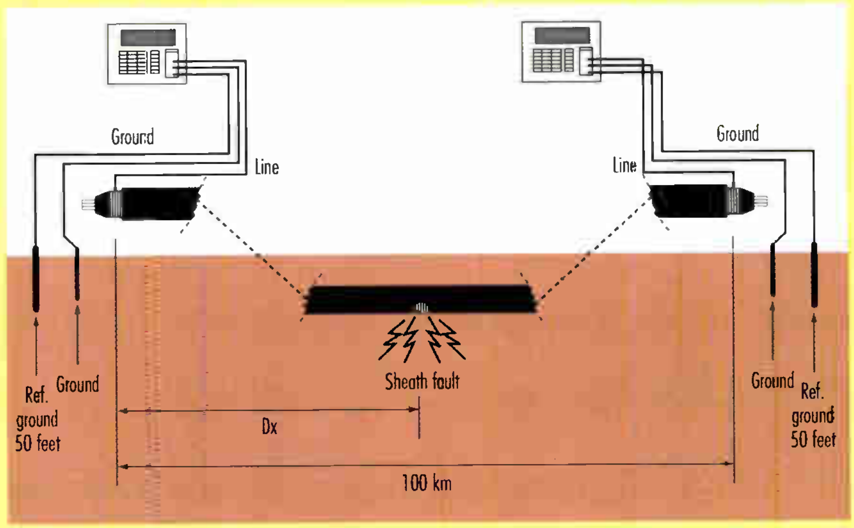
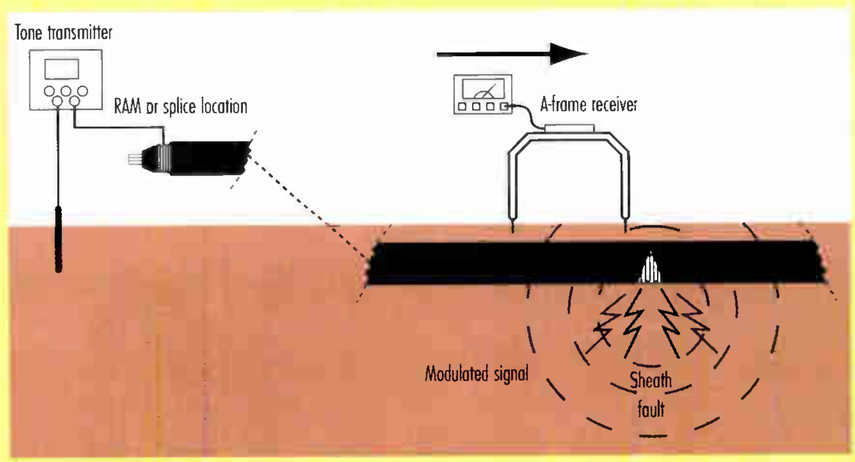


Figure 4: Precise locating using an A-frame



current flow from the fault to the transmitter, and when the operator physically steps over the fault, the current flow into ground at that location changes direction. (See Figure 4.) An indicator on the A-frame alerts the operator as to change in direction of the current flow. The location of the fault is now known and the appropriate actions are taken for sheath repair.

Aerial and subduct applications

The previous fault location discussion refers to direct buried cable plant. The same long-range fault location techniques described before can be used and are accurate for aerial plant and cable deployed in subduct. A-frames cannot be used in an aerial application and must be used very carefully in duct applications. In a duct application, the long-range fault location techniques are accurate, but an A-frame will locate the sheath fault where the duct exposes the sheath to ground. This point may or may not be at the actual sheath fault.

Although locating sheath faults takes education and experience, excellent tools exist to accurately accomplish this. Sheath fault location and repair are essential in any outside plant maintenance system and are effective deterrents to expensive fiber cable outages. **CT**

By Jack Watson

Internet security issues and microswitch technology

When security on the Internet is described, it is almost as difficult to describe as "the Net" itself. With some caution, reasonable and constructive evaluations and observations can be made. If the evaluation is constrained to paradigms of architecture, requirements, complexity (or simplicity), and the present time, the relative relationships and tradeoffs can be evaluated and understood. Fortunately "one-size" doesn't fit all, nor is it required or desirable.

The Net is an amorphous entity. At the user level, it consists of the huge (e.g., the Federal Reserve), down to the small (an individual subscriber), with all levels in between. An obvious connectivity solution for large organizations or entities is fiber-to-fiber. The requirements at this level are for both high data rate and capacity. It has to be recognized that data rate and capacity are not synonymous terms. The data requirements go from this high point to the lowest entity—the individual entity at home with a PC or PC-like device.

Jack Watson is an electronics engineer at Watson Systems. He can be reached at JWatson901@aol.com.

Forms of security

The security issue falls into two categories; the "intranet" and the "internets." The intranet security refers to access to the internal security of the controlled networks, such as local area networks (LANs) and wide area networks (WANs). The intranet security of these entities is being extensively addressed by various activities, but primarily at the software level with various levels of protection of the data inside the internal network. This activity is generically referred to as the firewall. The second aspect of security of the data—access to the data—can be protected for the large entities by the dedicated connectivity. As the entities that are being provided service on the Net are examined, it can be seen that the delivery of data moves from dedicated connectivity to switched delivery. (See Figure 1 on page 92.)

With dedicated point-to-point connectivity there is no vulnerability externally through the connectivity function. The only vulnerability resides internal of the connectivity point. The dedicated delivery retains the security integrity of the data. With the local loop, the switched delivery system has the potential to lose the security integrity of the system. This is not just the data, but access to the Net.

The telcos with their local loop switched systems, can retain their security integrity to the user. The existing physical plant supports this level of security. However, and it is a big however, if the total system requirements are examined, security is one of a number of other requirements. These requirements are: data rate (amelioration of latency), capacity, security, symmetry and a subfunction of noise control.

In the local loop, data rate and/or symmetry have been severely and inherently limited. In order to overcome primarily the data rate limitations, various forms of ingenious

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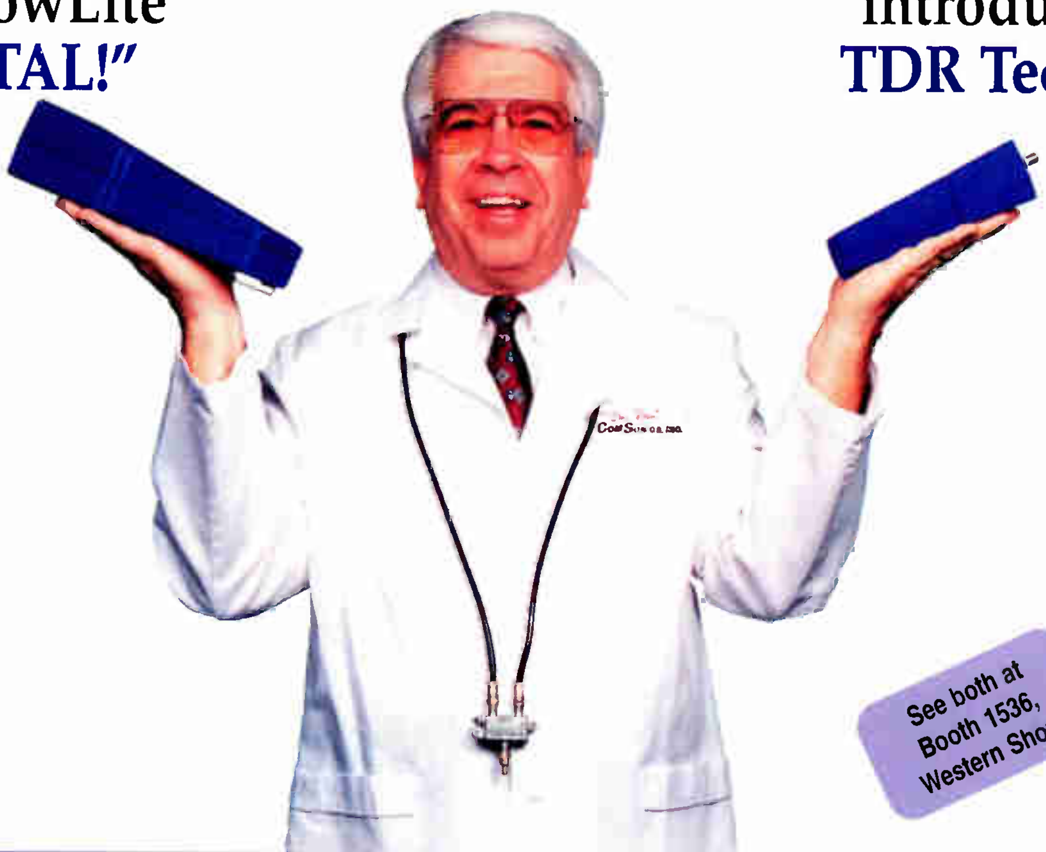

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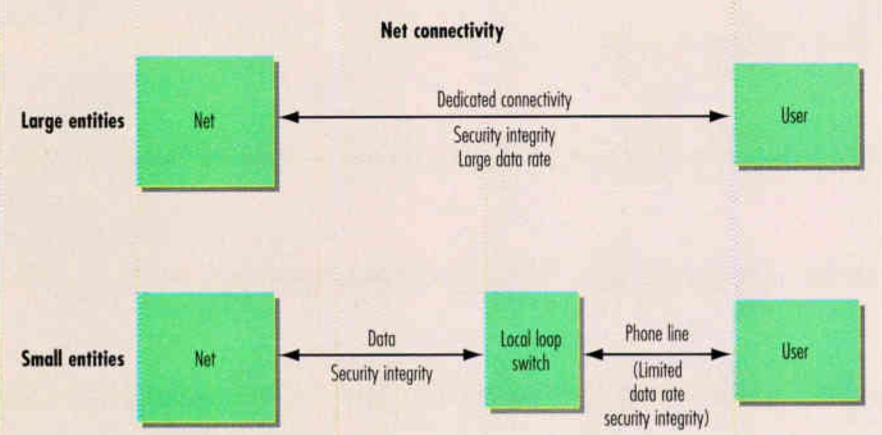
Figure 1: Present connectivity configurations



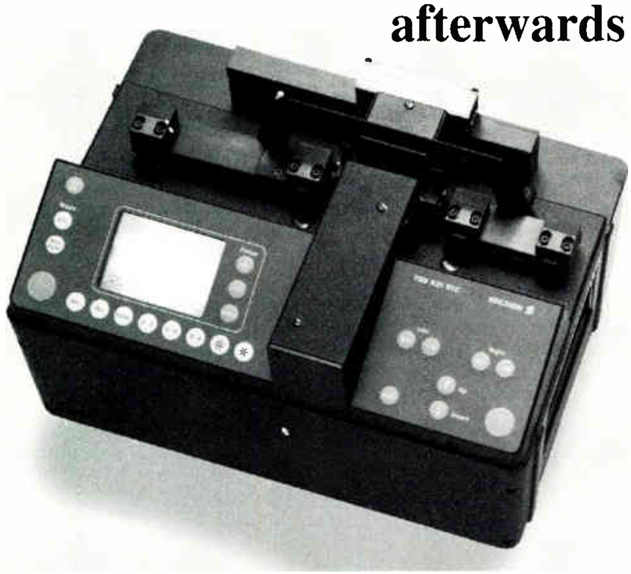
and sophisticated modulation techniques (e.g., ADSL, xDSL, etc.) have been proposed and are in limited beta tests. The claims for these techniques vary considerably, and whether they offer merely a transitional opportunity for the telcos or are more viable, the market forces will determine.

The cable modem

An alternative delivery system to the local loop is what is ubiquitously called the cable modem. The cable system has significant bandwidth and therefore inherently has no problem with data rate and capacity. The cable developed within the paradigm of a broadcast medium, primarily because it was broadcasting the analog TV entertainment channels. With a broadcast connectivity, the potential for the intercept, evaluation, corruption and modification of the data can lead to the corruption of the actions controlled by the data (i.e., the data can be "cooked" as well as read). Attempts to narrowcast even the TV channels such as pay-per-view (PPV), etc., through the so-called set-top box, have been less than satisfactory. This control of the PPV functionality suffers from the same type of problems that the cable modem system suffers from security (or lack thereof), and noise ingress from the subscriber drop onto the network.

How can the cable system solve the deficiency of security and the associated problem of noise on the cable? First, examine the elements where the potential difficulties occur and examine what a different paradigm or technique will do to ameliorate or eliminate the problem without adversely affecting the positive functions of the system.

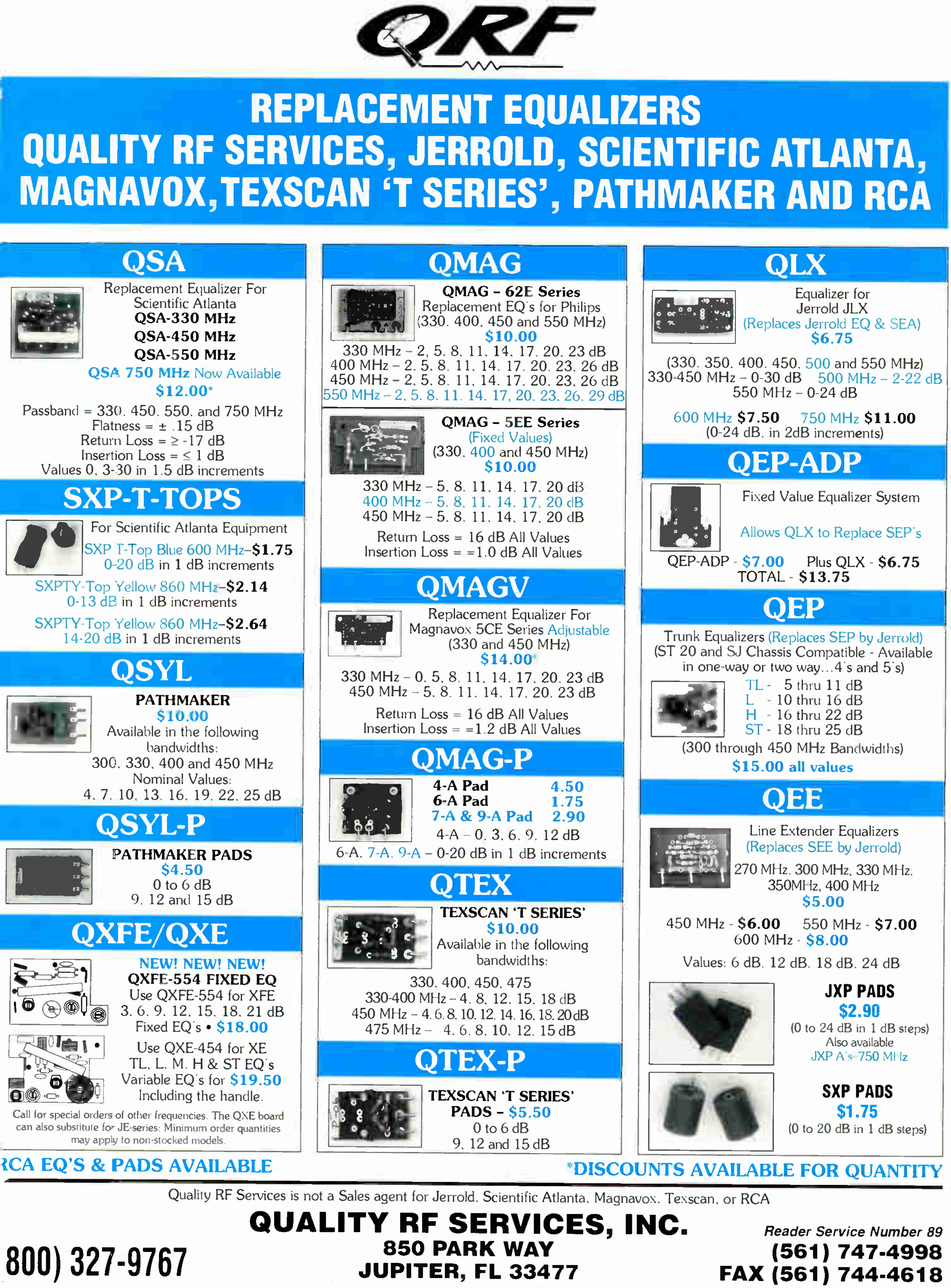
The system security integrity is



compromised at the subscriber drop element. If the data to/from the subscriber could be delivered in a controlled narrowcast manner, the desired attributes of data including security integrity and noise suppression could be achieved. However, on the trunk cable, the broadcast characteristics must be retained for all of its inherent advantages. This leads to the obvious solution that a switch must exist at the demarcation point of the broadcast location and the narrowcast location. (See Figure 2 on page 96.)

What is required is a "microswitch." What are the requirements and attributes of such a microswitch? They include the following:

- Outside the physical control/access of the user, but in the close proximity to the user; either on the pole, strand, or in the distribution box for trenched systems, or in a secured equipment or distribution box for multiple users.
- Operationally transparent to the user.
- Prevents unauthorized access to, or observation of unauthorized information on the network. This firewall is at the user interface.
- Transparent to other users on the network.
- Transparent to data content to/from the user and source (i.e., there is no translation of data content—encryption, etc.)
- Prevents ingress of noise from the user onto the network.
- Allows standardization of modem frequencies from modem manufacturers or variable modem frequencies while not requiring specific frequency allocation per user and user frequency network allocation.
- Provides cost minimization/efficiencies for modem manufacturers.
- Dynamically adjusts the allocation of the user's frequency onto the network bandwidth.
- Dynamically optimizes network bandwidth for traffic utilization by user characteristics.
- Optimizes spectrum management and time management of the bandwidth.
- Provides the capability that there is no frequency adjustment required between the user and the cable provider (plug-and-play).
- Independent of coax or fiber.
- Has functionally moved major portions of the central office (CO)/PBX to the "pole." This has been possible because of the reduction in size and cost of electronics.
- Has changed the management of control from the user's standpoint, from centralized control (the CO) to distributed control. This is possible not because of the modem, but because the microswitch has redistributed the control to the user interface.
- Has done for the user of data (decentralization of control of data) what the Internet did for data (decentralization of the database).
- Moves the control/management of information requests and delivery of information as close to the user as possible, while still retaining functional and physical security of the information.
- Distributes the data management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400 MHz – 2, 5, 8, 11, 14, 17, 20, 23, 26 dB
450 MHz – 2, 5, 8, 11, 14, 17, 20, 23, 26 dB
550 MHz – 2, 5, 8, 11, 14, 17, 20, 23, 26, 29 dB
QMAG – 5EE Series
(Fixed Values)
(330, 400 and 450 MHz)
$10.00
330 MHz – 5, 8, 11, 14, 17, 20 dB
400 MHz – 5, 8, 11, 14, 17, 20 dB
450 MHz – 5, 8, 11, 14, 17, 20 dB
Return Loss = 16 dB All Values
Insertion Loss = =1.0 dB All Values
QMAGV
Replacement Equalizer For Magnavox 5CE Series Adjustable
(330 and 450 MHz)
$14.00*
330 MHz – 0, 5, 8, 11, 14, 17, 20, 23 dB
450 MHz – 5, 8, 11, 14, 17, 20, 23 dB
Return Loss = 16 dB All Values
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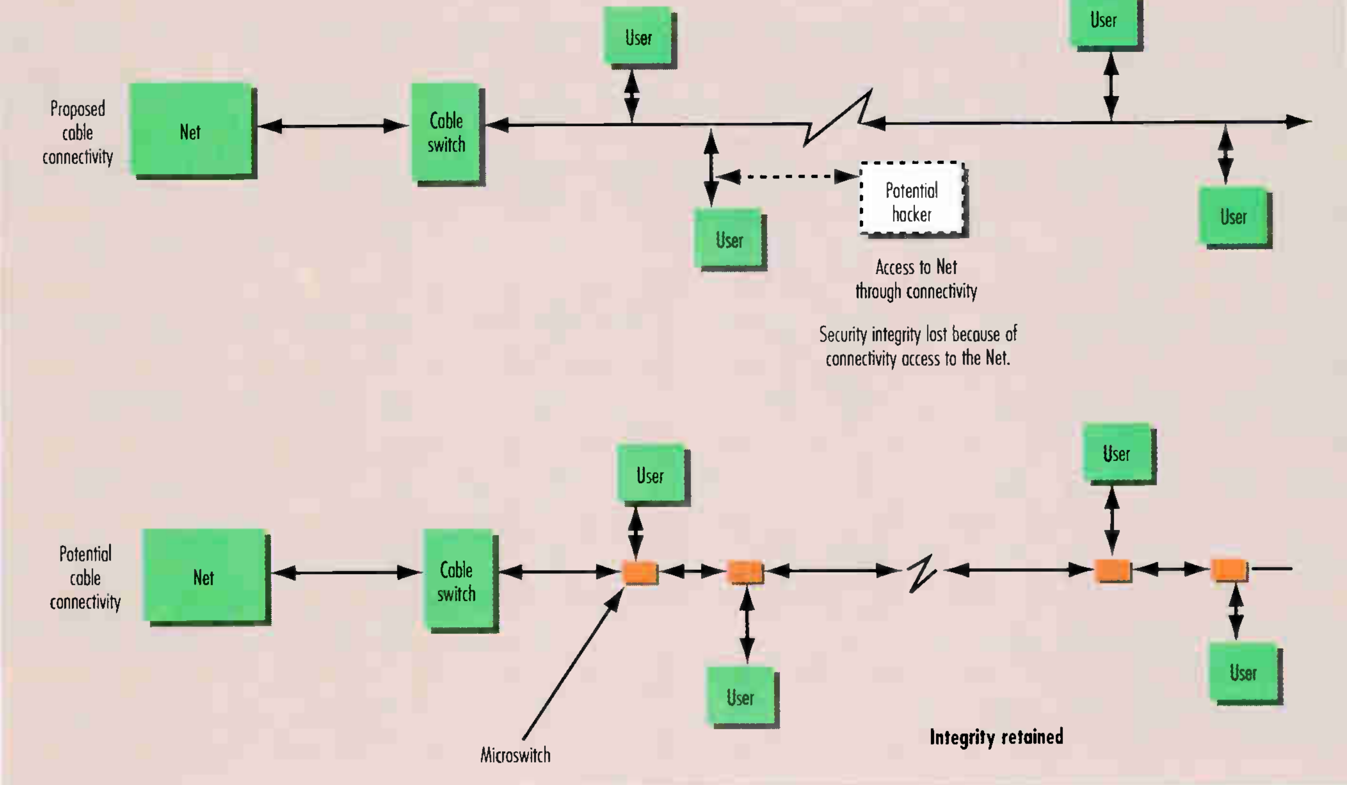
Figure 2: Cable modem connectivity



(traffic management) in smaller units closer to the user (smaller data bandwidth required at control nodes).

- Electrically isolates the user from the network, but not functionally.

The microswitch has taken the desirable attributes of the local loop switch and distributed them farther into the network, at the subscriber interface to the network, to achieve the required functionality. This retains simplicity of the delivery, system economy, and the required Internet security.

Conclusion

The Net has many and varied security issues. This article has addressed one of the more vulnerable areas—the cable modem to subscriber connectivity link, and focused on the nature of that problem area. The significance of this issue will become more apparent as the field trials of the cable modems progress and as more individual subscribers access the Net and request higher data rates. **CT**

By Bronwen Lindsay Jones, Richard Prodan and David Eng

Compressed picture performance

The following is adapted from the "1996 National Cable Television Association Technical Papers."

The advent of differing compression schemes and bit rate combinations for video and audio information has caused confusion in the industry. (Over 100 combinations have been reviewed to date.) Optimization or best-fit for viewer preference and expectation of picture quality is expected to vary with program content and demographics. Answers that will help guide industry standards are needed as are recommendations regarding variability with program content and source format.

Because standard definition, compressed digital picture artifacts have not been examined in any formal subjective manner, their effect on perceived picture quality to various viewer populations is not known. This article describes an initial small pilot study aimed at getting these answers, using industry experts as observers.

Method

The uniqueness of this study is in the new and very subtle nature of the manner in which compression artifacts manifest themselves in pictures. Objects in motion can exhibit blockiness, edge business, and a shimmery, twinkling "mosquito" noise that is visible in high contrast areas around sharp transitions.

Test methods must be chosen carefully to fit experimental test conditions in order to avoid overly influencing the outcome. For example, compression artifact differences are small. A subjective scale with too little resolution will show large differences but not small ones. Small differences are perceived, but will not show up in the data.

Due to the expertise of the observers, the small differences in compared picture quality, and the internal nature of the initial study, a special combination of test methods is being employed. Unlabeled graphic scales are presented for recording viewer judgments in a continuous, proportional ratio-scale manner. In addition, viewers are encouraged to record comments in an information gathering technique that has become known in the industry as Expert Observation & Commentary (EO&C).

Observers

Expert observers from within CableLabs, including the authors/experimenters, set up the study and finalized the choice of appropriate test methods and test materials.

Expert observers from within CableLabs' membership (i.e., industry experts and video engineers) will be used as subjects in these pilot studies; nonexpert viewers may be added later for more generalized test results. Experts are defined by the ITU-R (formerly CCIR) as "observers who have had recent extensive experience in observing picture quality or impairments, particularly of the type being studied."

Material selection

New motion-picture test material has recently been assembled by groups such as The Moving Picture Experts Group, the Federal Communications Commission's Advisory Committee on Advanced Television Systems Planning Subcommittee Working Party 6 on Subjective Assessments, and some private parties. It generally consists of 10- to 35-second segments of video material (no audio) originated on film, on HDD 1000, on D1, and on Beta SP. This ensured excellent quality origination. Such quality origination is especially important for source comparisons.

Additional test material originated on film was provided by Lucasfilm Ltd. Test material that was representative of high-motion cable sports programming was provided by ESPN Engineering. Video sequences from the original CableLabs/Viacom compression test source were included.

The choice of which test material selections to use in an experiment is made by expert review and includes seeing all test material under all viewing conditions. Those sequences that are most sensitive to the

Bronwen Lindsay Jones is an independent contractor, Richard Prodan, Ph.D., is senior vice president and chief technical officer, engineering, and David Eng is director, laboratory testing, engineering, for Cable Television Laboratories.

impairments or artifacts being studied are chosen. The selected sequences are displayed according to system M 525-line component standards, after compression and expansion. As a result, a compilation of 17 selections from MPEG, Lucasfilm Ltd., ESPN and Viacom are the primary test material grouping. The material is arranged for presentation in several blocked and balanced pseudorandom orders.

Material production

A studio-quality, Panasonic D-5 digital component VTR input source material to a digital video compression encoder connected to a decoder produced by the same vendor were used.

The encoder output fixed values of constant bit rate. The output of each decoder was tape recorded with a second studio-quality digital component VTR. A short segment of compressed digital information in MPEG transport stream format was captured and verified by CableLabs. The verification process included bit rate, resolution and profile elements, as well as MPEG-2 bit stream syntax at the system and video layers.

Test equipment

Hardware included a studio-quality videotape recorder (Panasonic model AJ-D580P), the randomized tapes, and two or more Sony BVM-1911 CRT monitors. If viewer response gathering becomes automated at a later date, computer keyboards may be included.

The study was conducted in a viewing environment closely matched to ITU-R viewing-room specification. One to three viewers participated at a time.

Design and procedure

This study was segmented into two or three primary blocks:

1) Source and four compression techniques including full CCIR-601 resolution MPEG main profile (MP) using I, P, B frames; simple profile (SP) using I, P frames with MPEG-2 dual prime smart prediction; intra-coded and predicted-frame coded (IP) MPEG-2 profile using I, P frames without smart prediction; and a proprietary profile using I, P frames with General Instrument DigiCipher extensions. Processing was accomplished by a single manufacturer's encoder/decoder at bit rates of 8, 6, 4.5 and 3 Mb/s;

2) Source and full resolution MPEG MP, SP, IP, and proprietary processing as generated for comparison by two primary encoder/decoders at bit rates of 8, 6, 4.5 and 3 Mb/s;

3) Source, full, and 3/4 resolution MPEG MP, SP, IP and proprietary processing as generated by all encoder/decoders at bit rates of 8, 6, 4.5 and 3 Mb/s.

Block 1 is an evaluation of a single coding system operating at full resolution, but at different bit rates and with different profiles to determine just exactly how similar they are. There are as many as 32 possible operating conditions tested. Block 2 and 3 evaluate between and across manufacturer's systems.

Side-by-side pair comparisons, in parallel rather than in sequence, will be the primary response-gathering

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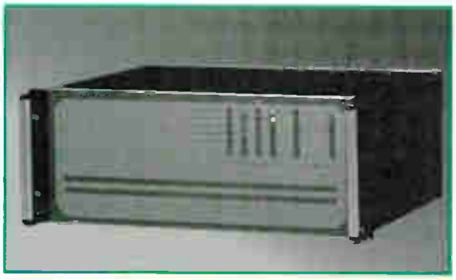
Reader Service Number 254



New Cost-Effective Last-Mile Telephony Products

A new series of last-mile telephony products for customer premise applications is now available from Radiant Communications. These products combine all customer voice, data and fax information into a T1 output (fiber or leased phone line.) The cost-effective systems enable CATV systems to offer voice and data service and to compete with local exchange carriers.

Reader Service Number 255

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 two to twelve fibers with customer specified node connector. Also available are fiber optic assemblies, couplers, fiber management systems and the industry's first and best low backreflection attenuators— both fixed and variable.

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procedure. Unlabeled graphic scales will be used in a continuous, proportional, rather than discrete, manner. (This approach asks not only if something is better, but how much better; rating scales ask merely for a position on a continuum). Both members of each pair are judged and scored, in accordance with ITU-R Recommendation BS 1116. EO&C, as was used in the listening tests for the FCC ACATS in the U.S. audio standards effort (recently concluded end of 1995, high definition TV sound), will accompany the scaling procedure.

Test material will be made up of different groupings of the 17 test material selections previously described. The viewing distance from the screen (three or four times the picture height) was chosen by the expert observers and noted and reported.

Block 1 may be conducted repeatedly with any or all systems if deemed in need of a similar thorough evaluation. Blocks 2 and 3 will be used in the same manner for comparison across systems: ratio scales in side-by-side pair comparisons using EO&C. Depending on the visibility of artifacts, it may be necessary to impose top and/or bottom anchors by including uncompressed source and/or very low bit rate compressed test material.

"The uniqueness of this study is in the new and very subtle nature of the manner in which compression artifacts manifest themselves in pictures."

Results

The presentation of results includes graphs and tables of means and standard deviations. Ratio scaling of data usually makes use of geometric, rather than authentic, means and standard deviations in order to lessen the influence of the spread of the members (proportions are of interest, not numerical values).

The size of this study is fairly small and manageable, therefore, viewer responses can be gathered with paper and pencil and the analysis of results can be done manually. If demonstrations become important or the number of observers grows a great deal, it may become desirable to automate viewer-response gathering. When this is done, the statistical processes are incorporated into the software and data can be plotted immediately upon completion of the test. This kind of automation also considerably speeds up data analysis and report writing. **CT**

References

[1] Recommendation ITU-R BS.116, Methods for the Subjective Assessment of Small Impairments in Audio Systems Including Multichannel Sound Systems.

[2] Recommendation ITU-R BT.500-6, Methodology for the Subjective Assessment of the Quality of Television Pictures.

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Reader Service Number 130

By Wavetek and Orion Business Services

What causes leakage?

Leakage may occur at many points in a cable TV system, from headend to the subscriber terminal and anywhere in between. Experience has shown that the most common sources of leaks are drop-related. Although drop-related leaks are the most abundant, leaks from the trunk and distribution equipment may be more serious. For example, a leak emanating from trunk or bridger output is likely to radiate greater RF energy than a drop and produce a bigger effect on the system's total leakage.

Common trouble spots in all cable TV systems include the following:

• *Splices and fittings*. Water and weather can result in pulled out (sucked out), loose or corroding fittings.

• *Splices at taps, line extenders, splitters, amps and ground blocks.*

• *Illegal hookups involving twin-leads, inferior passive devices, poor or no connectors, and improperly terminated splitters, jumpers from drops to taps or ground blocks.* Note that weather boots or heat shrinks should be used when replacing jumpers on splices.

Other less common sources include: malfunctioning TV sets and VCRs; bad converters; FM splitters; inferior quality coaxial cable; two-piece fittings; splitters used outside without weather bonding; and F-fittings with pinched jackets from poorly adjusted hex crimpers.

Underground leakage

Common underground drop-related leaks often found at the pedestal taps are caused by broken or unterminated tap ports, malfunctioning terminators, loose F-connectors at the tap and loose fittings. Underground damage can frequently be found at driveway, road and sidewalk bores because of the difficulties encountered in the original installation or heavy road traffic above the bore. Similarly, damage may be caused when fence or mailbox posts are set in the ground and pierce underground cable.

This article is primarily excerpted from a new revision of a booklet titled "Monitoring and Measuring Signal Leakage," jointly published by Wavetek and Orion Business Services in 1990.

"A difficult and costly problem exists if the underground leak in a feeder or trunk line is caused by poor workmanship or inferior materials."

A difficult and costly problem exists if the underground leak in a feeder or trunk line is caused by poor workmanship or inferior materials. Some contractors are known to have constructed cable TV systems poorly using below grade supplies. These plants are found to have scraped and perforated cable sheaths, poorly spliced lines, and crimped cable with small bending radii. The repair costs of system constructed in such a shoddy manner are extremely high because it is difficult and time consuming to rebuild plant. Often, long sections of cable must be replaced in damaged areas.

Damage to sheathing

Another form of damage occurs when slices or holes form in the cable sheath. Water enters the cable through the holes and causes corrosion inside the cable. Even a tiny hole in the sheath can suck water into the cable. Water damage with foam cable is less of a problem because there is less tendency for water migration to occur with the solid foam dielectric. However, in fused disk cable, the water collects inside the cable, where it corrodes the center conductor and sheath. Water and further corrosion then can migrate (flow) up or down the cable.

When looking for damage to the coaxial cable, the following areas are chronic trouble spots. Always check for holes and possible water migration at or near suspension clamps, bonding clamps, span clamps, guy lines, trees and expansion loops. Pole hardware rub throughs are a major cause of cable damage. Use straps and spacers to prevent damage at rub points.

Be extra careful with span clamps, both at the pole and at midspan. They can cause problems when carelessly installed. Down guys and overhead pole-to-pole guys sometimes come in contact with the cable and eventually wear through the cable sheath. Use tree guards to protect the cable. Tree limbs also are trouble spots. Trim branches or use tree guards to prevent cable damage. Cable may be damaged by pole transfers or animal chews (particularly squirrels). Moreover, the integrity of sound cable diminishes with age even though it may show no visible damage.

Other problems

Expansion loops are a problem in older cable TV systems, especially with .412 cable. Repeated seasonal expansion and contraction eventually causes the cable to crack at the flex points. If a hole is found in the cable, splice out the damaged section of cable and check to see if the problem is corrected. If the problem persists, it may be necessary to replace the entire span.

Water damage to equipment occurs when a poor seal is made between a housing and its cover or lid. Over a period of time, water can

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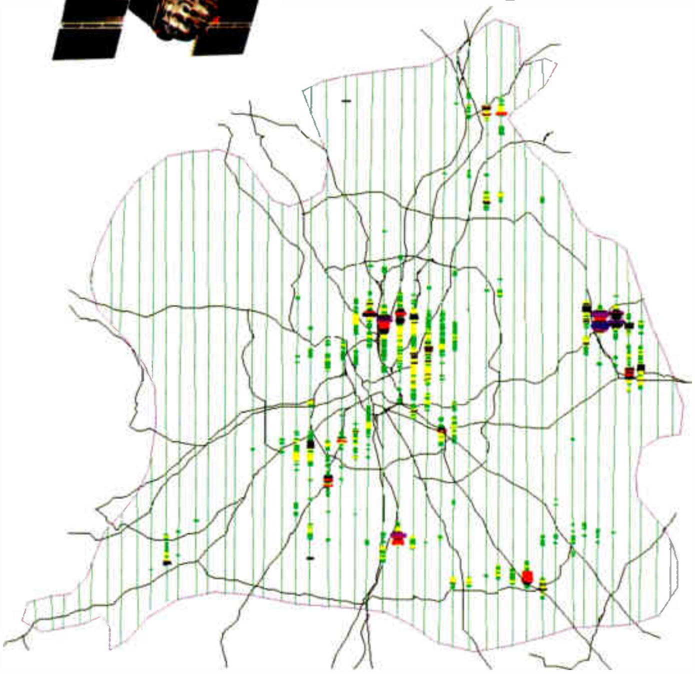

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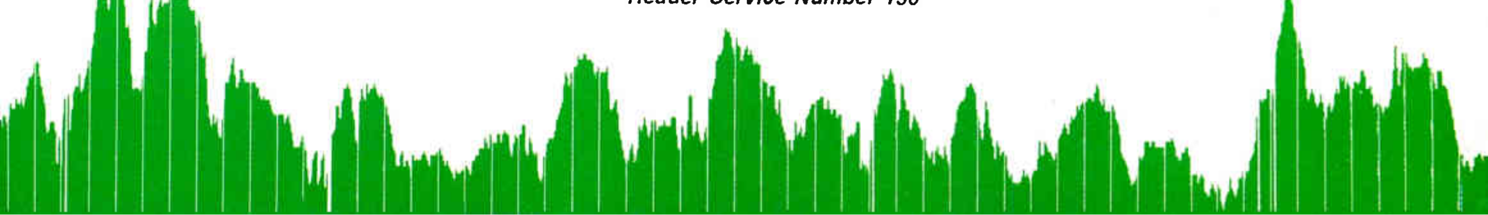

"Touching or moving the leak source frequently changes the leakage level and may even eliminate it temporarily."

collect inside the housing, eventually causing corrosion and component failure.

Troubleshooting

A leak should be recorded as soon as it is discovered. Touching or moving the leak source frequently changes the leakage level and may even eliminate it temporarily. Locate the leak with a minimum amount of disruption to the cable.

For most leaks at fittings, repair generally entails finding the defective component and then tightening it or replacing it with a new fitting. Be sure that the new fitting is well-prepared and sound. Use a detector to confirm that the repaired leak was the one that generated the signal. If the signal persists then the wrong fitting may have been repaired. In such a case, start over and look for the source.
A well made fitting and splice will eliminate many leak sources and prevent future leaks.

Sophisticated and comprehensive leakage equipment is now priced economically to provide service technicians with meters that are well suited for both the signal level measurement and the leakage detection and measurement portions of their jobs, in many cases eliminating the requirement to carry more than one instrument. These meters enable monitoring for leaks between service calls or installations and measuring leaks according to government prescribed procedures when they are found.

These new combination meters are just as accurate and feature-rich as meters previously designed to fulfill one purpose

(signal level measurement or leakage), and are ideal for day-to-day use and for the annual cumulative leakage index (CLI) test. For line technicians that need a leakage meter in addition to their high-end meter/sweep analyzer, leakage-specific products with high-end leakage detection and measurement features are available at a reasonable price.

The alarm threshold may be set by the operator to enable the operator to patrol the system using a "peel the onion" technique. This refers to the method of finding the largest leaks first by setting the alarm at a relatively high threshold level so that only the most severe leaks are revealed. Then, the alarm threshold is gradually decreased to find less severe leaks until all leaks are identified and fixed.

The new leakage products may be used for hand-held location of the leak source when the alarm sounds. The alarm beeps speed up as the leak intensity increases, which enables the operator to move the receiver in such a way as to determine the direction from which the leak is emanating.

The flexible rubber antenna, or "rubber duck" has a radial pattern with a "null" spot—where the beep speed slows to a minimum—in the direction in which the antenna is pointing. The null direction is straight out from the top of the antenna. Therefore, in order to locate a leak, the technician simply rotates the meter in many directions and listens to the beeps. When the alarm beep speed nulls, and the level read out is at a minimum, then the antenna is pointing in the direction of the leak.

If the receiver is close to a relatively strong leak, the beep speed may be at maximum. In these cases, the technician may remove the antenna entirely and move the sensitive meter around the location of the suspected leak source. The meter will beep when it passes the source.

As mentioned previously, there are new products available that combine all of the functions required to properly locate leaks in CLI compliance and also to perform the measurements needed for service and maintenance at the subscriber level. These measurements include quick go/no-go level tests, scans of signal levels, automated 24-hour tests, and now even scanning the reverse path spectrum to check for ingress or noise that might interfere with two-way services. In use, once the installation is complete, the meter can be connected to the tap end of the drop and the reverse scan mode selected. A user-programmable limit can be set for simple identification of problem drops. To check for intermittent ingress, the meter can be set in the peak hold mode to catch transient signals.

Now more than ever, proper control of leakage is critical to the competitive strength of the cable TV network. This means that technicians must not only be aware of probable causes of leaks, but be properly equipped to locate and repair leaks as they are found. Modern test equipment is available to meet these more stringent and all-encompassing requirements. **CT**

By Dick Shimp

Cable TV signal leakage fundamentals

Controlling signal leakage is your new assignment and, generally, you feel that the whole thing is a mystery. If you took a few minutes to chat with veterans of previous battles who have "been there, done that," the advice they offer probably would be invaluable. While they are talking with you, I bet they mention stuff like cumulative leakage index (CLI), microvolt per meter (uV/m), dipole, monopole and leakage detector. They might introduce standing waves, wavelength, propagation, multipath and maybe global positioning satellite system (GPS). These are all tools of the trade and, as so often happens, some earn recognition, others do not. To avoid getting inundated with words, the following few paragraphs give each of the terms a handle so that you have something to get your hands around.

FCC definition

The Federal Communications Commission imparts limits on signal leakage from cable TV systems in 47 CFR 76.605(a)(13). For frequencies at and below 54 MHz and greater than 216 MHz, the allowable leakage must not exceed 15 µV/m when measured at a distance of 30 meters from the leakage source. Frequencies greater than 54 MHz and up to 216 MHz must not exceed 20 µV/m at a distance of 3 meters from the leakage source.

As you can see, the FCC refers to signal leakage in terms of field strength and uses µV/m as the unit of measure. It also could be correct to refer to signal leakage in any number of other units such as microvolts (µV), decibel microvolts (dBµV), decibel millivolts (dBmV), etc. However, reluctance to change from the early broadcast days keeps the standard unit as the µV/m.

Dick Shimp is manager of technical support for ComSonics Inc.

Microvolt per meter

All broadcast signals get their start from some point source and continue a trek to infinity. During its propagation journey, the signal retains an impressive amount of its original energy, losing only a tiny bit to heat as it moves through the atmosphere at nearly 300 million meters per second. *(Editor's note: The speed of light in a vacuum is actually 299,792,458 meters per second.)* The electromagnetic wave, however, must cover an ever increasing spherical area as it makes its way outward from its relatively tiny beginning. Eventually, the energy fades into obscurity, swallowed by surrounding natural elements, much as ripples made by dropping a rock into an otherwise motionless pond.

Imagine placing a 1-meter length container so the trough-like opening just skims the quiet pond surface. Since we know where we plan to drop the rock, we will move the vessel 3 meters (about 10 feet) from impact. Splash! The wave front approaches our container and we trap an amount of fluid. Moving the vessel further from the point of impact traps less fluid. The energy initially transferred from the rock to the water distributes over a much larger circumference as the wave front moves outward. This results in exponentially decreasing wave height.

Increasing the vessel throat width to more than 1 meter traps more of the passing wave, just as throat reduction traps less. With appropriate trough calibration, a method of measuring the intensity of the wave front emerges. The intensity, quantified, for example, in kilograms per meter (kg/m), represents the amount of water spilled into the container by the passing raised wave front.

Substitute for the pond wave, the propagated electric wave. Passing over any conductor, energy from the electric field forces a current to flow within the conductor. Connecting the conductor to a terminal resistance allows the current to pass through, producing a proportional voltage. The wire can be any length, but a meter was convenient to the principle originators, and became a standard. So, a 1-meter length conductor, connected to a calibrated measuring instrument and exposed to a propagated electric wave front, produces an electrical signal proportional to the wave front intensity. Appropriate calibration allows signal expression in volts-per-meter, any superset or any subset, including µV/m.

Wavelength and velocity

We never measure field strength with a 1-meter length of wire. Rather, we use a quarter-wave monopole antenna or a half-wave dipole antenna. Why should we complicate the measurement procedure using nonstandard tools? Actually, the 1-meter length of wire is the nonstandard item. Its use is purely conversational. Returning to the pond for a moment, while similar dispersion principles apply, pond ripple and electric wave constructions differ. In order to be propagated, a signal must continuously alternate through positive and negative half-cycles, separated by a zero crossing. One complete cycle constitutes one wavelength.

Constructing any portion of a wavelength takes time. As previously mentioned, in free space, the velocity of propagation equals 300 million meters per second. Constructing one wavelength from one complete alternating cycle requires the time equal to the reciprocal of the alternating rate (frequency). Given the well-known relationship that equates distance equal to rate multiplied by time, it follows that for a 100 MHz signal:

Wavelength (λ) =
speed of light x (1 ÷ frequency)
and
l = 300 million (1 ÷ 100 million) =
3 meters
or, expressed in feet
λ = 984 ÷ frequency in MHz
λ = 984 ÷ 100 = 9.84 feet

Routing this same 100 MHz signal through a length of contemporary trunk cable slows the velocity of propagation to about 87% of the speed of light. The calculation would then result in a wavelength reduced by an equal amount.

Associating quarter-wave and half-wave with antennas normally used for signal leakage investigation actually refers to the physical length of the receiving element or elements. A quarter-wave monopole tuned for 100 MHz would be just a bit shorter than one-quarter of 3 meters or three-quarters of a meter. Likewise, the combination of both half-wave dipole elements measures almost 1.5 meters.

Any medium, other than free space, slows the velocity of propagation and proportions the actual wavelength shorter. In the previous examples, the antenna element lengths measure slightly less than the calculated value for that reason. As the wave front passes over either of the conductive elements, the wave aligns itself with the physical dimensions of the element. Elements of the proper length match load and source impedances and, thus, support maximum signal transfer. Shorter or longer element length results in mismatched impedances and less than maximum signal exchange.

Useful tools

Sensitive receivers specifically designed to provide optimum performance in the relatively hostile electric environment bear the name signal leakage detectors. Basically, all such devices must be capable of interpreting the equivalent of 20 µV/m at 3 meters. The difficulty is satisfactorily identifying sources at this level from a distance of, say, 23 meters (75 feet) and 45 meters (150 feet).

Routine suburban signal leakage patrolling encounters basically two plant construction configurations. Standard construction practices locate the cable distribution plant alongside the street or in a rear easement, and maybe both in some areas. Either way, a drop enters the dwelling from one or the other. As an example, consider the worst case, a rear easement plant. To provide useful information in a practical monitoring program, the signal leakage detector acts as an alarm. It must warn the operator when encountering a signal leak creating a field equal to or exceeding 20 µV/m at a distance not exceeding 3 meters from the physical cable. Rear easement is, typically, 45 meters off the roadway with no alleys. At this distance, the 20 µV/m signal level appearing 3 meters from the plant reduces to about 1.33 µV/m by the time it reaches the monitoring vehicle on the street.

µV/m = 20 (3 ÷ 45) = 1.33

Assigning a practical monitoring frequency of 121.2625 MHz, a sensitivity of 1.33 µV/m equates to -65.6 dBmV or 0.52 µV.

dBmV = 20logE - 20log(20.95f) = -65.6

Where:
E = µV/m
f = tuned freqency in MHz
and
µV = 1,000 ($10^{-65.6/20}$) = 0.52

Distance from the receiving antenna to the point of potential signal leakage varies with the configuration. Therefore, having a signal leakage detector that automatically considers this variable while calculating the appropriate level is convenient. Results, however, are only as good as the operator's devotion to matching the instrument's settings to the measurement environment.

Antennas used to gather signal leakage data also depend upon the circumstances. Practicality plays an important role in deciding whether to use a dipole or monopole. During drive-out monitoring, a vertically polarized monopole presents a much less formidable structure on the roof of a vehicle than does a horizontally polarized dipole.

Either antenna type provides a fairly representative picture of the prevailing signal leakage amplitude. Consider the physics that apply to propagation polarity. Typically, transmitting conductors mounted parallel to the earth's surface emit horizontally polarized waves. These opportunities include stranded cable sheath, power lines, phone lines and high-rise electrical conduit. Conductors mounted perpendicular to the earth's surface will propagate vertically polarized waves. Among these are pole plant neutrals, drops from roof-lines to grounding blocks and high-rise electrical conduit. Other examples, such as pole plant and supported antenna guy wires, high-rise steel structure and wiring conduit fall somewhere in between.

A purely theoretical environment blesses the dipole with a bit more gain than the monopole because the latter contains only one quarter-wave element rather than two. Mounted onto a vehicle for plant monitoring, both structures exhibit unpredictable sensitivity to ground planes surrounding their attachment. In practice, this generally offsets any actual or apparent advantage one may have over the other. Always allow plenty of margin, at least 3 dB, when measuring leakage to compensate for the lack of field interception precision.

Never attempt to use a monopole as a hand-held antenna. This device requires mounting perpendicular to a ground plane of at least one-quarter wavelength radius to provide any semblance of signal pickup accuracy. Measurements used to compute CLI require the use of an appropriately suspended dipole antenna. Rotate the device to cross all possible planes, thus intercepting the worst-case field.

Complications

Familiarity with a few of the most adverse characteristics found while seeking out signal leakage will ease the task of isolating and clearing the faults.

Standing wave patterns accompany all signal propagation. Energy transported through a medium seeks a terminal impedance equal to the generating source impedance. In most of the CATV world, this is 75 ohms. Load impedance differing from the source results in incomplete energy absorption. The unabsorbed portion returns to the source at an amplitude dependent upon the purity of the termination plus any applicable cable loss. At that point, the source impedance becomes the load and the process repeats until the energy reduces to insignificance. Electrical short and open circuits return almost all the transmitted energy since no load exists for dissipation. A very small amount of energy returns during normal CATV signal delivery because source and terminal products, generally, contain well-controlled input and output impedances. Minimum standing waves exist under this condition.

"Exhibiting patience and logic wins the war; frustration guarantees an ongoing siege."

CATV signals, contained within the coaxial tube, skim along the conductor surfaces at near light speeds, capable of interfering only with each other. Signals seeping from within the cozy coaxial pipeline at points of shielding interruption, however, journey down the outer sheath surface and create a sizable monster. To those signals, the termination impedance approaches an open circuit. Open circuits reflect nearly 100% of the transmitted energy, creating a standing wave on the outer surface of the sheath.

Standing waves are observable by slowly driving parallel to a shielding compromised cable plant in a properly outfitted vehicle. A distinct pattern emerges from the simultaneous presence of the incident and the reflected signals. The pattern appears as static beads of energy with alternating peaks and nulls occurring at half wavelength intervals. At 121.2625 MHz, each occurs at 1.24 meters or 4.06 feet.

$\lambda/2 = 0.5\ (300\text{ million} \div 121{,}262{,}500)$
$= 1.24$ meters
or, expressed in feet
$\lambda/2 = 0.5\ (984 \div 121.2625) = 4.06$ feet

Several leakage points complicate the pattern, resulting in the eventual erasure of the nulls. Given a sufficiently large number of significant leaks, the nulls blur, leaving a sequence of indistinguishable signal peaks. This results in undetectable signal level increase at the point of integrity failure. Attempts to locate multipath leakage sources become frustrating because there are so many.

Exhibiting patience and logic wins the war; frustration guarantees an ongoing siege. Facing the most reasonable option at this stage favors systematic replacement of the most likely cause of integrity loss; the drop cables. Pick a manageable geographical area to work in and clear first the largest offenders, followed by another round and another, until the area is in compliance. Persistence pays off in the end and, quite likely, rewards everyone with fewer trouble calls. **CT**

By Mike Wohrle

Hantavirus and cable TV

Many of us have entered our rural headends, flipped on the lights and seen the mice scramble for cover. It just seems to be a fact of life, right? Well not anymore. Those cute, furry little mice may be carrying a deadly virus. By simply breathing dust from sweeping the floor, you could be dead in a few weeks. It's that serious!

Common deer mice found in rural areas are attracted to warm places in the winter and cool in the summer, so our headends are a perfect place for them to set up housekeeping. Great care must be taken when dealing with a headend contaminated by these mice. Even buildings outside the high-risk areas of the southwest United States should be treated with extreme caution.

Mike Wohrle is AML technician with Falcon Cable TV.

It is believed that this common mouse, found throughout the United States, sheds live virus in saliva, droppings and urine. Humans are infected when they inhale airborne dust particles that contain the virus. Once infected, flu-like symptoms of high fever, muscle ache, cough and headache will typically appear in seven to 14 days, the shortest being four days and the longest 42 days. Hospitalization usually occurs about five days after the onset of symptoms. After several days of symptoms, respiratory problems worsen rapidly and death can occur shortly after.

Since there is no known treatment for this illness, the key is prevention. If you have a building that is contaminated, it must be properly disinfected. This means airing out the building, properly disposing of nests and dead rodents, then disinfecting the site.

Prepare a solution of one part household bleach to five parts water. Wear gloves, a dust mask, long sleeved clothing and protective eye wear before entering the building. Start by airing out the building (using fans if necessary), leave the area for one hour, then remove any nests and dead animals. Dispose of them as directed by the local health officials. Animal debris should be thoroughly moistened by misting it with the prepared disinfectant to reduce airborne dust. Debris should then be wiped up and placed in double plastic bags for disposal, together with any clean-up materials such as paper towels. *Do not* use vacuum cleaners or sweep with a broom be-

"Since there is no known treatment for this illness, the key is prevention."

cause dust will be generated. Never touch a rodent, its droppings, or its urine with bare hands.

Before removing the gloves, wash your hands in a general household disinfectant, then in soap and water. Thoroughly wash your hands with soap and water after removing gloves as well. Protective goggles will keep dust from entering your eyes; the use of a respirator or dust mask will be based on your area's risk factor. The extent to which these recommendations are appropriate or necessary in areas not currently affected by hantavirus is uncertain, so contact your local health agency for details. But remember—you're better safe than sorry. You don't want to be the first reported case in your area. If you have had possible contact with the deer mouse and *any* symptoms occur, contact your doctor immediately.

Again, prevention is the key. Rodent-proof your buildings by sealing all openings, cracks, holes and screens over vents. Choose a sealing material appropriate for the situation. Some foam sealers will be chewed up and used for nesting material, so use mortar and other types of hard-setting sealers; even steel wool can be used for space filling.

Another area of concern is for service technicians and installers, who may come in contact with rodents and nests in crawl spaces, underground vaults and pedestals. If your area is suspected of harboring the virus, carry protective gloves and dust masks on the truck and use them.

Repair facilities also are at risk from the virus because headend gear can come in from an infected facility. The amount of risk and precautions taken are based on where the equipment was shipped from. Again, check with your local health department for details. **CT**

The author wishes to acknowledge Kurt W. Emery, MPH, San Bernardino County Department of Public Health, and the Department of Health Services, State of California.

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Compiled by Eric Butterfield

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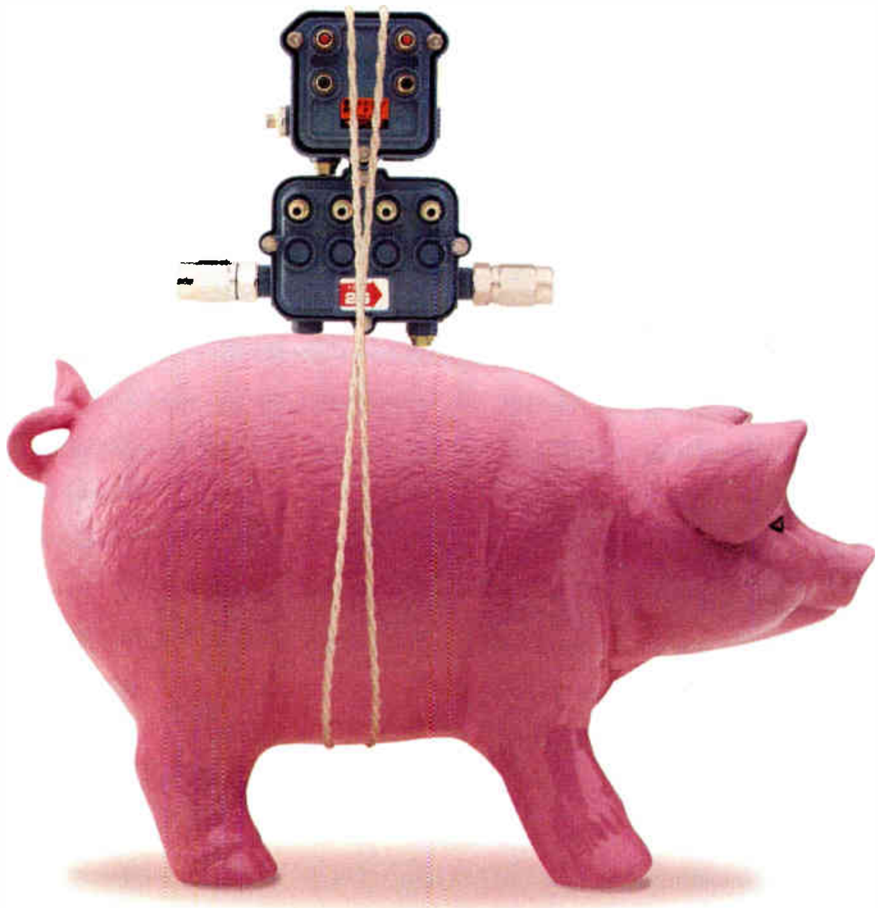

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A. Are you a member of the SCTE (Society of Cable Television Engineers)?
01. ___ yes
02. ___ no

B. Please check the category that best describes your firm's primary business (check only 1):
Cable TV Systems Operations
03.___ Independent Cable TV Syst.
04.___ MSO (two or more Cable TV Systems)
05. ___ Cable TV Contractor
06. ___ Cable TV Program Network
07. ___ SMATV or DBS Operator
08. ___ MDS, STV or LPTV Operator
09. ___ Microwave or Telephone Comp.
10. ___ Commercial TV Broadcaster
11. ___ Cable TV Component Manufacturer
12. ___ Cable TV Investor
13. ___ Financial Institution, Broker, Consultant
14. ___ Law Firm or Govt. Agency
15. ___ Program Producer or Distributor
16. ___ Advertising Agency
17. ___ Educational TV Station, School, or Library
18. ___ Other (please specify)_____

C. Please check the category that best describes your job title:
19. ___Corporate Management
20. ___ Management
21. ___ Programming
Technical/Engineering
22. ___ Vice President
23. ___ Director
24. ___ Manager
25. ___ Engineer
26. ___ Technician
27. ___ Installer
28. ___ Sales/Marketing
29. ___ Other (please specify)_____

D. In the next 12 months, what cable equipment do you plan to buy?
30. ___ Amplifiers
31. ___ Antennas
32. ___ CATV Passive Equipment including Coaxial Cable
33. ___ Cable Tools
34. ___ CAD Software, Mapping
35. ___ Commercial Insertion/ Character Generator
36. ___ Compression/Digital Equip.
37. ___ Computer Equipment
38. ___ Connectors/Splitters
39. ___ Fleet Management
40. ___ Headend Equipment
41. ___ Interactive Software
42. ___ Lightning Protection
43. ___ Vaults/Pedestals
44. ___ MMDS Transmission Equipment
45. ___ Microwave Equipment
46. ___ Receivers and Modulators
47. ___ Safety Equipment
48. ___ Satellite Equipment
49. ___ Subscriber/Addressable Security Equipment/ Converters/Remotes
50. ___ Telephone/PCS Equipment
51. ___ Power Suppls. (Batteries, etc.)
52. ___ Video Servers

E. What is your annual cable equipment expenditure?
53. ___ up to $50,000
54. ___ $50,001 to $100,000
55. ___ $100,001 to $250,000
56. ___ over $250,000

F. In the next 12 months, what fiber-optic equipment do you plan to buy?
57. ___ Fiber-Optic Amplifiers
58. ___ Fiber-Optic Connectors
59. ___ Fiber-Optic Couplers/Splitters
60. ___ Fiber-Optic Splicers
61. ___ Fiber-Optic Transmitter/Receiver
62. ___ Fiber-Optic Patchcords/ Pigtails
63. ___ Fiber-Optic Components
64. ___ Fiber-Optic Cable
65. ___ Fiber-Optic Closures & Cabinets

G. What is your annual fiber-optic equipment expenditure?
66. ___ up to $50,000
67. ___ $50,001 to $100,000
68. ___ $100,001 to $250,000
69. ___ over $250,000

H. In the next 12 months, what cable test & measurement equipment do you plan to buy?
70. ___ Audio Test Equipment
71. ___ Cable Fault Locators
72. ___ Fiber Optics Test Equipment
73. ___ Leakage Detection
74. ___ OTDRs
75. ___ Power Meters
76. ___ Signal Level Meters
77. ___ Spectrum Analyzers
78. ___ Status Monitoring
79. ___ System Bench Sweep
80. ___ TDRs
81. ___ Video Test Equipment

I. What is your annual cable test & measurement equipment expenditure?
82. ___ up to $50,000
83. ___ $50,001 to $100,000
84. ___ $100,001 to $250,000
85. ___ over $250,000

J. In the next 12 months, what cable services do you plan to buy?
86. ___ Consulting/Brokerage Services
87. ___ Contracting Services (Construction/Installation)
88. ___ Repair Services
89. ___ Technical Services/ Eng. Design
90. ___ Training Services

K. What is your annual cable services expenditure?
91. ___ up to $50,000
92. ___ $50,001 to $100,000
93. ___ $100,001 to $250,000
94. ___ over $250,000

L. Do you plan to rebuild/ upgrade your system in:
95. ___ 1 year
96. ___ more than 2 years

M. How many miles of plant are you upgrading/ rebuilding?
97. ___ up to10 miles
98. ___ 11-30 miles
99. ___ 31 miles or more

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39. ___ Fleet Management
40. ___ Headend Equipment
41. ___ Interactive Software
42. ___ Lightning Protection
43. ___ Vaults/Pedestals
44. ___ MMDS Transmission Equipment
45. ___ Microwave Equipment
46. ___ Receivers and Modulators
47. ___ Safety Equipment
48. ___ Satellite Equipment
49. ___ Subscriber/Addressable Security Equipment/ Converters/Remotes
50. ___ Telephone/PCS Equipment
51. ___ Power Suppls. (Batteries, etc.)
52. ___ Video Servers

E. What is your annual cable equipment expenditure?
53. ___ up to $50,000
54. ___ $50,001 to $100,000
55. ___ $100,001 to $250,000
56. ___ over $250,000

F. In the next 12 months, what fiber-optic equipment do you plan to buy?
57. ___ Fiber-Optic Amplifiers
58. ___ Fiber-Optic Connectors
59. ___ Fiber-Optic Couplers/Splitters
60. ___ Fiber-Optic Splicers
61. ___ Fiber-Optic Transmitter/Receiver
62. ___ Fiber-Optic Patchcords/ Pigtails
63. ___ Fiber-Optic Components
64. ___ Fiber-Optic Cable
65. ___ Fiber-Optic Closures & Cabinets

G. What is your annual fiber-optic equipment expenditures?
66. ___ up to $50,000
67. ___ $50,001 to $100,000
68. ___ $100,001 to $250,000
69. ___ over $250,000

H. In the next 12 months, what cable test & measurement equipment do you plan to buy?
70. ___ Audio Test Equipment
71. ___ Cable Fault Locators
72. ___ Fiber Optics Test Equipment
73. ___ Leakage Detection
74. ___ OTDRs
75. ___ Power Meter
76. ___ Signal Level Meters
77. ___ Spectrum Analyzers
78. ___ Status Monitoring
79. ___ System Bench Sweep
80. ___ TDRs
81. ___ Video Test Equipment

I. What is your annual cable test & measurement equipment expenditure?
82. ___ up to $50,000
83. ___ $50,001 to $100,000
84. ___ $100,001 to $250,000
85. ___ over $250,000

J. In the next 12 months, what cable services do you plan to buy?
86. ___ Consulting/Brokerage Services
87. ___ Contracting Services (Construction/Installation)
88. ___ Repair Services
89. ___ Technical Services/ Eng. Design
90. ___ Training Services

K. What is your annual cable services expenditure?
91. ___ up to $50,000
92. ___ $50,001 to $100,000
93. ___ $100,001 to $250,000
94. ___ over $250,000

L. Do you plan to rebuild/ upgrade your system in:
95. ___ 1 year
96. ___ more than 2 years

M. How many miles of plant are you upgrading/ rebuilding?
97. ___ up to10 miles
98. ___ 11-30 miles
99. ___ 31 miles or more

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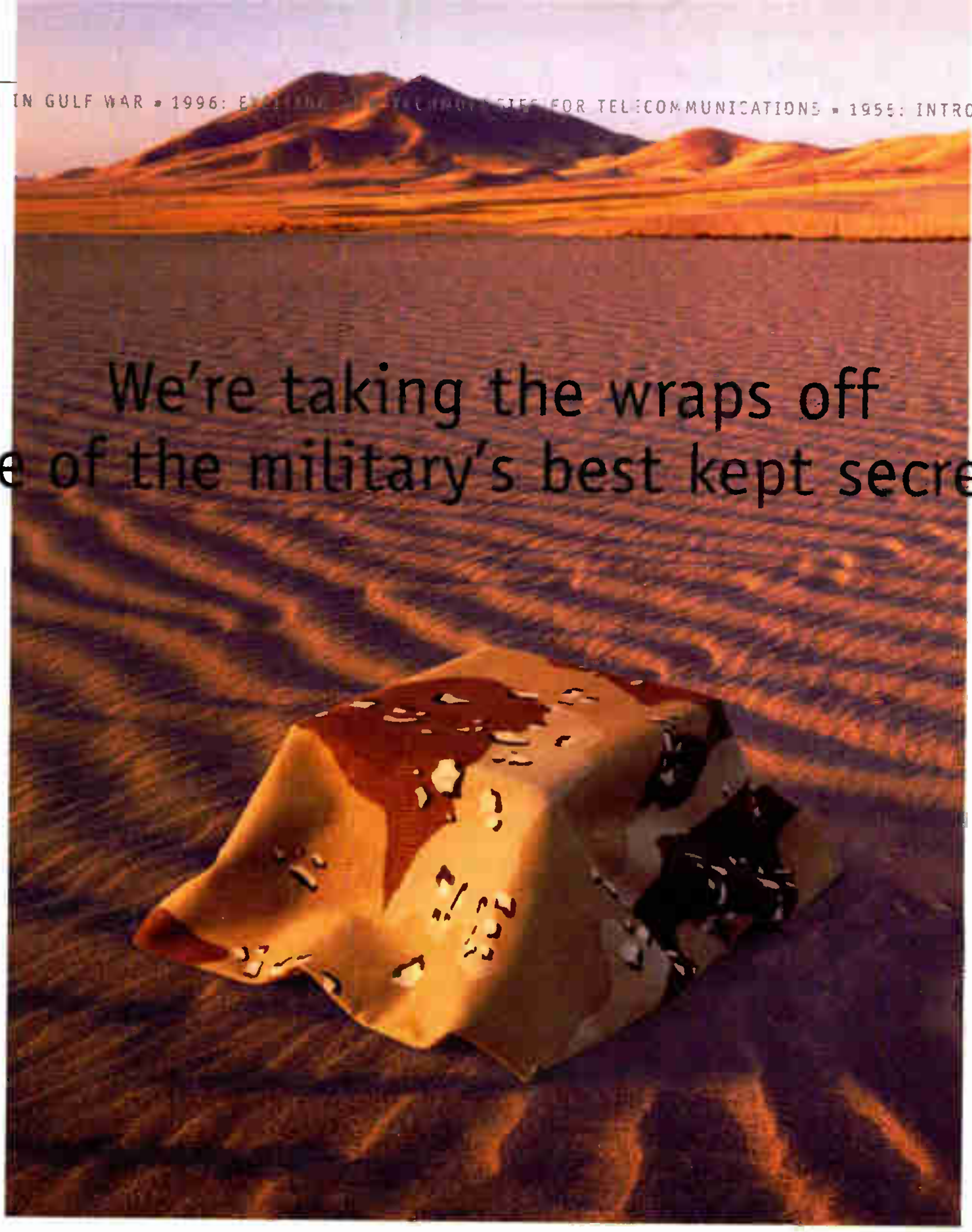


Cable modem

Scientific-Atlanta introduced its dataXcellerator cable modem system. S-A said the product is intended to provide a cost-effective way for cable operators to deliver high-speed data services over existing broadband networks. The company expects the pricing to be at $259, or with volume purchases, $199.

Scheduled to be ready for commercial delivery in the first quarter of 1997, the system operates over one-way plant using the public telephone network for the reverse path. It provides throughput of 1.2 megabits per second, or about 40 times faster than today's fastest telephone modem and about 10 times faster than integrated services digital network (ISDN) services for rapid data access. Status monitoring and remote network management through S-A's Melbourne, FL, operations center is provided.

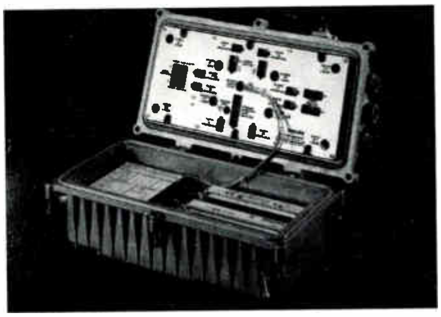
The system utilizes one-half of a 6 MHz channel and includes a built-in analog 28.8 kbps telephone modem in an externally installed cable modem. This is said to eliminate compatibility problems with subscribers' computers and provides sufficient upstream capability for most at-home applications.

Requiring no immediate investment in the transmission or distribution components of the cable plant, the system also doesn't require asynchronous transfer mode (ATM) equipment in the headend.
Reader service # 312

Optical node amplifier

New from Phillips Broadband Networks is the Diamond Net optical node amplifier (6-DNA) that features four of the company's active Power Doubling outputs with full analog capabilities at 862 MHz. This is said to allow and operator to reduce overall active count, improve system reliability and lower life-cycle costs.

The unit can be configured to provide up to four high-level outputs. Its right angle ports are adaptable



to both pedestal and underground installations.

With fewer external splits than conventional units, the four-port DNA is said to provide greater system reach and added flexibility in design. The patented diagonal-fin housing promotes optimum heat dissipation for increased protection of internal electronic components.

The 90% efficient switching mode power supply lower operating costs and reduces the number of line power supplies necessary for each application, according to Phillips. With an input voltage range of 42-90 VAC, the DNA is readily adaptable to both 60 and 90 VAC systems. With the addition of a 7th port powering kit, power inserters are no longer required. The product also supplies 15-amp power-passing capability at -70 dBc hum modulation.
Reader service #311

Mini OTDR

Hewlett-Packard's HP E6000A portable mini optical time domain reflectometer (OTDR) features a 35 dB dynamic range, 16,000 data points with 15 cm resolution, and 20 m deadzone. One-button automatic test and analysis is said to make it easy for technicians to take measurements and characterize links instantly.

An intuitive user interface and on-line context-sensitive "help" is included. Also provided are sophisticated features such as the optimize mode, which provides the best possible performance for a given parameter: dynamic range or resolution.

It weighs less than 2.8 kg (6.2 pounds) and incorporates the latest "smart battery" technology, which features long battery life, short charge times and exact charge status information.

The product also can be used as a fiber break locator or a stabilized light source. It is compatible with the company's full-size OTDR (HP 8147) and remote fiber test system (HP 81700 Series 200).
Reader service # 310

Data processor

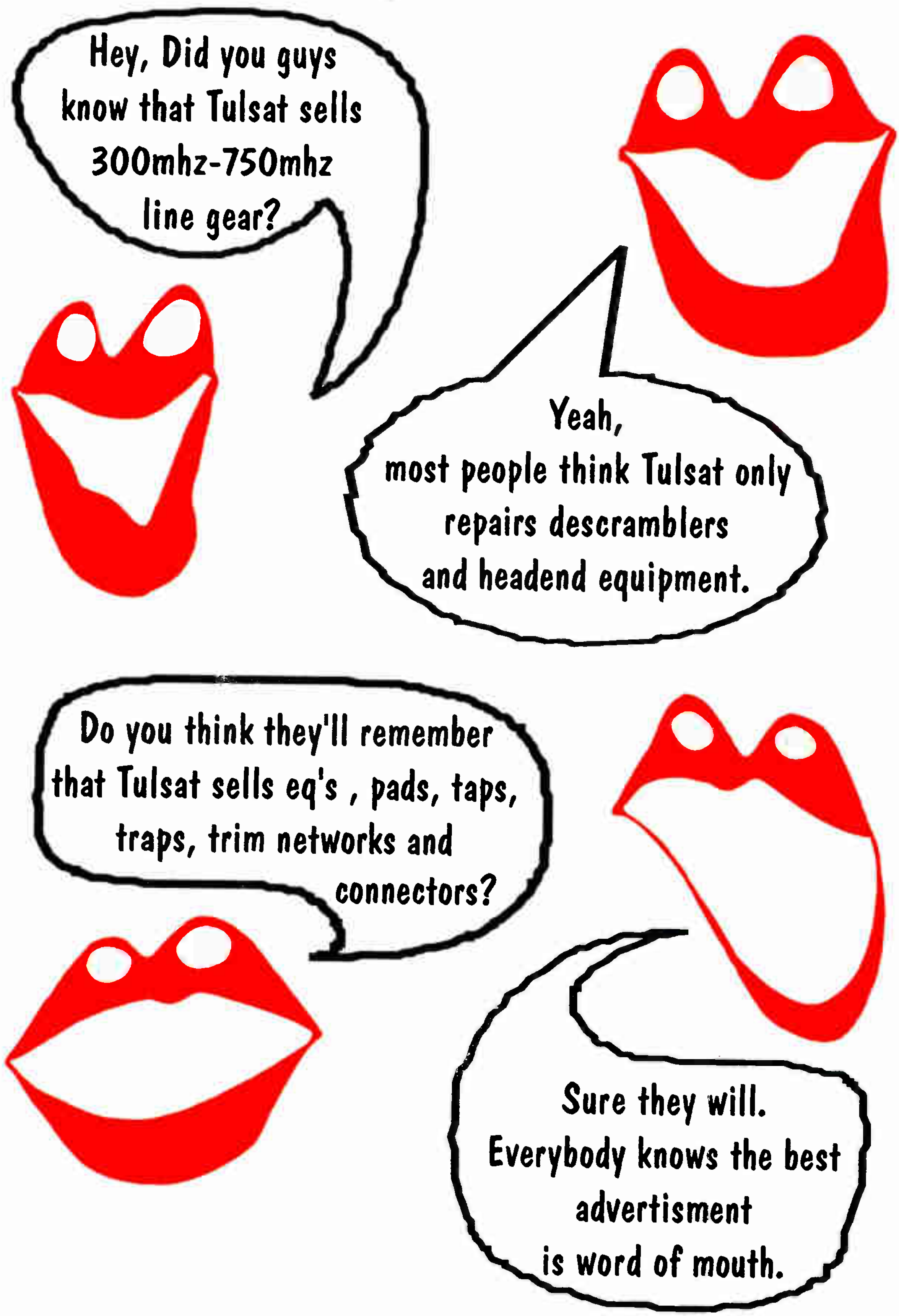
TV/COM's new Universal Data Processor (UDP) is the first in the company's series of DVB-compliant data processing products that will add high-speed data capabilities to uplink, headend and downlink systems.

The global market for uplinks and cable headends will increasingly demand a range of data applications, which will require different data rates depending on the transmission of the data to the uplink site and the types of information being transmitted to the end user. Standard data rates, including T1 and E1 ranging from 1.544 to 2.048 Mbps, are said to be most likely required as inputs. Long-term, the data requirement will range from 19.2 to the "fire-wire" IEEE 1394 speeds of 100+ Mbps.

The UDP product line consists of the UDP itself, a rack-mountable computer that provides the power to process the required maximum bandwidth; and two PCI-based platform products developed by TV/COM—an uplink data insertion (UDI) module, and a downlink data extraction (DDE) module for the downlink side. Both the UDI and DDE are installed in a UDP.

The UDI provides an interface to insert a data stream and transform it to DVB/MPEG-2 transport packets (T-Link). The output T-Link stream is connected to the company's universal services processor (USP), which multiplexes the data stream with video and audio channels, thus providing an outgoing video/audio/data MPEG-2 transport stream. The DDE accepts T-Link inputs at the downlink and extracts the data from the transport stream for processing.

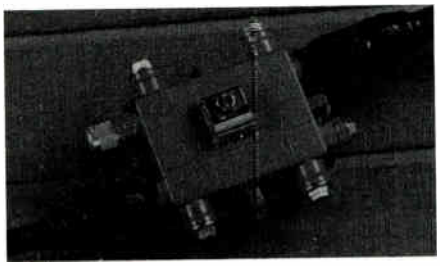
Direct monitoring and control of the UDP is through TV/COM's network management system.
Reader service # 309 →



Reader Service Number 34

Shrink tubing

Tubing that provides environmental protection for cable TV equipment above ground and underground is now available from 3M Telecom Systems Division. The CCT heat shrink tubing protects splices, trunk amps, line extenders, splitters, ground blocks, drops and taps against damage from UV, temperature, water, chemicals and mechanical strain.



The product has a cross-linked polyolefin outer wall that is resistant to sunlight and weathering. Its adhesive lining functions as a sealant to prevent moisture and corrosion damage. It shrinks to one-third of its expanded size, forming a strong protective barrier against vibration and movement.

Two thermochromic stripes darken when the tubing has been installed properly. The tubing has an adhesive lining designed to make stripping and reentry easy by merely reheating the tubing to soften the adhesive.

Reader service #308

Optical alarm unit

The 2000 optical alarm unit (OAU) is the newest module to be designed for Norscan's 2000 cable monitoring system. It is a plug-in unit that monitors the power loss of a pair of single-mode fibers in a communications cable. It contains an FC-PC connectorized 1,550 nm laser transmitter and optical receiver.

The product provides continuous optical loss monitoring over two single-mode optical fibers that are looped back at the end of the monitored span. By detecting attenuation changes in the monitored fiber, the system provides early warning of microbending and macrobending optical loss increases that are the result of changes on or damages to the cable structure.

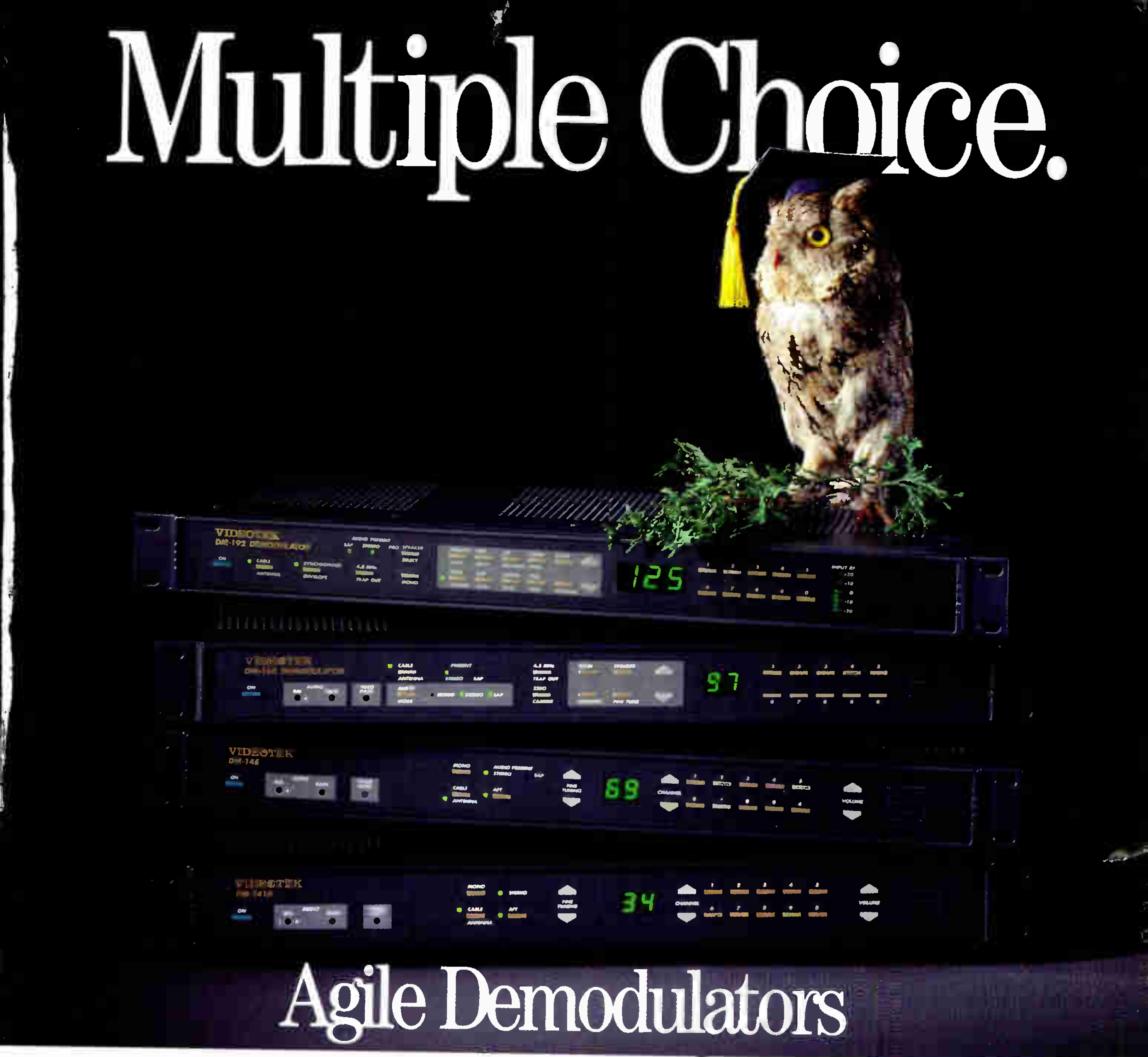
Reader service #307

Emergency channel switching

The SMC system from Tekron Communications Systems is designed to perform scheduled and controlled channel switching in remote headends or hub sites. It can be configured for IF (nonblocking) or baseband matrix switching.

It is said to be ideal for emergency broadcast system (EBS) "emergency channel switching," and can be configured for multi-matrix operation to switch selected or all channels in the headend and replace them with one channel in emergency situations. The system also can be used for channel system program substitution (Syndex), channel substitution during black-out periods, redundancy switching, special events and maintenance.

Reader service #306



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BOOK SHELF

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.

☛ *RF Field Strength: Principles and Practices*—An effective presentation of the basics of an RF field, relating what it is and how it reacts both inside and outside of a cable. Ron Adamson covers the principles of shielding, wavelength and the use of a dipole antenna for detection. In addition, the terminology of the Federal Communications Commission's "microvolt per meter" is discussed in relation to cable's "dBmV." (1 hr.) Order #T-1053, $35.

☛ *Signal Leakage and CLI Testing*—A basic presentation of signal leakage and CLI testing including what they are and how to deal with them. This program, which features Tom Polis and Robert V.C. Dickinson, provides necessary information concerning FCC rules and limits, grandfathering, filing and equipment. Ground measurement techniques and flyover procedures also are discussed. This is a useful tool for developing your own plan to deal with FCC requirements. (70 min.) Order #T-1060, $45.

☛ *Category V Review Course: Data Networking and Architecture*—Al Kuolas discusses digital data and methods of transmission, covering such topics as bits and bytes, parity bits, verification, formats of information, networking, modulation and multiplexing. (1 hr.) Order #T-1061,$35. **(Reference for BCT/E Category V)**

☛ *Category VI Review Course: Terminal Devices*—William Cohn and Mike Long discuss regulatory agencies and standards, signal levels, noise figures, locating the source of ingress, installation equipment and practices, converters, remote controls, interfacing with consumer equipment and emerging technologies. (1-1/2 hrs.) Order #T-1062, $45. **(Reference for BCT/E Category VI)**

☛ *Category III Review Course: Transportation Systems*—Tom Straus provides a technical look at transportation systems, including the benefits and trade-offs of different methods. This program begins with a basic discussion of the decibel and then goes on to cover baseband video and its waveform, distortion, harmonics, ingress and satellite transmission. It also deals with microwave transmission and refraction, including AM and FM transmitters and receivers. (1 hr.) Order #T-1063, $35. **(Reference for BCT/E Category III)**

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.

CABLE TRIVIA

By Rex Porter

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 80 of the November 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, faxed or e-mailed 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.

Your answers need to be sent to: The Trivia Judge, *Communications Technology*, 1900 Grant St., Suite 720, Denver, CO 80203; fax: (303) 839-1564; e-mail: CTmagazine@aol.com. Good luck!

Trivia #11 answers

1) Rockwell International
2) Burt Harris
3) 89%
4) Dallas
5) Cable
6) Alex Best
7) James Hirschfield, Jr.
8) Luther Holt
9) Frank Drendel
10) Sid Fluck

Trivia #12

1) The Telecommunications Act of 1996 was approved on:
a) May 5, 1996
B) Feb. 8, 1996
C) April 18, 1996
D) March 28, 1996

2) Before the advent of UHF television, one state in the U.S. had no commercial TV stations. It was:
A) Alaska
B) Nevada
C) New Jersey
D) Maine

3) The first inventor to work with voice over light by reflecting light off a mirror that vibrated to the voice sound waves was:
A) Thomas Edison
B) Alexander Graham Bell
C) Samuel Morse
D) Guglielmo Marconi

4) He was owner of the Utah Stars, sponsored a car in the Indy 500, flew Navy fighters in both World War II and the Korean War, and once entered the race for governor of Colorado. He is:
A) Bob Magness
B) Gene Schneider
C) Monroe Rifkin
D) Bill Daniels

5) Of course, a yagi is an antenna with sets of one or two dipoles. It gets its name from:
A) The fact that it can be folded inward toward its support.
B) An Indian inventor named Hassish Yagi.
C) A Japanese engineer named Hidetsugu Yagi.
D) A Hindu relaxation position

6) With a B.S. and M.S. from the University of Illinois, he was the founder and first president of CTAM. He won the first National Cable Television Association award ever presented for excellence in local community service programming. Five years ago, at the NCTA Convention, he moderated "Old World Opportunity: Cable In Europe." He is:
A) Richard Loftus
B) Greg Liptak
C) Bruce Lovett
D) Jeff Marcus

And the winner is...

At press time the winner for Cable Trivia #11 (which ran in the November issue) was not decided. Look for the winner's name to be published in a future issue of *Communications Technology*.

December

3: SCTE Southeast Texas Chapter, BCT/E exams, Houston. Contact Jimmy Smith, (409) 646-5227.

3-6: Light Brigade Fiber Optics 1-2-3 seminar, installation, design and maintenance, San Diego. Contact (800) 451-7128.

4: SCTE Smokey Mountain Chapter vendor show, Quality Inn, Johnson City, TN. Contact Roy Tester (615) 878-5502.

4: SCTE West Virginia Mountaineer Chapter vendor show and technical program, Ramada Inn, South Charleston, WV. Contact Steve Johnson, (614) 894-3886.

Planning ahead

Jan. 9-11, 1997: SCTE Conference on Emerging Technologies, Nashville, TN. Contact (610) 363-6888.

Feb. 19-21: Texas Cable Show, San Antonio Convention Center, San Antonio, TX. Contact (512) 474-2082.

March 16-19, 1997: NCTA Cable '97, New Orleans. Contact (202) 775-3606—exhibitor information; (202) 775-3669—other information.

June 4-7, 1997: SCTE Cable Tec-Expo '97, Orlando, FL. Contact (610) 363-6888.

4-5: ADC Telecommunications seminar, introduction to fiber theory, Columbia, SC. Contact (800) 366-3891.

5: SCTE Chattahoochee Chapter seminar, telephony over coax and reverse path alignment, Atlanta. Contact Dean Cromer (770) 613-2076.

5: SCTE Gateway Chapter seminar and BCT/E exams, Overland Community Center, Overland, MO. Contact Chris Kramer (341) 579-4627.

5: SCTE Great Plains Chapter, BCT/E exams, Bellevue, NE. Contact Randy Parker, (402) 292-4049.

5: SCTE New England Chapter, BCT/E exams, Best Western, Marlboro, MA. Contact Tom Garcia, (508) 562-1675.

6: SCTE Oklahoma Chapter, BCT/E exams, Edmund, OK. Contact Oak Bandy, (405) 364-5763, ext. 249.

9: SCTE Badger State Chapter, Installer Certification exams, Fond du Lac, WI. Contact Brian Revak, (715) 493-2605.

9-12: Light Brigade Fiber Optics 1-2-3 seminar, installation, design and maintenance, Sunnyvale, CA, and Portland, OR. Contact (800) 451-7128.

10-12: SCTE Wheat State Chapter, BCT/E exams, Wichita, KS. Contact Joe Cvetnich, (316) 262-4270.

11: SCTE Badger State Chapter, BCT/E exams, Fond du Lac, WI. Contact Brian Revak, (715) 493-2605.

11: SCTE Bluegrass Chapter seminar, 750 MHz design and reverse setup problems, Frankkfort Plant Board Clubhouse, Frankfort, KY. Contact Max Henry, (502) 753-6521.

11: SCTE Heart of America Chapter seminar, Jones Intercable Technical Center, Independence, MO. Contact David Clark, (913) 599-5900.

Reverse optical transmitters: Part 3

This is the final part of a series on reverse optical transmitters, excerpted from a lesson in NCTI's Fiber Optic Technician Course. Part 1 covered theory of operation; Part 2, controls and test points. © NCTI.

The accompanying table lists operating specifications for five common brands of reverse optical transmitters. These specifications are: 1) transmitter RF input signal level; 2) transmitter optical output power level; 3) optical wavelength; 4) channel capacity, which depends partly on the type of signal transmitted (video, FSK, etc.); 5) return loss; 6) frequency response; 7) operating temperature; and 8) DC test point ratio.

Reverse optical transmitter specifications

	Transmitter RF input signal level	Transmitter optical output power level	Optical wavelength	Channel capacity	Return loss	Frequency response	Operating temperature	DC voltage/ optical power test point
C-COR								
LA-4301-TXL	20 ±5 dBmV	-10 dBm (0.1 mW)	1,310 ±20 nm	1 video channel	—	5-30 MHz	—	Direct RF signal monitoring
LA-4301-TXF	20 ±5 dBmV	0 dBm (1 mW)	1,310 ±20 nm	4 video channels	—	5-112 MHz	—	Direct RF signal monitoring
Jerrold								
AM-MB-RPTD	25-35 dBmV	-3.98 dBm (0.4 mW)	1,310 ±20 nm	10 FSK data signals	18 dB	5-40 MHz	-4°F to +140°F (-20°C to +60°C)	1 VDC = 0.1 mW
AM-RPTV4	22 dBmV	-3.98 dBm (0.40 mW)	1,310 ±20 nm	4 video and 2 data, or 10 data	18 dB	5-40 MHz	-4°F to +140°F (-20°C to +60°C)	1 VDC = 0.1 mW
Philips								
7-ORT-WB1	15 dBmV (max.)	0 dBm (1 mW average)	1,310 ±50 nm	Alert/data/ limited video capability	16 dB	5-50 MHz or 5-200 MHz	-40°F to +140°F (-40°C to +60°C)	1 VDC = 0.1 mW
Scientific-Atlanta								
Model 6920	7-17 dBmV depending on channel capacity	-7 dBm (0.2 mW)	—	4 video channels	16 dB	8-50 MHz	-40°F to +140°F (-40°C to +60°C)	1 VDC = 1 mW
Texscan								
RDL-2	10 dBmV	-3.98 dBm (0.40 mW average)	1,310 ±50 nm	10 FSK data signals	16 dB	5-42 MHz	-40°F to +140°F (-40°C to +60°C)	1 VDC = 1 mW
RVL-GP	19-24 dBmV depending on channel capacity	-3 to 0 dBm (0.5 - 1 mW)	1,310 ±50 nm	4 video channels	16 dB	5-100 MHz	-40°F to +140°F (-40°C to +60°C)	N/A
RVD-GP	19-24 dBmV depending on channel capacity	+3 dBm (2 mW minimum)	1,310 ±50 nm	4 video channels	16 dB	5-200 MHz	-40°F to +140°F (-40°C to +60°C)	N/A

In addition to providing the answers to the review questions below, next month's installment will begin a new series on the RF return path.

Hands-on performance training

Proficiency objective: *Determine your reverse optical transmitter's technical specifications and describe the importance of each spec.*

Provide each student with a copy of the above table or your system's reverse optical transmitter specifications.

While discussing each of the following specifications, describe how they relate to the transmission of signals in your system's return path:

- Transmitter RF input signal level
- Transmitter optical output power level
- Optical wavelength
- Channel capacity
- Return loss
- Frequency response
- Operating temperature
- DC test point ratio

Verify that each student knows the specs on your reverse optical transmitter and can describe their importance. **CT**

Review questions for series

1) A reverse optical transmitter in an optical node converts ________________ to an optical signal.

2) Reverse RF signals may be ________________, ________________, ________________ or ________________ using modulation techniques.

3) The ________________ in the reverse optical transmitter module prevents the reverse RF signals from interfering with the forward RF signals.

4) The automatic power control in a reverse optical transmitter controls the ________________ of the laser by compensating for temperature changes and slight variations in the received RF signal level.

5) A DC voltage/transmitted optical power test point ratio of ____ VDC = ____ mW for a reverse optical transmitter means 1 volt DC measured at that transmitter's DC voltage test point equals 1 mW of transmitted optical power.

By Bill Riker

A look at 1996

This year certainly has been an event-filled one for the Society! Fortunately, all the excitement has been captured in SCTE's *Membership Directory and Yearbook*. By the time you read this, members should be receiving their personal copies of the yearbook and can enjoy the articles and photographs showing the Society's highlights for 1996 and learn of its achievements, member activities, award winners and training events.

As in previous editions, the 1996 publication will include regular features such as the useful listings of Active, Senior, Sustaining Members and Supporting Companies. A listing of our members by region, included for the first time in last year's edition, was so well-received that we are again offering this feature in this year's directory. Other popular features, such as members listed by e-mail and ham radio addresses, also appear in the directory.

To commemorate the 20th anniversary of SCTE's Annual Engineering Conference, which kicks off Cable-Tec Expo every year, a history of the conference is featured in the 1996 yearbook. From the Engineering Conference's origins in 1976, when it was first held as a conference on reliability issues in CATV systems, it has evolved into the major industry event that it is today. The yearbook's historic overview provides an interesting glimpse into the conference's evolution over the past 20 years.

In my annual "President's Report," I discuss many accomplishments in 1996, including the long-awaited recognition of the Society as a Standards Developing Organization by the American National Standards Institute. The process of developing standards and submitting them to ANSI for approval has been long and arduous, but progress is being made and after having the Society's first submission adopted by ANSI, there are five more standards currently being submitted for approval.

Also in the report, I touch on SCTE's two new subcommittees, the Digital Video Subcommittee and the Data Standards Subcommittee, and their progress in developing technical standards. New publications available through the Society are detailed, and I conclude by discussing new programs and services that the national headquarters staff plans to introduce to members by the end of the year.

In John Vartanian's "From the Chairman" message, he encourages our members to voice their opinions, get involved at the local level, participate in our engineering subcommittees and run for positions on the national board of directors. The Society exists to serve its members, which requires their important contributions. Member participation at all levels is the fuel that keeps the Society running, and it is the membership that will guide the directions that SCTE will take in the future.

An exciting feature of this year's directory is the section documenting the move of our national headquarters operation to its new location. Photographs cover the story, from the final stages of construction on the building to packing up the old office and actually moving into the new facility.

As anyone who has visited the new national headquarters can tell you, it is a beautiful facility that offers plenty of space to accommodate our recent staff expansion and planned future additions. Many people have visited the new office, and all of them have been extremely impressed by its layout, as it was designed specifically to meet the needs of the Society and its various activities.

The yearbook documents the building's grand opening, when the SCTE Board of Directors, members of the press and local dignitaries got their first opportunity to see the completed construction with the facility in full operation. Also featured is the first of what are sure to be many regional training seminars to be held at SCTE national headquarters. Members that attended in March commented on how pleased they were with the new building, which includes the cable museum, warehouse, large training room and cafeteria to accommodate regional seminar attendees.

On a more humorous note, this year's directory contains a new section called "The SCTE Staff Remembers..." It features legendary SCTE tales and anecdotes as told by the members of the national headquarters staff. Staff members speak candidly about the first contact they had with the Society, memories of their first days working at SCTE, strange but true tales from the headquarters office, Cable-Tec Expos of years gone by, special recollections, staff interaction, great accomplishments, the move into the new office and their plans for the future of SCTE.

I would like to thank the Society's membership for making 1996 such a successful, active year for SCTE. It is the members who dedicate their valuable time and energy to make SCTE programs and services so successful.

I also would like to thank the many industry vendors who support the Society and make it possible for SCTE to produce such a thorough and fine-quality yearbook for the membership.

Just a glance at the "Milestones" section of the yearbook shows how many major SCTE events occurred in 1996. This has been an incredible year in the history of the Society's development, and with a larger staff to better serve the needs of our members, 1997 will undoubtedly be even more successful. Until then, enjoy this look back at a year full of advancement and accomplishment for SCTE! **CT**

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