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Envi[...] networks

January 1996

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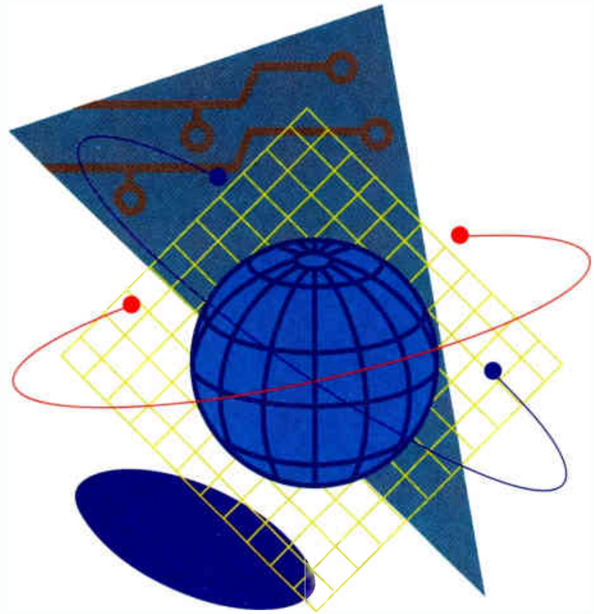

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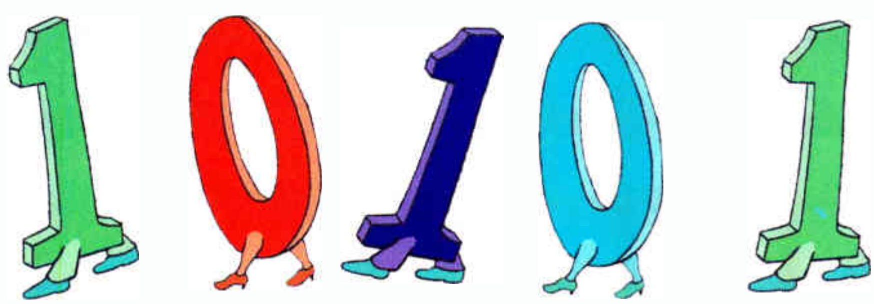

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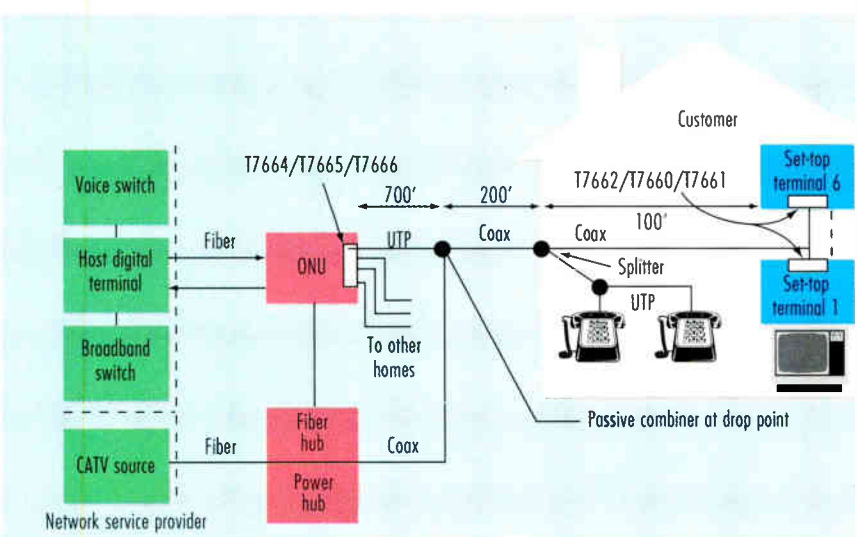

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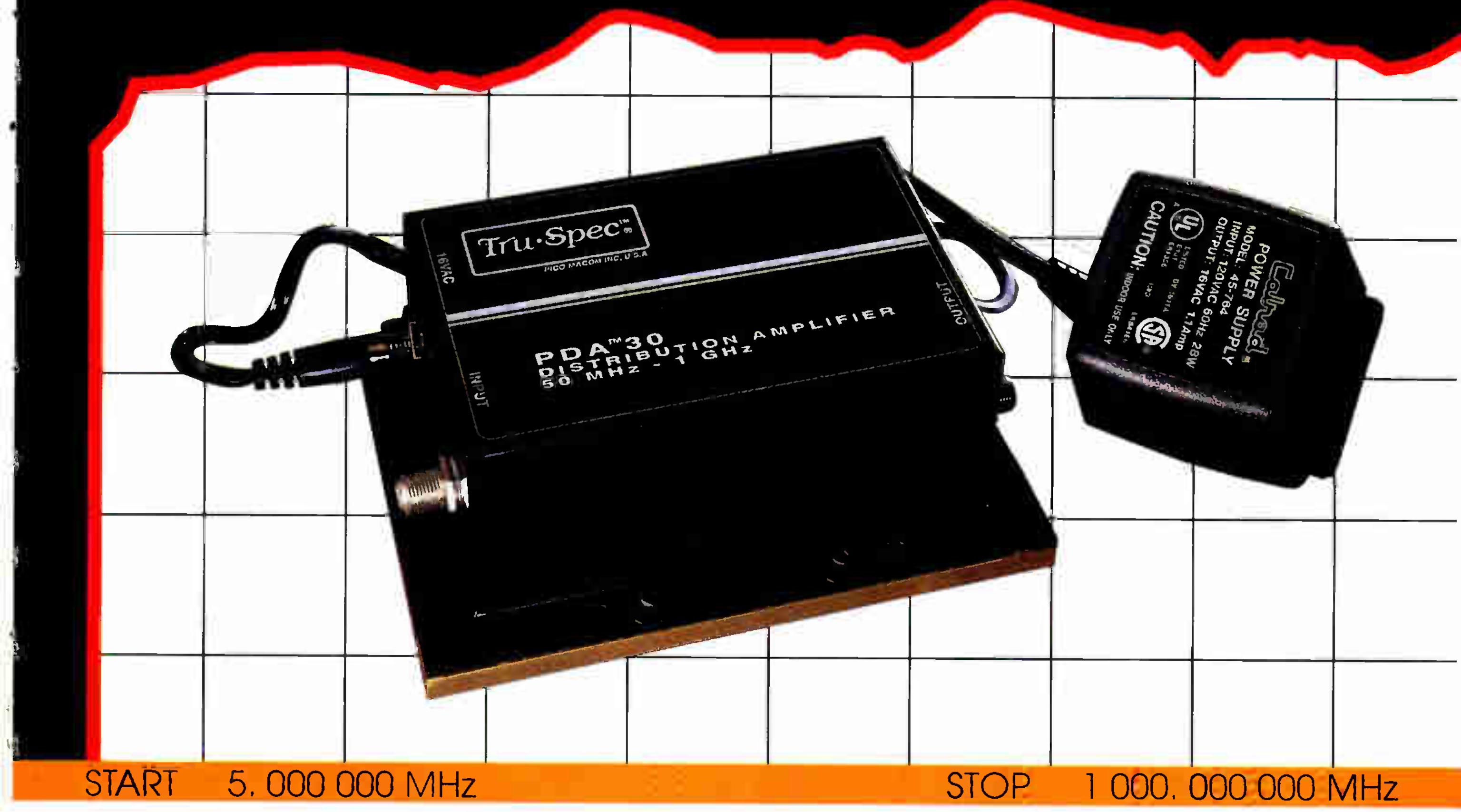

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77	+20 dBmV	+50 dBmV	-55	-50	-50

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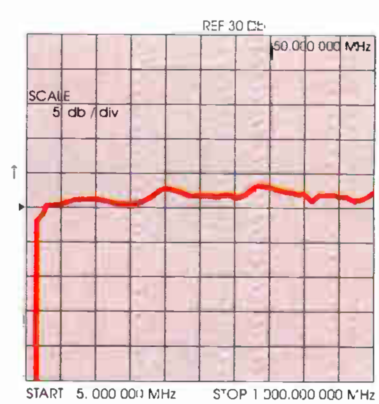

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New footprints

What a wonderful and exciting time to return to the world of cable TV! After a short sabbatical (really about five years), it's great to be back — especially as editor of *Communications Technology*. I had just enough time to settle into my job in Denver and suddenly it was time for the Western Show and the Society of Cable Telecommunications Engineers Emerging Technologies seminar.

Even though *CT* has always been CATV's leading technical magazine, our 1996 goal is to create some new avenues for interface between the cable, telephony, power and computer industries.

The job world of technicians and engineers has never been brighter. No sooner do you begin to reap the rewards of programming via satellite and pay TV than you are faced with engineering and maintaining systems capable of supplying data and telephony.

The common theme in the presentations at this month's Emerging Technologies seminar in San Francisco is reliability. And a big reason behind the focus and push toward more reliable systems is cable's phenomenal potential in telephony and especially data delivery. (Cable modems are promising the capability to increase the speed of data flow by as much as 1,000 times over some modems in use today.) Systems unprepared for superior two-way capability risk the loss of cash flow not approached by premium channels and/or pay-per-view. Today's technician/engineers must be qualified for this modern technology.

Yesterday's "blue sky" is today's reality. Pure cable training won't suffice. Yesterday's top-paying tech slots required second- or first-class licenses. Today's and tomorrow's top-paying jobs will require SCTE Broadband Communications Technician/Engineer (BCT/E) certification. Unable to wait for national conferences, those who want the very latest technical information and equipment will surge into local SCTE chapter meetings and depend on trade magazine articles. Smart techs and engineers are signing up for local SCTE chapter meetings and training seminars, Cable-Tec Expo, Emerging Technologies and BCT/E certification. These avenues are your paths to senior engineering status and *CT*'s goal is to bring you the latest technological information you'll need to succeed in the new communications arena.

"The job world of technicians and engineers has never been brighter."

Rex Porter
Editor

COMMUNICATIONS TECHNOLOGY

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(draft—ietf-ipsec-skip-06.txt) is a promising approach for exchanging secret keys via public key encryption and signatures.

• *ITU-T X.509:* The X.509 portion of the X.500 directory specification defines a format for public key certificates. This provides a standard method in which to bind distinguished names to public keys and other information such as expiration date of the key.

• *DAVIC:* DAVIC is the Digital Audio-Visual Council and is an international standards-producing body for multimedia applications. In the DAVIC 1.2 Specification, Part 10, the group defined a general security architecture, interfaces and basic security tools for use with the more general DAVIC 1.0 specification. In its tool kit, DAVIC requires authentication of numerous entities in a multimedia system. It has endorsed a three-way public key approach based on ITU-T Rec. X.509 certificate processing. It also has defined a smart card interface.

• *SCTE:* The Society of Cable Telecommunications Engineers is currently embarking on an effort to produce North American standards (under American National Standards Institute rules) for various component technologies of digital video systems. One of the five categories under consideration is security and conditional access. This work is just now beginning, but should be watched because it may have significant impact on emerging digital networks.

• *SET:* The secure electronic transactions specification (http://www.visa.com/cgi-bin/vee/sf/set/settech.html?2+0 or http://www.mastercard.com/set/set.htm) is the result of work of primarily two consortia of companies. Mastercard, IBM and Netscape were working on the secure electronic payment protocol (SEPP) while Visa and Microsoft were producing the secure transaction technology (STT). Both are aimed at the development of secure Internet payment protocols for credit cards.

• The public key cryptography "standard" is a technical note of RSA Laboratories. In the absence of existing standards for public key protocols, RSA DSI Inc. released the revised version of this specification in 1993 to provide a common point of reference for developers. There are 11 standards although two (#2 and #4) have been deactivated.

• *IEEE P1363:* To promote the transition from paper to electronic media security, the Institute of Electrical and Electronic Engineers is sponsoring an effort to create a balloted standard for public key techniques. Called P1363, the group (which is composed of cryptographers and mathematicians from government, academia and industry) produced a first working draft in August 1996.

Contemporary methods

It may not be long before many cable operators face the security issues involved in the scenarios described previously. New applications call for new security measures that are beyond the capabilities of legacy conditional access approaches.

A practical, effective conditional access system for contemporary broadband networks would include the following attributes:

• Seamless integration of analog and digital services in either broadcast or interactive environments.

• Enabling of many classes of applications—including video and data access—from a common security approach.

• Combination of appropriate elements of public and secret key methodologies.

• Provision of means to securely identify the sender and authenticate the content of a message.

• Using the proper protocols, integration of all critical cryptographic elements, including key generation, encryption/decryption, digital signature and authentication.

• Implementation of security algorithms, logic and key storage in a tamper-proof module (such as a "smart card").

• Renewable physical security by replaceable functions for common "attack points" (key management, entitlement storage, entitlement messaging, and set-top personalization).

Without performing any cryptographic functions directly, the subscriber can still be assured of excellent security and privacy. Public key technology allows placing conditional access identity mechanisms in the set-top itself, which can generate a public/private key pair. Neither the manufacturer, the end user, nor anyone in between needs to know the private key. The set-top can "publish" its public key while keeping the private key in secure memory. **CT**

Antec, Nortel launch new integration firm

As anyone who set foot on the Western Cable Show floor back in November can attest, the future of cable telecommunications is not just telephony. High-speed data transfer and near-video-on-demand (NVOD) applications are just as likely, ushering in an age of Internet connectivity and interactivity that will transform cable networks from broadcast-only service providers to fully vested players in the Information Age.

Eventually all these services may be delivered by a single ATM packet, according to Andy Paff, CEO and president of Integration Technologies, a systems integration firm launched jointly by Antec and Nortel. In the near term, however, cable operators who want to take advantage of the new opportunities the industry offers should expect to manage more than one network and upgrade their existing HFC setup — then have a strategy for migrating to whatever new network technologies may emerge.

Enter IT. One of several joint ventures announced by the cable broadband technology vendor Antec and telephony network expert Nortel, Integration Technologies was formed last fall to integrate today's HFC networks into the global telecommunications network and help broadband operators deploy interactive services. Network management and system planning are key elements of the range of services provided by IT, whose executive staff also includes Chief Operating Officer Ron Cotten, CEO of Engineering Technologies Group.

IT does not sell products, according to Paff. Rather, the company, which its executives stress is "vendor independent," will provide "best-of-class solutions" for domestic cable operators' network design, including SONET (synchronous optical network) transport, widearea networking, and upgrading of HFC design. "HFC design is changing radically, with a lot of upstream configurations that haven't been needed in the past," said Paff. IT makes LAN, WAN and ATM switching recommendations to its clients, and develops solutions for migratable platforms for network operators, as well as field implementation services.

Paff said that the telephony and data transfer are the areas likely to develop first for cable operators. "A couple of years ago, we would have said telephony would be the first area of concentration," Paff noted. "Now, operators are saying, 'I don't care which we do first, we're going to do both.'" While acknowledging technical and operational issues such as network reliability and isolation of ingress as challenges for cable operators, Paff added that "the good news is HFC remains the best alternative for broadband interactive services to the home."

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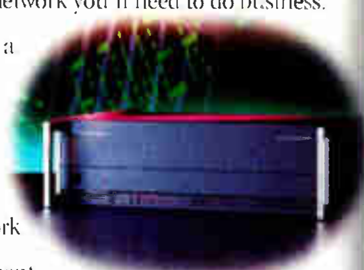

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Reader Service Number 62

into the company in the next month or so, as Paff has suggested — IT is prepared to handle the issues of network availability and network quality so crucial to telecommunications over cable. Paff predicts that, particularly with cable telephony, vendors and MSOs will work closely to ensure standards that will facilitate comparatively easy integration of communications technology with cable networks.

"MSOs have to make a business out of (telecommunications services), so you're going to see the MSOs become more vigilant about standards," Paff said. "Three or four years ago, we didn't care. We were isolated CATV networks; it really didn't matter that we had proprietary systems on the HFC networks. Access and control wasn't a big issue universally. Now it is." - *Alex Zavistovich*

Motorola inks cable data deals

Motorola Inc. Multimedia Group announced an agreement in principle to provide Tele-Communications Inc. with up to 200,000 of its CyberSURFR cable modems and Cable Router infrastructure products for the introduction of high-speed data communications services. TCI will commercially deploy the equipment to its business and residential customers throughout the U.S.

Motorola also agreed in principle to provide Time Warner Cable and its affiliate companies with up to 50,000 CyberSURFR cable modems and Cable Router infrastructure for high-speed data communications over Time Warner's hybrid fiber/coax network. This will be deployed over a 12-month period, beginning in April 1996, to Time Warner's business and residential subscribers nationwide.

AT&T, H-P to build broadband networks

AT&T Network Systems and Hewlett-Packard Co. signed a memorandum of understanding to cooperate in exploring new kinds of public and private wireless and wired networks that make the delivery of multimedia information and interactive services more cost-effective and reliable. (AT&T Network Systems will split off from AT&T as part of a separate systems and technology company this year.)

Using intelligent networking solutions created by the two companies, regional Bell operating companies, cable TV companies and other communications and computing industry players will be able to offer customers Internet access, home shopping, telecommuting, interactive games, personal audio channels, virtual communities, distance learning, interactive advertising and telemedicine.

In other news, AT&T Network Systems, Hewlett-Packard Co., Hybrid Networks Inc. and Intel Corp. announced their intention to develop interoperable products for delivering high-speed data services to personal computers via broadband networks. At press time, the companies had announced plans to publish an open specification by end-1995, which will be submitted to the appropriate standards committees as well as to CableLabs and cable operators for their review and recommendation.

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Nelson named VP, tech programs

The Society has promoted Marvin Nelson to the newly created position of vice president, technical programs.

Nelson, 41, joined the Society in 1991 as director of chapter development and was responsible for fostering the growth of the Society's now-74 local chapters and meeting groups. In 1993, he was appointed director of certification programs and became responsible for the administration of Broadband Communications Technician/Engineer (BCT/E) and Installer examinations as well as interfacing with volunteer groups updating the program's curriculum and exam questions. In his new position as vice president of technical programs, Nelson will oversee all technical aspects of the Society's operations, including supporting the SCTE Engineering Committee's development of technical standards.

"One of the reasons that the Society's board of directors elevated me to the position of president in 1992," stated Riker, "was to make way for the creation of vice president positions on the national headquarters staff. I am pleased to announce Nelson's appointment and look forward to continued quality efforts from Marv and his staff as we prepare for the challenges that 1996 is sure to bring for the Society and the entire industry."

Society/GI co-sponsor seminar

The Society has joined with General Instrument to co-sponsor its Cable Insights seminar series. The first SCTE co-sponsored seminar was held Nov. 13-14 at the Sheraton Valley Forge Hotel in King of Prussia, PA.

SCTE President Bill Riker delivered the opening address to attendees of this two-day event. He also will be addressing attendees of future Cable Insights seminars, with the next one scheduled to be held in California sometime in April.

SCTE's At-Large Director Wendell Bailey, who is vice president of science and technology at the National Cable Television Association, was a featured speaker for the November seminar. He has spoken at many previous Cable Insights seminars.

The seminar is intended for nontechnical executives and managers who wish to gain greater understanding and knowledge of the basic technical workings of the cable industry. This is *not* a GI product seminar. Its purpose purely is to provide basic technical information on the broadband industry.

This joint venture between GI and SCTE provides an overview of both present cable industry technology and future technologies. It covers technological information for headends, distribution systems, signal access and digital compression. Alternate transmission media, high definition TV, telephony, interactive services and regulatory concerns also are addressed.

"SCTE is delighted to join General Instrument in the co-sponsorship of this valuable seminar," Riker stated. "It will specifically benefit individuals in the cable industry, or those from the many converging industries who don't have a technical background but wish to gain a greater understanding of the cable industry's present and future technologies. This can aid nontechnical personnel in making important decisions that will guide the directions of their companies." →

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WAVETEK

New national SCTE Headquarters nears completion

The construction of the new SCTE national headquarters move-in is scheduled to follow this month's Conference on Emerging Technologies. The building shell and site work were completed in October before the cold weather set in and now the interior construction is in full swing. When complete, the building will accommodate staff offices, warehouse storage, a technical display room, and conference and training space with adjacent cafeteria for catered events.

The new headquarters is only a few miles from the current Exton Commons location, which enables SCTE to make the transition with minimal disruption of service to the membership. All telephone and facsimile numbers will remain the same, and there will be service to both buildings during the relocation period. The new mailing address will be printed on all Society material beginning January 1.

The new building will have facilities that will accommodate conferences and training seminars. The Introduction to Fiber Optics and Introduction to Telephony seminars will be held there in March. Also hosted will be the new Introduction to Data Communications and the popular Technology for Technicians II seminars in September.

The training area will be equipped with a small headend to enhance training capabilities and provide cable service to the building. This will be an important addition, as SCTE's training programs are designed to encompass both technical theory and hands-on skills.

A special area for guests will be the Technical Display Room. Anyone with historic cable equipment is encouraged to donate it for display, so visitors may enjoy viewing the progress and advancement of CATV technology over the years. Each display will include a description of the equipment, its use, history and donor.

SCTE also wants to highlight the achievements and awards that our members have been given by the industry for exceptional service and/or skill. If you have received a significant award, commendation or certificate, we will exhibit it in the Display Room for the acknowledgment of other industry personnel.

The SCTE Board will hold its next meeting in the new facility, in conjunction with the grand opening, in late February. We also plan to hold several open houses for local chapters and area cable system management to introduce them to the facility and our services.

SCTE is looking forward to the move to enable it to increase the scope and quality of its services through improved product fulfillment facilities, new training and meeting space and room for future growth.

Reader Service Number 107

By Lawrence W. Lockwood

Switched digital video

SDV (switched digital video) — yet another acronym from the seemingly endless supply generated with the advent of digital video.

A number of phone companies have dropped plans for HFC (hybrid fiber/coax) systems and some have invested in wireless cable systems. However, Bell Atlantic, Southwestern Bell, Bell South, Nynex and US West have expressed renewed interest in SDV systems.

BroadBand Technologies Inc. of Research Triangle Park, NC (a descendant of Siecor), has been promoting FTTC (fiber-to-the-curb) systems for over a decade. It has announced a new SDV system that is the result of a joint development project with AT&T Microelectronics of Berkeley Heights, NJ. This new SDV system supports POTS (plain old telephone service) and simultaneous delivery of regular CATV services along with switched 51.84 Mbps ATM services of digital video, audio or data (which is the SONET OC-1 rate) over unshielded twisted-pair (UTP) telephone lines and coax to the home. In addition it provides 1.62 Mbps in a return channel, which could be used for many services such as video conferencing, remote LAN access, etc. This return channel is QPSK (quadrature phase shift key) modulated and is in the 27 to 30 MHz band.

The BBT system is called FLX SDV and is being installed by Southwestern Bell in Richardson, TX. This system runs an optical fiber between a host digital terminal (HDT) located in the system's distribution center (either the headend or central office in the case of a telephone system) and an optical network unit (ONU) located within a neighborhood. (See Figure 1 on page 20.)

Lawrence Lockwood is president of TeleResources and the East Coast correspondent for "Communications Technology." He is based in Arlington, VA.

POTS, the downstream OC-1 51.84 Mbps and the upstream 1.6 Mbps data are all located in the subsplit frequency range — i.e., below 50 MHz. (See Figure 2 on page 20.) Because the encoded video is transmitted at a frequency band of 6-26 MHz — well above the sub-1 MHz voice band used in telephone and well below broadcast channel frequencies — simultaneous voice and interactive video can travel over the same copper wiring.

At the headend

At the network headend, telephone signals are packaged into DS-1 packets while digital video and other data are combined and sent to the ONU in streams of ATM cells. The ONU reads the address of each digital packet and directs it to the proper residential drop.

These streams of cells may contain one or more streams of digital video, CD-quality audio channels, along with data streams from Internet sites or other remote hosts. Telephone signals are converted to their analog form and shipped as a 0 to 4 kHz signal down the twisted copper pair along with the high-rate digital traffic. Near the curb, the twisted-pair is fed into a passive combiner that adds the normal cable TV spectrum to the signal and provides

the impedance matching required to bring it into the home via a normal coaxial cable. Once inside, a simple splitter separates off the low-frequency telephony signals from the ATM traffic, which is sent to the TV set-top boxes.

CAP

AT&T's 16-CAP encoding technology enables transmission of up to 51.84 Mbps up to 1,000 feet over ordinary UTP such as that used for telephone service to the home (the 1,000 feet might be apportioned as shown in Figure 1). The 16-CAP effectively triples the previous data transmission capacity of ordinary UTP. CAP stands for carrierless amplitude-modulation

GLOSSARY OF ACRONYMS

AAL5	ATM adaptation layer number 5
ATM	Asynchronous transfer mode
CAP	Carrierless amplitude/phase modulation
DS-1	Digital signal, level 1, 1.544 Mbps
FLX	Fiber loop access
FTTC	Fiber-to-the-curb
FTTH	Fiber-to-the-home
HDT	Host digital terminal
HFC	Hybrid fiber/coax
MBA	Multipoint broadband access
MSLD	MPEG-2 system layer demultiplexer
MPEG	MovingPicture Experts Group
OC-1	Optical carrier, level 1, SONET rate of 51.84 Mbps
ONU	Optical network unit
POTS	Plain old telephone service
QAM	Quadrature amplitude modulation
QPSK	Quadrature phase shift keying
SAR	Segmentation and reassembly, protocol layer that divides packets into ATM cells
SDV	Switched digital video
SONET	Synchronous optical network
STS 1	Synchronous transport signal, level 1; electrical equivalent of OC-1 (51.84 Mbps)
UTOPIA	Universal test and operation physical interface for ATM. This acronym is used to define the data path "interface" between the ATM layer (performing the segmentation and reassembly) and the physical layer (PHY) components of an ATM subsystem
UTP	Unshielded twisted-pair

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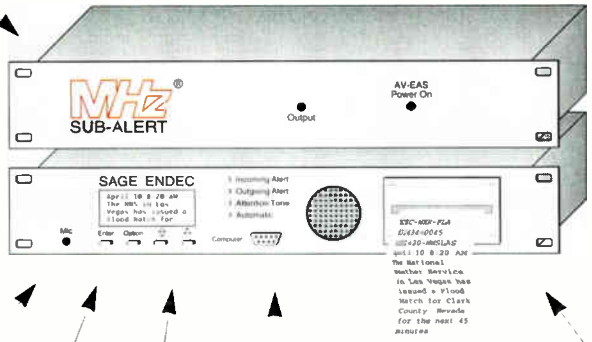

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phase-modulation that was developed at Bell Laboratories in the mid-1970s as part of an effort to produce a variant of QAM that could be implemented on a digital signal processor. In 16-CAP, the number 16 refers to the size of the signal's constellation. (See my December 1995 column, "VSB & QAM.")

Data encoded using CAP has the same spectral characteristics and provides the same theoretical performance as QAM, but does so without a carrier frequency. In SDV applications, 16-CAP is used to minimize bandwidth requirements for the 51.84 Mbps downstream signal, which occupies roughly 20 MHz of bandwidth — the whole scheme is known as multipoint broadband access (MBA). Working with BBT, AT&T embedded its 16-CAP technology within a chip set specifically designed for SDV applications. The chip set is actually a pair of chip sets, one group for the pole-mounted ONU, and the other group for the set-top. (See Figure 3 on page 22.)

Within the ONU, a single T7664 16-CAP transmitter can supply up to four homes with individual 51.84 Mbps ATM data streams. The T7665 QPSK receiver handles four 1.6 Mbps upstream data channels. Both transmitter and receiver are linked to the network's optical backbone via the T7666 transmission convergence chip.

Within a set-top box, the T7661 serves both as a QPSK transmitter and an analog front-end for the incoming 16-CAP signals. Once the incoming analog signal is equalized and cleaned up by the T7661, the T7660 CAP receiver converts it to a digital data stream that is timed and framed. In T7662 a dedicated on-chip ATM adaptation layer 5 (AAL5) reassembly is provided for ATM cells with MPEG-2 data. This interface outputs an MPEG-2 data stream for direct connection to an MPEG-2 demultiplexer (MSLD) and is passed to an MPEG decoder. →

Figure 1: Broadband SDV FTTC

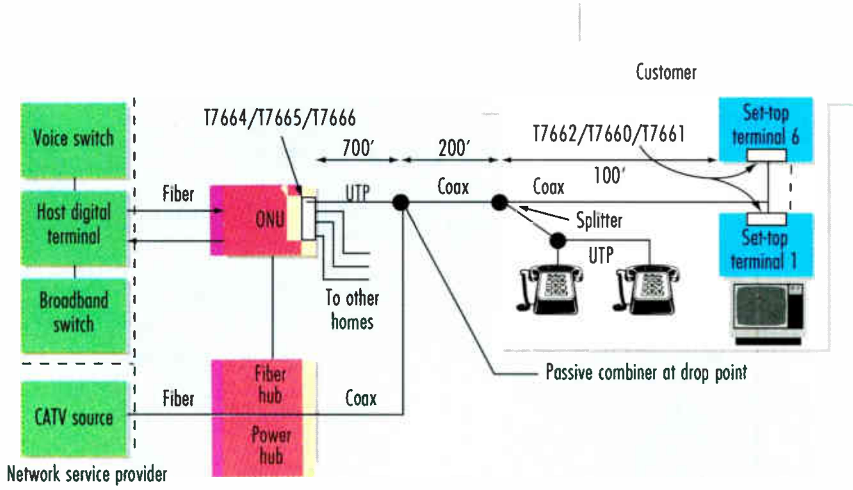
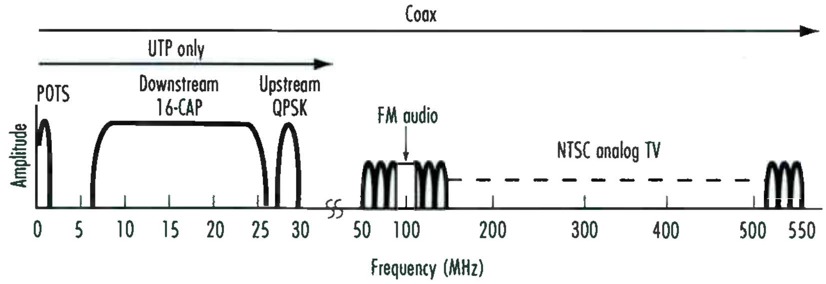


Figure 2: Frequency spectrum over UTP and/or coax



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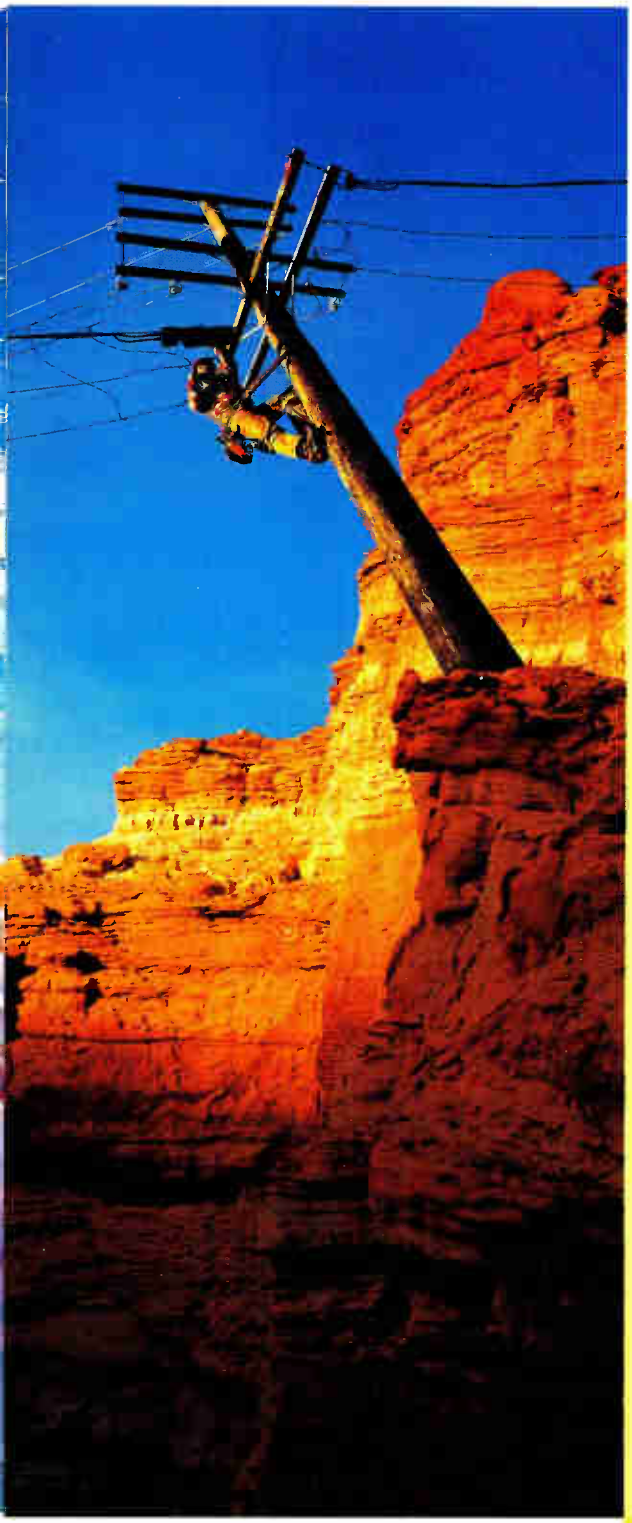

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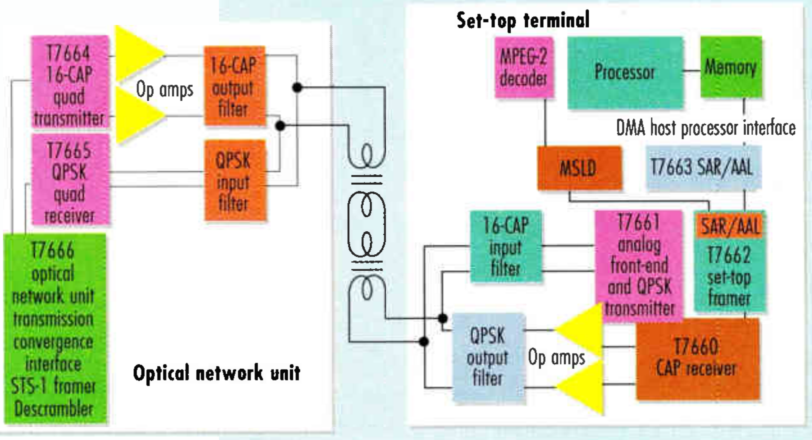
The switching fabric architecture provides exceptionally tight security. The switches in the HDT are controlled from commands issued from the upstream video providers. These switches only respond to requests from the viewer if the services have been pre-authorized from the video providers. A data stream never leaves the HDT if the home is not authorized to see it. In other words, unauthorized signals are never there to steal and therefore scrambling/encryption is not required.

The number of homes served by a single ONU may be increased from the four provided by the MBA chip set by adding more MBA chip sets. Don McCullough, product line manager of BBT, suggested it might be from eight to 24 homes per ONU, depending on the density of the homes.

The MBA chips are sampling now, with volume quantities priced at $45 for a set-top implementation and under $40 for each home served by an optical network unit installed in the neighborhood. (See Figure 4.)

Figure 3: MBA chip set



Conclusions

Since up to six set-tops can be connected to a single SDV line and since ATM can support many virtual channels within a single data stream, it is quite easy to conceive of several services being used simultaneously within a household. An MPEG-encoded studio-quality picture with stereo sound can be sent using a 6 Mbps data stream. That's little more than 10% of the system's capacity. It is not hard to imagine a home where a first-run movie is playing on the living room TV set, an educational how-to video on carpentry is being piped into the workshop, and an interactive game is being played in the bedroom, while two or three computers are running interactive sessions on the Internet.

Of great significance is that the BBT FLX SDV system is not merely a paper design. The necessary circuitry to perform all the SDV functions has been fully designed and more importantly implemented in chips that are currently being manufactured. **CT**

Figure 4: MBA chip set

References

1) "Brains and Bandwidth: Fiber Service at Copper Prices," L. Goldberg, *Electronic Design*, Oct. 2, 1995.

2) "SDV: Delivering Multimedia to the Home," D. McCullough, *CED*, September 1995.

3) "MPEG-2 on ATM," L. Lockwood, *Communications Technology*, October 1994.

By Ronald J. Hranac

Fundamentals of navigating cyberspace

If you're a regular reader, you'll notice my column is under a new name. But I'm not quite set on it and I'm still trying to think of something catchy. Among the ideas being considered are "Multipath," and "Hranac's Hramblings." (OK, the second one is not being considered too seriously.) Suggestions are welcome, so e-mail yours to me at:
RHranac@aol.com

Welcome to the new year, and welcome a few changes in *Communications Technology* magazine. First of all, the "Editor's Letter" column, which I used to pen, is now inhabited by cable pioneer and industry veteran Rex Porter. Rex has joined Phillips Business Information as *CT*'s new editor. I've been given even more monthly column space, and will continue to serve in the role of senior technical editor, a freelance position I've enjoyed for the past five-plus years. For those of you who still confuse me with a real journalist, my 8-to-5 job is senior vice president of engineering for Coaxial International. Yes, I'm really a cable engineer.

On-line surfing

With that addressed, let's move to the subject of this month's column. By now you've no doubt heard of the proliferation of commercial on-line services such as America Online, CompuServe, Delphi, Prodigy and others. And who hasn't heard of the Internet? It's not an on-line service *per se*, but rather is a loosely defined global network of computers that is owned and operated by no one in particular, yet is widely accessible to almost everyone. Add your local computer bulletin board services (BBSs) to this growing din, and you begin to understand the complicated maze that some call cyberspace.

Once a haven for computer nerds, on-line services and the Internet have become part of the mainstream of electronic communication. More often than not, many people and businesses now have both a physical address and an e-mail address. For example, you can send this magazine a letter to the editor via "snail mail" (regular postal service) at 1900 Grant Street, Suite 720, Denver, CO 80203. After you've dropped the envelope in a mailbox, it will likely take a few days to reach *CT*'s editorial offices. If your letter is a note to me, add a couple more days if the folks at the magazine have to drop it in another envelope and forward it to my office. Now you can see why it's called snail mail. Of course, you could always use your fax machine.

"The on-line world can be an asset to your daily work and your personal life, if used properly."

For truly speedy service (while avoiding the long-distance charges to send a fax), you could send your letter to the editor via e-mail. Using the following address, a matter of moments is all that's necessary to send the text of your letter directly from your computer:
CTmagazine@aol.com

Of course, you'll need to have access to the Internet or an on-line service to send the e-mail. Or maybe your company's local area network (LAN) has a gateway to the outside world. Check with your MIS department.

What, you're not yet on-line? Remember all of those offers for 10 free hours of on-line use you pitched in the round file? Well, the next time you get one in the mail, inside a box of software, or bundled with your favorite computer magazine, you might want to think about trying out this world of cyberspace. After all, there's much more than just e-mail.

I've been a big fan of CompuServe for the past couple of years. Besides providing access to news, weather, sports, stock and financial information, CompuServe has literally hundreds of user forums, each of which is like a specialty BBS. There are forums for education, computers, hobbies, research, entertainment, business, travel and almost any other topic you can imagine. These forums have places to post messages and participate in discussions on current topics, live keyboard-to-keyboard conferences, and libraries with lots of software and other data that's available for downloading. My two favorite

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

CompuServe forums include the CATV/SCTE/MMDS section of the broadcast professional forum (GO BPFORUM) and the ham radio forum (GO HAMNET). The former has been a good place for CATV technology discussions (it's moderated by Communications Support Corp.'s Jonathan Kramer, one of the forum sysops), while the latter caters to one of my favorite hobbies. My CompuServe ID is 71730,347.

A few months ago I decided to try America Online. Probably a bit more family-oriented, it has a very user-friendly interface. Like CompuServe, America Online has news, weather, sports, etc., plus a large number of special interest forums. Unfortunately there is no CATV-specific forum available. I use America Online primarily to access the Internet, although CompuServe also has this feature available. My America Online screen name is RHranac.

I haven't tried Prodigy yet, so I can't give you my impression of cable-related happenings there.

As far as the Internet is concerned, besides occasional e-mail, I participate in something called a list server. Basically you "join" a list server (which is really a computer that is connected to the Internet) and all messages that are sent to the list server are rebroadcast to all of its "subscribers." There is no fee for this, other than what you normally pay to access the Internet or your on-line service provider. The list server to which I belong is called the SCTE-List, and as of the time of this writing has well over 400 subscribers. The computer supporting this operation is located at the University of Wisconsin, and David Devereaux-Weber is the on-line sysop. On a typical day, you might receive four to six messages from the SCTE-List, but if a particularly hot topic is being discussed (a recent one that comes to mind is John Dvorak's column in *PC Magazine* a couple months ago about cable modems) the number can be substantially greater. The SCTE-List also is an excellent forum for technical exchange. For example, you may find someone asking a question about fiber-optic connectors one day, followed that same day or the next day by several helpful responses from both end users and manufacturers.

Assuming you have a way to send and receive e-mail, here is how you can subscribe to the SCTE-List. I'll use my name in this example. The subscription process is fully automated, so you just need to send an e-mail message to:

listserver@relay.doit.wisc.edu

You don't need to put anything in the subject line of the message, but in the body of the message type the following (remember to use your own name where I've shown mine):

subscribe scte-list Ron Hranac

That's all you have to do! After you become a subscriber — which will happen almost instantly after you send the message — you can send general e-mail messages to the list at the following address. Remember, all 400+ subscribers will get your message. It's recommended after you first become a subscriber that you send an introductory message to the group, with a little bit about yourself, where you work, what you do, what your company does, how long you've been in the industry, hobbies, etc. The list's address is:

scte-list@relay.doit.wisc.edu

Remember, every message you send to the list will be seen by every other list subscriber. If you want to send a private reply to someone, you will need to send a message to that person's individual e-mail address. And finally, if you decide you no longer wish to subscribe to the list, send an e-mail message to:

listserver@relay.doit.wisc.edu

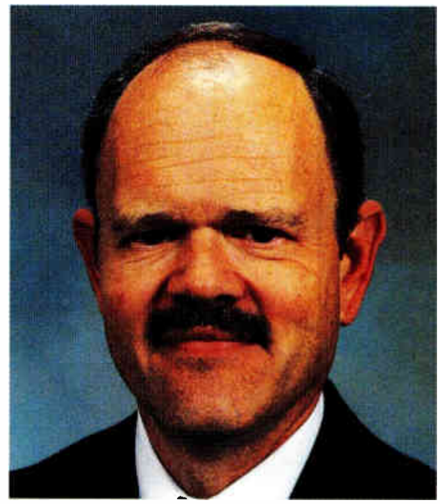
The body of the message needs to include the following text. It won't be necessary to include your name in the unsubscribe message:

unsubscribe scte-list

The on-line world can be an asset to your daily work and your personal life, if used properly. Like so many other things, though, it also can be abused and become a great waste of time. See you online! **CT**

By Justin J. Junkus

Lessons in reliability



Old lonely! I don't know about you, but when I hear those words, I immediately recall the ads showing the home appliance repairman languishing by the phone. He never meets a customer because there's nothing in the field requiring a service call. Is this reliability or just a clever marketing image? Either way, cable telecommunications engineers can learn something from our counterparts in the appliance industry.

The first lesson is that reliability doesn't necessarily mean "never breaks." It just has to seem that way. Telecommunications reliability is defined by standards that specify maximum allowable unscheduled downtime in minutes per year. For a large digital switch, the Bellcore standard is three cumulative minutes per year for the system as a whole. That equates to system availability of .99999! How much service is affected by those three minutes of downtime depends on when and where it occurs.

Justin Junkus has over 25 years experience in the telecommunications industry. He is currently the AT&T cable TV market manager for the 5ESS switch. He can be contacted via e-mail at JJunkus@aol.com.

Even at .99999, an outage at peak traffic periods in a metropolitan area can be devastating to transaction-intense businesses such as banks and brokerage houses. For this reason, most service providers and their equipment vendors accept the standard as their minimum goal for performance. Perhaps another contributing reason is that the Federal Communications Commission publishes U. S. digital switch downtime statistics in its quarterly ARMIS report, which is publicly available to regulatory bodies, consumer groups and competing equipment vendors for comparisons.

The second lesson is that although equipment failure doesn't cause all downtime, it is one of the more visible causes. Reported failures of telecommunications switches from the ARMIS report can be grouped into 15 categories, including "acts of God," and only three are related to switching equipment. Yet when telecommunications systems are being designed, a vendor's hardware and software reliability statistics are of paramount importance to most planners. That's because a failure here will point directly to the planner. With this in mind, let's examine the three downtime cause categories of hardware design, software design and hardware failure.

Design and equipment failures

A failure due to design error means that the hardware or software simply did not perform according to its specifications. The correction of design errors is typically a vendor's responsibility. However, downtime due to this type of error can be minimized by examining your vendor's requirements for quality control and

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By Sandy Gordon

ATM's promises: Speed and scalability

Asynchronous transfer mode (ATM) is a technology that seamlessly integrates voice, data and video in the converging networks of the future. The promise of this technology is revolutionary. Voice, multimedia and on-line data services are transparently delivered to consumers over cost-effective community area networks. Two-way data transmission is at speeds, quality and affordability undreamed of a decade ago.

While ATM can be integrated with existing networks so as to preserve users' investments in existing equipment, a full ATM network will provide exponential productivity boosts, both in MIS and in businesses as a whole, rather than the incremental productivity boosts attained with evolutionary network standards.

Today's networks are essentially data highways, subject to the delays of heavy commuter traffic and/or collisions. Bandwidth-hungry applications like graphic-intensive Web pages can seriously slow today's network speeds and cripple productivity. This is because conventional Ethernet networks share a physical transmission medium in which only one station can transmit at a time. As traffic builds, the system throughput erodes and response time decreases becoming unacceptable to all users. In addition, Ethernet interfaces must operate at peak rate, regardless of how much data is being sent. Most importantly, shared media networks do not scale to higher speeds, larger numbers of ports or broader physical extent. This means that as you add users, network congestion becomes worse.

Sandy Gordon is corporate communications manager at COM21 in Mountain View, CA.

ATM fundamentals

ATM uniquely addresses these speed and scalability issues. It is an international packet switching standard using a cell-based approach in which each packet of information features a uniform size of 53 bytes. Of the total cell, 48 bytes is the "payload" or to be transmitted. Five bytes are used as a "header" providing all the addressing information for that particular packet in question. ATM could switch and route information of all types, including such services as video, voice and data.

By breaking data down to 53

Networking alphabet soup

ABR (available bit rate): A lower priority ATM traffic class of service that negotiates for whatever bandwidth is available.

ATM (asynchronous transfer mode): An international packet switching standard using a cell-switched approach in which each packet of information features a uniform size of 53 bytes (digital words of eight bits each). Of the total cell, 48 bytes is the "payload" or information to be transferred. Five bytes are used as a "header" providing all the addressing information for that particular packet. ATM could switch and route information of all types, including video, voice and data.

Asynchronous transmission: A method of sending data over a communications line by placing a block of transmitted bits in an "envelope." The envelope begins with a "start" bit that tells a computer a character is beginning. The "stop" bit sends a message that a character has ended. Asynchronous transmission also has the advantage of not needing precise clocking mechanisms that maintain a time relationship between transmitter and receiver.

Baud: Frequently confused with bits per second (bps), baud is the number of times a state change occurs on a communications channel per second. A 2,400-baud modem changes its signals 2,400 times a second. The baud rate equals BPS only when a state change represents a single bit of data.

BER (bit error rate): A measure of transmission accuracy. It is the ratio of bits received in error to bits sent.

BISDN (broadband integrated services digital network): A high-speed ISDN service intended to support full-motion video and image applications, as well as data, at speeds of approximately 150 Mbps.

Bit/byte: A bit is the most basic element of digital information. One bit—represented by either a 0 or 1, the absence or presence of electricity or light—is combined with other bits to form an 8-bit word or byte. Bytes are the words of our digital language. Depending on how the bits within them are ordered, these bytes can be translated into numbers, words or commands.

Bit rate: The speed at which digital signals are transmitted, expressed in bits per second.

BRI (basic rate interface): This ISDN scheme is identified as 2B+D, and permits two "bearer" channels, each operating at 64 kbps, and one "data" channel,

(Continued on page 61)

testing prior to field deployment. Hardware and software releases should be both laboratory- and field-tested by the vendor prior to general availability. The service provider also should perform acceptance tests at its own site prior to service cutover.

Hardware failure is different from design error. With this cause of downtime, something that normally functions according to specs stops working, and service is interrupted. There are several ways to minimize downtime from this type of failure.

While an obvious solution is to build your system from components with individually low failure rates, most telecommunications service providers do not build from the component level. They rely on vendors to provide them with fully assembled network elements, such as switches, digital cross-connect systems, amplifiers, etc. These network elements are where reliability control begins for the service provider.

One way to ensure continuous service is to maintain dual configurations of every network element. The duplicated units can be in a hot standby condition, tracking every action of the active component. When an abnormal condition is detected in an active component, the standby unit reverses roles with the active unit, taking over operations without service interruption. While a hot standby is the most reliable, it also tends to be the most expensive, due to total duplication and the need to continually manage two units performing exactly the same task. Remembering our appliance industry analogy, that's like having two washing machines running at all times because you don't want to wait for your blue jeans to get done when something breaks.

How can you cut the cost of duplicated systems and still gain the advantage of their reliability? The answer becomes apparent when you realize that network element reliability is not necessarily the sum of component reliabilities. Some equipment vendors increase network element reliability by only duplicating critical components of the network element — such as the call processor, where failure could cause total system failure. Component failures affecting a smaller universe, such as line card failures, can be fixed by field replacement with a maintenance spare. That's similar to the appliance repairman replacing a failed component, except better. In this case, the jeans are still being washed, albeit without the water softener, while the machine is being repaired! Careful analysis is required with this approach, however, because a vendor's opinion of what is critical to service operation may not agree with your own.

An alternative way to minimize the cost of duplicated network elements is to provide backup to another working system that normally handles an entirely different set of end users. While there is duplication of equipment similar to the hot standby, in this case the duplicated equipment has tasks for which it has primary responsibility, and only performs the tasks defined for backup when the other unit fails. In certain designs, Switch Module A is the backup for Switch Module B, and vice versa, providing protection against failures in either unit. The drawback here is that Switch Module A and Switch Module B both require additional capacity to handle backup, and that capacity is unused except in the backup scenario. Unused capacity equates to extra expense. This is like running our washing machine half full most of the time, so that if our neighbor's machine breaks, we can toss in his blue jeans along with ours.

The moral of this appliance industry analogy is that reliability can be achieved in several ways, and being reliable doesn't mean being perfect. As telecommunications engineers, your reliability discussions with vendors should be to find the basis for their reliability claims. You will then be in a position to make your choices considering both performance and cost.

One final thought: This column has examined reliability from the perspective of network elements. Many of the comments on duplicating critical components also pertain to the transmission facilities between network elements. Cable telecommunications engineers are well aware of "backhoe outage" from their experience in cable TV, and this type of failure is even more devastating in telecommunications. The choices between performance and economics are similar, whether you are evaluating duplicate network elements or dual-fiber ring architectures. **CT**

By C. David Chaffee

Cable TV — Fiber-rich

Fiber is one of the most important things to have happened to cable in the United States in the 1990s.

To better understand that statement, one only needs to revisit conditions of the 1980s. Interexchange carriers such as AT&T, Sprint and MCI, as well as the Bell regional holding companies (RHCs), were installing fiber optics in major doses.

The cable TV companies were not. They were being questioned about their traditional line services, and the reliability and quality of signals they were providing over them. To compound the problem, wireless cable and direct broadcast satellite lurked as major potential competitors.

To be honest, the cable industry's early experience with fiber optics was disappointing at best and disheartening at worst. Lured by the promise of suddenly rushing an array of services to people's TV sets, trial systems in Japan (Hi-OVIS) and the United States (Times Fiber Communications' Mini-Hub) only demonstrated that the cost of such systems would be expensive and technically challenging.

Then, thanks to engineers such as Jim Chiddix at Time Warner Cable and Dave Fellows, then at Scientific-Atlanta and now with Continental Cablevision, cable became the beneficiary of a brand new architecture — hybrid fiber/coax (HFC). It provided fiber from the headend to the node, and coaxial cable to people's homes.

HFC did many things for cable to improve what had become a deteriorating situation. For one thing, it helped improve the industry's reputation. At once, it provided much of the clarity and reliability of fiber and the economics and simplicity of coax. By reducing the number of amplifiers, fiber offered improved reliability. It also allowed ops to provide more channels as the result of the increased bandwidth it offered.

HFC also created a platform through which cable could more aggressively compete with the telephone industry. Officials at the two major optical fiber-producing facilities in the United States — Corning and AT&T — say cable demand is second only to that of the RHCs. And this is very much a work in progress.

"The trend in the cable TV industry is to go deeper and deeper into the network," says Tim Wilk, director of strategic planning at S-A.

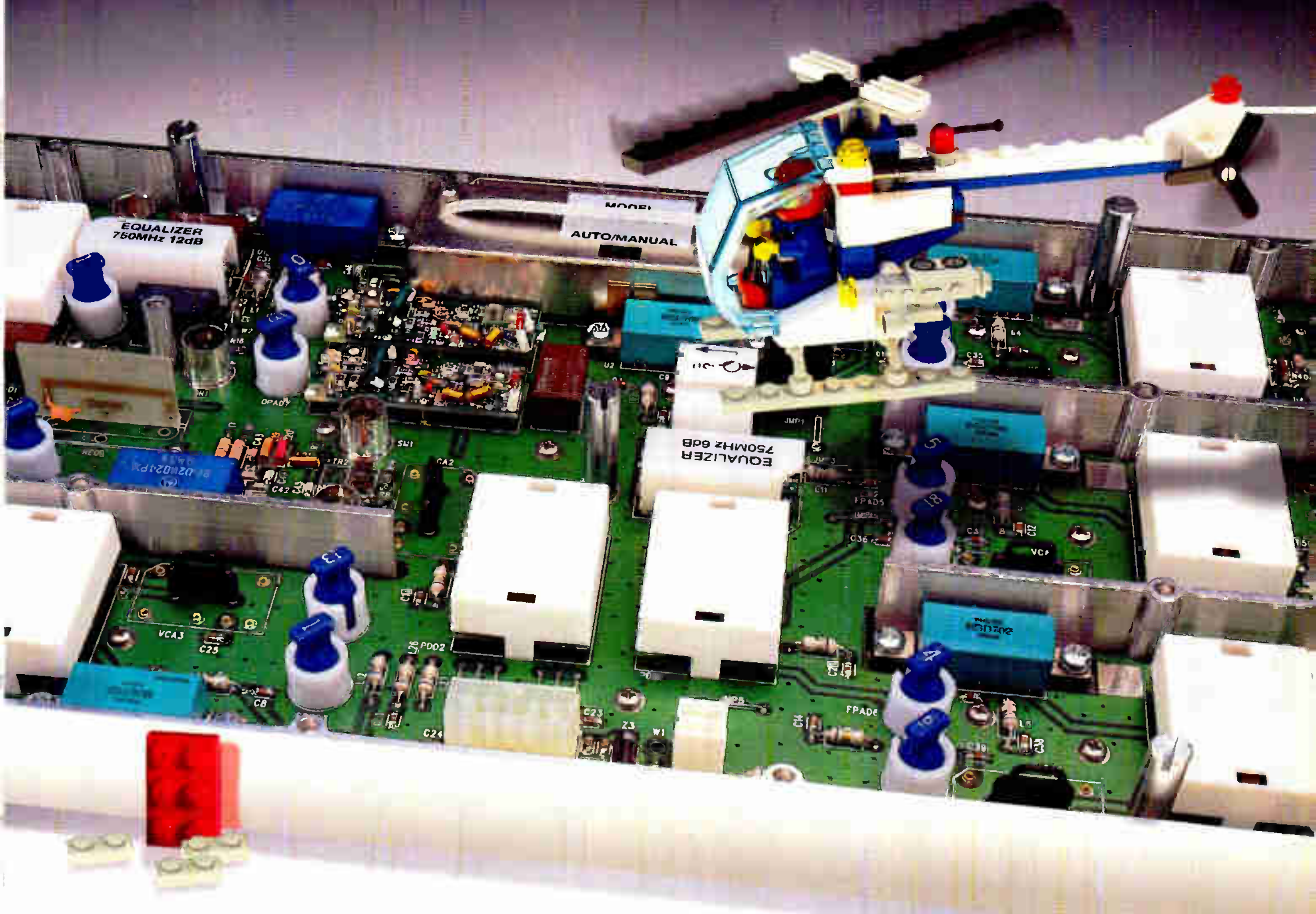
"It's a no-brainer that cable TV companies are going to use fiber," concurs Andy Paff, president and CEO of Integration Technologies, a joint venture of Antec and Nortel.

Wilk estimates that 95% of cable systems now going in operate at the higher 750 MHz range, which HFC is suited for. Advantages of using higher bandwidth are that ops can sell more channels (up to 110 analog, several hundred digital) and reduce operating cost by providing greater reliability.

Only from one-fourth to one-third of U.S. rebuilds that will be accomplished

C. David Chaffee is senior editor of Phillips Business Information's "Fiber Optics News." He is the author of The Rewiring of America: The Fiber Optics Revolution (Academic Press Inc., 1989). He can be contacted at (301) 340-7788, ext. 4330, or via e-mail at dchaffee@phillips.com.

You used to build everything with these.



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using HFC have been so, meaning major fiber installation is guaranteed for years to come. Time Warner Cable is investing $4 billion during the next five years to accomplish this — and that commitment is not wavering, says Time Warner Cable spokesman Mike Luftman.

Indeed, while the telephone industry at times became mesmerized with regard to the potential of fiber-to-the-home, cable has been busy deploying HFC. In a reversal of roles, a number of RHCs have now gone to HFC as well, as switched digital video (SDV) languishes, at least temporarily.

The HFC platform is important because it allows cable companies to contemplate competing in some of the same add-on services that are taking so much of the RHCs' attention. Indeed, Time Warner Cable says the preliminary results of a fast Internet trial it is offering are favorable. It will ramp up the service in 1996.

Fiber optics also has the advantage of providing a gateway for cable TV carriers to interconnect. This is particularly true as major consolidations occur and cable TV transforms itself into a broader network orientation. Fiber also is being installed by carriers consolidating regional networks. One example is a network Cox received from a swap with TCI in the Phoenix, AZ, area. To interconnect with its surrounding Arizona network, which is HFC, Cox is rebuilding the Phoenix network with fiber.

Cable continues to intelligently fit the advantages of fiber to its own requirements. A recent example is the introduction of Scientific-Atlanta's System 70 platform, which the company says has greater reliability, upgradability and maintainability. The industry also is accepting synchronous optical network/synchronous digital hierarchy as a way to improve the reliability and performance of the fiber portion of its HFC network, much as telephony is.

Innovative cable companies continue to push the envelope for HFC, running fiber closer to the home. A pioneer in fiber-to-the-serving-area is Jones Intercable. The company's advanced system in Alexandria, VA, will eventually have individual nodes feeding approximately 150 homes. The price tag is $35 million.

Opportunities will only continue to blossom as entertainment and communications services blend and the bandwidth pipe opens even more. One venture, Australia's Optus Vision, is funding ADC to the tune of $185 million to supply advanced fiber transmission electronics. While the Bell Atlantic/TCI merger (which no doubt would have aggressively moved in this direction) did not go through, other partnerings may. In one case, TCI began working with partners to install a fiber ring around San Francisco (although as the network nears completion, TCI is the sole owner, having purchased all of its partners).

To provide a near-term perspective, the worldwide fiber-optics market this year has reached $7.1 billion, according to the marketing firm of Kessler Marketing Intelligence. That market is anticipated to grow to $17.38 billion by the year 2000. An important driver, of course, is and will continue to be the cable TV industry worldwide. **CT**

By Michael L. Smith

"Reality Check": New year, new column

This column will focus on emerging technologies and their impact on system operations, staffing and training. While these technological advancements are new and exciting, I realize that not everyone has had an opportunity to work with these new architectures and products. I will attempt to outline some of these details and discuss how they work to help you remain better informed and prepared for the challenge when your system is called upon to deploy new services.

I am a 23-year veteran of the cable TV industry and have recently joined Superior Electronics Group as the director of technical services. As well, I currently serve as chairman of the Society of Cable Telecommunications Engineers' Engineering Committee, vice chairman of the its Emergency Alert Subcommittee and am the Region 10 director. I am completing my sixth year of service on the SCTE's national board of directors and also serve on the Executive Committee. I have previously served as eastern vice chairman and co-chaired an Emerging Technology Conference and Expo Engineering Conference.

Prior to joining Superior Electronics Group, I had the opportunity to work with several MSOs (Adelphia, Warner, Cable America and Storer). I remain involved, first hand, with some of the new technologies, architectures, products and services. When I say first hand, I mean in the field, hands-on. I have developed a different appreciation and am able to quickly sort out what works and what doesn't. I believe this perspective will allow me to shed a slightly different light on the issues that will confront the industry as it moves forward on the information superhighway.

Michael Smith is the director of technical services for Superior Electronics Group, based in Sarasota, FL. He can be reached at (813) 756-6000.

Change is here

Every industry magazine, newsletter, etc., today has a number of articles about new services, products or architectures. It is a foregone conclusion that change is here. This change is often quick and significant. Decisions must be reached early as to how these changes can be turned into positive opportunities. Detailed planning will play an important role in the success of deploying these new services.

"It is a foregone conclusion that change is here. This change is often quick and significant."

Traditionally the cable TV industry has focused on the delivery of analog video signals. Some new opportunities include: digital services, telephony, interactive video-on-demand, PPV, increased channel capacity, access to allow work at home (telecommuting), and access to Internet/information services.

These are major changes that encompass numerous technical issues and have significant cost investment impact. The consequences of poor planning and preparation could be devastating — both financially and operationally.

Polls have shown that data and telephony customers have very high quality expectations. How will the industry meet these expectations? Will status monitoring become a system prerequisite? How will network management be implemented? What can be done today to minimize the impact on operations as new services are added later? How do you prepare for all the migration issues? Training issues?

The list continues to grow daily and, at times, appears to be endless. This is not unexpected when the technology is changing as rapidly as it is. Again the issue is, "How will the industry turn this into a positive opportunity to prove that it can meet the challenge at hand?"

Help me help you

In upcoming issues I plan to address specific topics that answer these significant questions. These topics will include: the return path and its activation/operation; status monitoring strategies; network management (what is it and why have it, as well as open interfaces); performance testing; training issues; and planning issues.

I look forward to receiving any input you might have concerning the column or ideas/suggestions for future topics. I hope that I am able to present information that will help you better understand the new technologies. My intent is to facilitate an understanding of the challenges presented to provide the services and information that customers have requested, while optimizing the functionality of the equipment and the expertise of your technical staff.

Until next time — read on. **CT**

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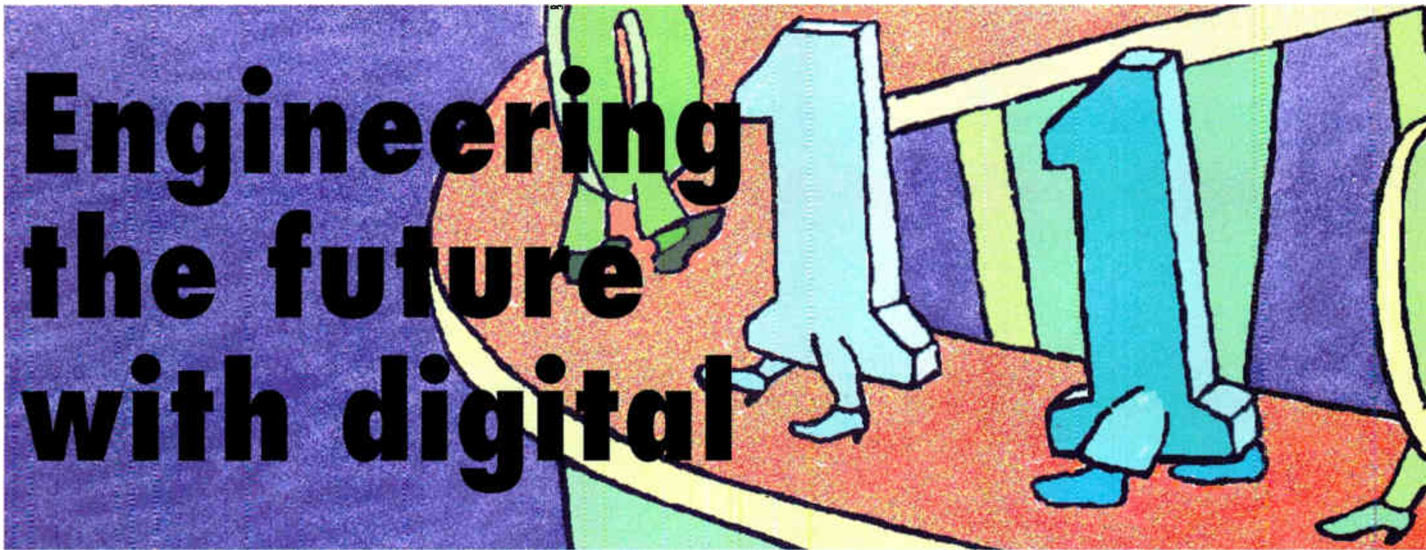
By Megel Brown

Engineering the future with digital



Debra Gavant Swan

There is no escaping it. Everywhere we turn, it proves to be the topic of discussion. Digital technology seems to be the premise behind most emerging technologies facing the cable industry. Be it high-speed cable modems, telephony or increased channel capacity through compressed digital video, an appreciable understanding of digital technology will be required to move our organizations to the next technical level.

If we examine cable's emerging technologies, we will notice that many digital concepts are interchangeable. For this reason, digital TV will be used here to introduce these fundamental, yet important concepts. As seen in Figure 1, the major components of digital TV include:

1) Digital encoding
2) Digital compression
3) Error coding
4) Digital multiplexing
5) Digital modulation

Megel Brown, BSEE, is an area project engineer for Comcast Communications, based in Sarasota, FL.

Digital encoding: Analog-to-digital

Pulse code modulation (PCM) can be used to transform an analog signal into a digital representation. Recall that in CATV, amplitude modulation (AM) is used to describe the video portion of a signal, while frequency modulation (FM) is used for the sound portion. If we focus on the video component, we notice that the AM signal includes the information signal (a modulating signal such as baseband) and a carrier signal as seen in Figure 2. Together they form a modulated signal that can be transmitted across a physical medium such as coaxial cable (VSB-AM).

In PCM, the video information signal must be quantized. Simply stated, this signal, which was formerly represented with a voltage level, is now represented with a binary number (Figure 3). This binary number is a digital format that uses typically 8 to 10 bits. The more bits that are used, the better the resolution of the signal. Unfortunately, this means more information will be generated and ultimately more bandwidth consumed.

Any discernible difference between the new quantized signal and the actual waveform is referred to as the quanti-

Figure 1: The big picture

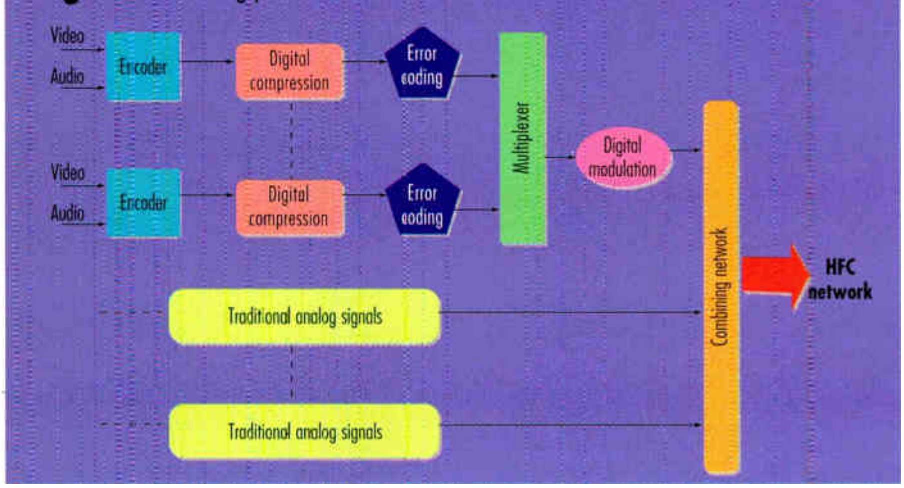
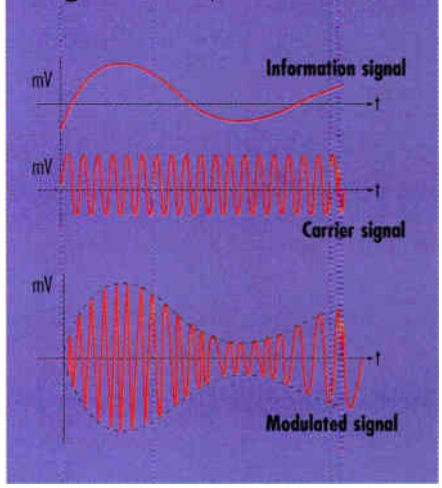
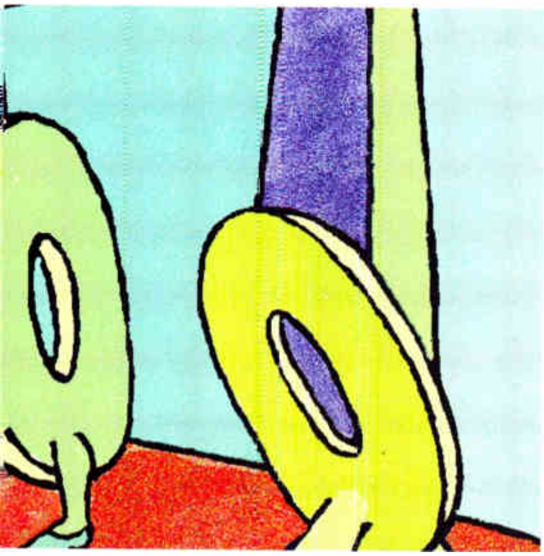


Figure 2: Amplitude modulation





zation error. This error results in a slightly different waveform at the receiving end when reconstructing it back into an analog signal. Figure 3 shows PCM using 3 bits.

If the information signal is sampled enough times within a second, the viewer will perceive it as being unaltered from its original form. This is much like a strobe light in a dim room. If the light continues to increase in the number of flashes per second (so fast that there is no flickering), continuous motion will be perceived. According to the Nyquist sampling rate, samples must be taken at a rate equal to or greater than twice the highest frequency within that particular band (Nyquist sampling rate $\geq 2f_{max}$).

If we sample lower than this minimum rate, aliasing will result. This means when the digital signal is changed back to analog, there will be discouraging differences as compared to the original waveform. Using the strobe light analogy, if we start to lower the rate of the flashing light, images start to look discontinuous and "jerky." The strobe light's frequency (number of light flashes per second) is not high enough to represent what is actually happening.

Digital video

Although sampling rates vary for NTSC signals depending on desired resolution and required circuitry, a common rate is four times the color subcarrier's frequency. This proves to be higher than the Nyquist sampling rate and is therefore known as oversampling.

Oversampling provides a greater quality of resolution and is used to prevent aliasing:

$$\text{Sample rate}_{NTSC} = 4\ f_{sc}$$
$$= 4(3.58\ \text{MHz})$$
$$= 14.32 \text{ million samples per second (MS/s)}$$

This sample rate translates to a throughput of 114.56 million bits per second (Mbps) and a data storage requirement of 96 gigabytes (GB) for a two-hour movie:

14.32 MS/s x 8 b/S = 114.56 Mbps, and

114.56 Mbps x 120 min x 60 s/min x 1 B/8 b x 1 kB/1,024 B x 1 MB/1,024 kB x 1 GB/1,024 MB = 96 GB

As will be explained later, to digitally send this signal, which would normally require a 6 MHz bandwidth, would now take well over 100 MHz. For this reason, a method for streamlining digital information is needed.

Digital audio

The frequency range for audio is considerably less than video, which implies less digital information will be generated. Because the dynamic range for audio is greater than video, a higher quantization level is utilized (i.e., 14 to 20 bits per sample). Some listeners can discern sounds as high as 20 kHz, although the typical listener peaks at 16 kHz. Using the Nyquist sampling rate, one would easily justify using a sampling rate of 2(20 kHz) = 40 kHz. It has come to be conventional to oversample at the same rate of a compact disc (CD). CDs sample at 44.1 kHz and use 16 bits per sample. Therefore, the same two-hour movie requires an additional:

44.1 kS/s x 16 b/S = 705.6 kbps data rate, and

705.6 kbps x 120 min x 60 s/min x 1 B/8 b x 1 kB/1,024 B x 1 MB/1,024 kB = 605 MB storage capacity

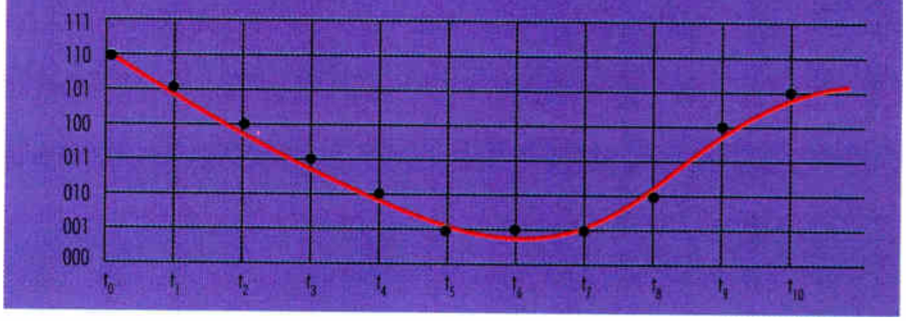
Higher oversampling may be used to acquire a particular signal quality without the use of expensive, close tolerance filters. It also can be employed for noise shaping purposes.

Pixels

After a specific sampling rate is determined, it is then necessary to understand how digital systems operate. Information is normally sent to a TV set via 525 interlaced scan lines (of which about 480 appear). Because these lines result in two different fields (odd and even lines interlaced) that are "slanted," it is necessary to digitally represent this waveform in such a way in which compression techniques can be utilized. Each sample on the line becomes a picture element or "pixel." Here, pixels are used to divide frames into tiny blocks of rows and columns (Figure 4 on page 40). The smaller the pixel size (more samples per second) the better the resolution. With higher resolution, increased bandwidth and storage space are demanded. Standard choices such as 704 pixels across and 480 pixels down lend for a good discussion. If we use 8 bits/pixel to represent the luminance of the frame, a data rate of 81.1 Mbps would be required:

(704 x 480) pixels/frame x 8 b/pixel x 30 frames/s = 81.1 Mbps (Y) →

Figure 3: PCM



Because the human eye can better discern between luminance (black and white) than chrominance (color), fewer pixels can be used to describe each color component. Thus, pixel dimensions of 352 across and 240 down can be employed for both R-Y and B-Y color components:

(352 x 240) pixels/frame x 8 b/pixel x 30 frames/s =
20.275 Mbps (R-Y)

(352 x 240) pixels/frame x 8 b/pixel x 30 frames/s =
20.275 Mbps (B-Y)

Summing audio and video throughputs, over 122 Mbps can be used to generate information for one channel which would normally take 6 MHz in the analog world. Once again, this information would call for multiple 6 MHz channels. Because this clearly hinders digital deployment, compression techniques are explored.

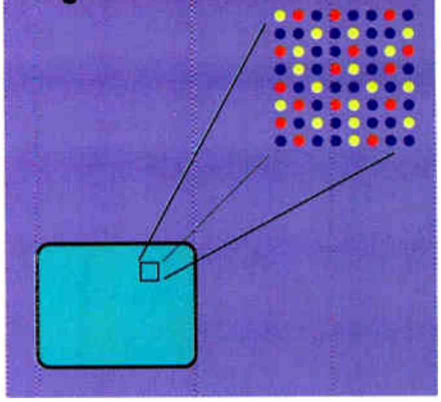
Digital compression

Digital compression is the process of using mathematical algorithms to eliminate redundancies in digital data. As a result, the amount of transmission rate and storage space required is quickly reduced. MPEG-2 standards play a significant role in digital compression and is implied throughout this section. (MPEG stands for the Moving Pictures Experts Group. MPEG-2 is an international standard for coding, multiplexing, sorting and transmitting digitally compressed video and audio.)

In digital video, compression at the encoder is done by eliminating redundancies. Here, compression methods can be distinguished as lossless or lossy. With lossless compression, deleted information is reinserted at the decoder. With this technique, essentially no information is lost between original data and received signals. Conversely, lossy methods take advantage of human perception and its disregard to certain details. Examples would be the fine details in a fast moving object or even the color information that requires less resolution. Collectively, these two methods fall under the larger umbrella of intraframe and interframe compression methods.

Intraframe compression analyzes any redundant information found within a frame. The entire frame is usually broken down into groups of 8 x 8 pixels called microblocks (Figure 4). The microblocks are then analyzed for similarities and redundant information is streamlined. An example of this is an all white background with a person centered in the screen. Here, many microblocks will be the same (i.e., all white). Instead of sending these microblocks individually, we can use one microblock to represent many other similar blocks. Only those microblocks that actually change are transmitted. Some methods of intraframe compression include vector quantization (VQ) and a form of discrete cosine transform (DCT), which are lossless and lossy methods respectively. Intraframe coding is referred to as I-frame coding in MPEG-2.

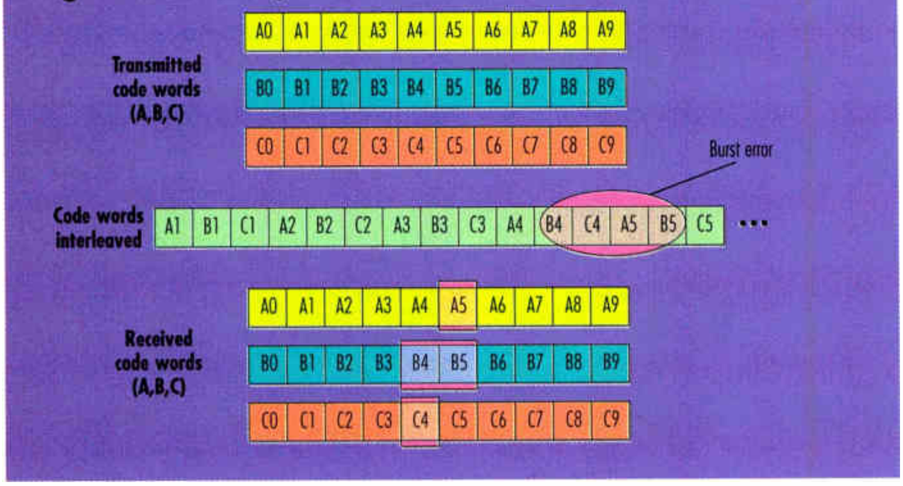
Figure 4: Pixels on the screen



Interframe compression takes advantages of redundancies that may occur as a result of comparing adjacent frames. Recall that within one second, 30 snapshots of a TV scene are taken. With the exception of scene changes, it is practical to think that there are few changes that occur between most frames. It is estimated that there is only a 10% frame change in this situation. This implies that 90% of typical images are redundant within a segment and can be eliminated before storage or transmission. This type of compression is not as effective where there are frequent amounts of scene changes or movement. MPEG-2 classifies this method as predicted frames (P-frames) and bidirectional frames (B-frames). With P-frames, only the difference between the new frame and the estimated frame is transmitted. B-frames are predicted from the most recent I- or P-frame and the next I- or P-frame that follows. Examples of interframe techniques are predictive coding and motion compensation (which uses a 16 x 16 pixel macroblock).

Huffman coding can be used to assign less bit information to data that is more likely to reoccur. Run-length coding can be used with Huffman coding. This coding counts the number of 1s or 0s sent in succession. This is very useful when long strings of 1s or 0s are sent. Both are lossless methods.

Figure 5: Interleaving



MPEG-2 methods allow for fantastic compression ratios. Each ratio will obviously depend on the amount of redundancies present along with other design parameters. One digital video trial reports taking 140 Mbps and reducing it to 3.5 Mbps with little or no picture degradation using MPEG-2. For compressed audio, 384 kbps is being used to produce CD quality sounds.

Error coding

It is realistic to think that data leaving the encoder may not be the same data that is received by the decoder. In

the case of digital storage, dropouts and mechanical errors may hinder magnetic recordings. Interruptions in the light beam may be the thorn in an optical recorder's side. With coaxial transmissions, ingress, microreflections, noise and loose or bad contacts are spawning fields for errors. The level of error will be determined by the bit error rate (BER). The level of error tolerated will be dictated by the application. (Less error can be tolerated with audio than in video.) Any small errors in a compressed signal are magnified upon decompression. With these premises, it is necessary to encode our information with an error checking scheme.

In error correction, bits are added to parts of the original data to create a code word. (Note: The definition of code word varies by author.)

Code word = Error correction bits + information bits

As a result, the amount of data and required bandwidth has increased. A simple example of error coding is the parity-check bit, which adds a single bit at the end of the code word. This bit will be 0 if there is an even number of 1s in the message, and 1 for an odd number of 1s.

Example 100110010 101011101

The veracity of the received message is checked at the decoder as it is compared with the parity-check bit. Action is taken on any discrepancies. Unfortunately, if there are an even amount of errors, no errors will be detected. This method is typically used with data communications and should only be used if a low BER is expected across coaxial cable.

More complicated solutions include using Reed-Solomon (R-S) codes. These codes are used to both detect and correct burst errors (errors that affect adjacent bits). R-S codes divide code words by mathematical polynomials to determine the magnitude of errors present. Interleaving also can be used to control burst errors, and is useful in conjunction with other error correcting methods. Interleaving takes code words and "weaves" them together with other code words (Figure 5 on page 40). With this method, burst errors stand a lesser chance of corrupting an entire code word. They are broken down into smaller errors spread across several code words. This reduces the redundant code needed to correct bytes and takes advantage of more efficient techniques used to correct bits. Interleaving does not increase data and bandwidth requirements. Other codes of interest include Hamming, Cyclic, Viterbi and Trellis codes.

MPEG-2 standards also provide for a level of error recovery and packet loss detection through the transport stream layer. The transport packet is 188 bytes in length. Of this, 22 bits may be used for the error detection.

The transport error indicator bit is used to detect whether there are packets in error that cannot be corrected.

The priority bit indicates whether there are higher priority packets that require preferential error protection or specific transmission routing.

The 4-bit continuity counter is increased as each packet is passed through the transport stream. Any discontinuity is an indicator of packet loss.

An optional 16-bit cyclic redundancy check can be used over each information message packet. This is positioned for isolating sources of intermittent errors across the network as opposed to at the end decoders.

Digital multiplexing

Now that the information has been placed in its most efficient form, it must be prepared for transmission. Traditionally in headends, many separate analog signals (i.e., channels) are combined to make one signal that runs on the supertrunk and out to the distribution network. The typical method for this is officially called frequency-division multiplexing (FDM). An analogous method in the digital world is called time division multiplexing — TDM. (*Editor's note: FDM also is used in digital transmission.*) TDM takes many digital signals and creates a single digital signal (Figure 6 on page 44). Two common forms of TDM are synchronous and asynchronous time-division multiplexing.

Synchronous TDM is in wide-scale use today by telephone service providers. [The 4 kHz voice signal is sampled at 8 kHz (i.e., 8,000 times per second). Each sample uses 8 bits, thus 64 kbps (DS-0).] Twenty-four separate voice lines are used to provide 24 different slots in a DS-1 frame (Figure 7 on page 44). Each slot holds one sample (8 bits). The 25th slot holds a single framing bit used for synchronization.

$$[(24 \times 8) + 1] \times 8{,}000 = 1.544 \text{ Mbps}$$

At the receiver, the framing bit is analyzed to make sure it follows a predetermined pattern (e.g., 101010...). If not, the receiver will wait until it sees its predetermined pattern before it continues its normal processing procedure. Other variations exist with data signaling, but the ideology is essentially the same. Higher rates can be established by multiplexing the multiplexed signals.

DS-0 = 64 kbps
DS-1 = 1.544 Mbps = 24 DS-0s
DS-3 = 44.736 Mbps = 28 DS-1s

It should be noted that video signals are sampled at much higher rates than telephone signals, resulting in higher data rates. Thus, DS-3 lines are more appropriate for digital video transmission.

Asynchronous TDM (also called statistical TDM) recognizes that it may not be practical to assign equal bandwidth to every digital video stream due to varying data rates required. (Football requires more throughput than *Sesame Street*.) With this said, time slots are allocated "on-demand." Some programs may take 15 Mbps, while others may take 5 Mbps. Perhaps the system will be designed for 10 Mbps/channel, but in actuality, it will be allocated accordingly in real-time (Figure 8 on page 44). With this dynamic bit rate allocation method, bandwidth can be more efficiently utilized. This is compared to synchronous TDM that would have a fixed data rate per channel.

Note that MPEG-2 also has provisions for packaging compressed video and audio streams into smaller packetized elementary streams. These streams are in turn placed in transport packets with sync information and error detection data, along with other transporting and multiplexing information.

Digital modulation

Once the digital signal has been multiplexed, it is now ready to be modulated for transmission. In order to do this, it must be in a form that the existing infrastructure already recognizes — analog. At this point, the analog signal may be used to dictate the variation of light over fiber-optic lines, or directly applied to coaxial distribution networks. The most popular means of terrestrial transport is QAM, while VSB appears to be the choice for broadcast digital modulation.

QAM

In binary digital modulation, only one of two possible signals can be transmitted during a signaling interval. With this in mind, our system would only have a theoretical bandwidth efficiency of 1 bps/Hz, or 6 Mbps across a 6 MHz channel. It was quickly realized that cost efficiencies and bandwidth savings could be attained by increasing the data rate within the same band space. QAM does just that. It takes an incoming bit stream and separates it into two groups of bits. Both streams pass through a digital-to-analog converter and a low-pass filter for spectral shaping. One phase is in quadrature (or 90° out of phase)

Figure 6: Multiplexing

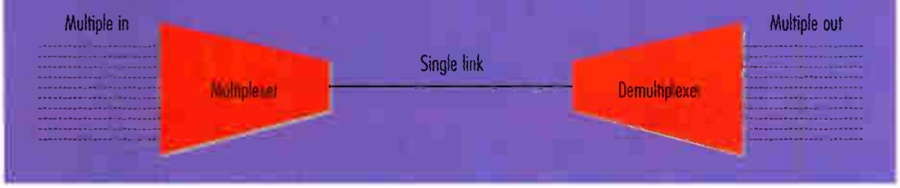


Figure 7: DS-1 transmission

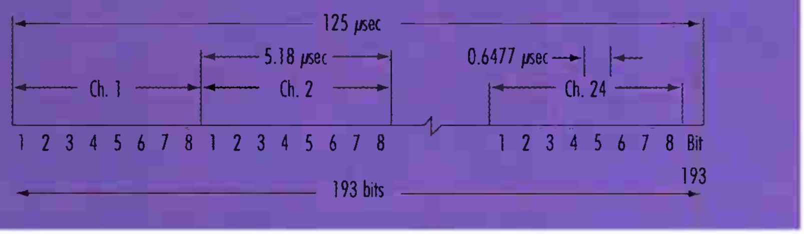


Figure 8: A dynamic multiplexed "pipe"

with the other (the in-phase). The two signals then pass through a quadrant multiplier that creates phase shift combinations. These two signals finally are summed and are prepared to be transmitted.

In the case of 64-QAM (Figure 9 on page 46), a 6 bit word is divided into 3 bit streams per phase. Recall that 3 bits yield 2^3 = eight amplitude levels. The quadrant multipliers provide four different phases for each amplitude, thus 8 x 4 = 32 phase and amplitude combinations. Once the I and Q phases are summed, we are left with 32 + 32 = 64 phase and amplitude levels. This provides a theoretical data rate of 6 bps/Hz or 36 Mbps across a 6 MHz band range. In practice, 30 Mbps is used, with 3 Mbps used for forward error correction. 16-QAM uses 2 bits per carrier reference for 20 Mbps, while 256-QAM utilizes 4 bits for approximately 40 Mbps per 6 MHz channel. Note that higher modulation methods require corresponding higher carrier-to-noise ratios to attain similar BERs.

VSB

Digital VSB is another method of transporting digital information across an analog infrastructure. It uses a single phase carrier that is amplitude modulated with respect to modulating digital data. This method eliminates the need for the complex upper and lower sidebands to be transmitted, unlike QAM. The carrier is put close to the lower band edge, which results in a lower portion of the sideband being transmitted in comparison to a NTSC signal. This pilot carrier is inserted and used for synchronous detection at the receiver.

At corresponding levels, QAM and VSB have the same digital-carrying capacity (for a 6 MHz channel). That is to say, 4-VSB equals 16-QAM (20 Mbps), 8-VSB equals 64-QAM (30 Mbps), and 16-VSB equals 256-QAM (40 Mbps).

We now see that transmitting an uncompressed digital channel of over 100 Mbps would take up much more than a single 6 MHz channel using QAM or VSB methods. A compressed 3.5 Mbps channel is much more realistic and can be shared with other signals across the same 6 MHz band space. Digital compression is essential to digital video deployment.

Transmission

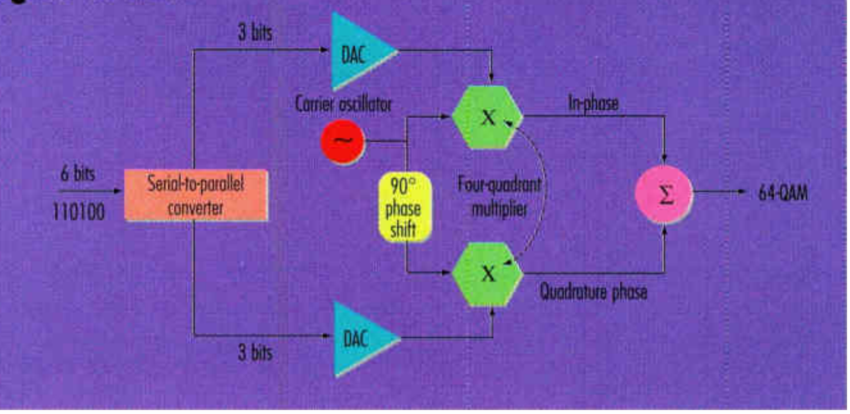
As we saw, an analog signal is changed to digital, then modulated across the system back in analog. Although this has the connotation that not much has happened, recall that this new analog signal is utilizing less bandwidth. Because these digitally modulated analog signals portray our new information, both fiber and/or coaxial cables can be used for transportation. Here, fiber-optic lines vary intensities of light to represent these analog waveforms of varying amplitudes. With coaxial cables, the last mile into the home is cautiously "business as usual," using RF carriers. On this important note, it is essential that systems go through great length to ensure that common problems such as ingress, noise, microreflections and bad/loose connections are kept to a minimum. If not properly addressed, these commonalities may place a false dependence on error correction. →

Conclusion

Once the digital signal reaches the home, it must be demodulated, demultiplexed and decoded into an NTSC signal. Understanding how this works is simply reversing the signal path flow of what has been discussed thus far (for the most part). Purchasing decisions for digital set-top converters must be based on their modularity and robustness. Operating systems must be given close scrutiny to ensure the deployment decision is the right one. Essentially, digital set-tops must have the ability to be easily upgraded, not quickly changed out.

In essence, it is critical that the cable telecommunications industry continues to understand digital concepts. It will be more important now than ever to migrate our technical organizations to the next level. We must task ourselves with the goal of understanding new ideas and concepts. With this in mind, cable companies will continue to secure their place in the highly competitive telecommunications industry of tomorrow. **CT**

Figure 9: QAM



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Reader Service Number 127

By the Council on Competitiveness

Part 1: Vision for a 21st century information infrastructure

Founded in 1986, the Council on Competitiveness is a nonprofit, nonpartisan organization of chief executives from business, higher education and organized labor who have joined together to pursue the goal of improving the ability of U.S. companies and workers to compete in world markets while building a rising standard of living at home. The Council focuses on issues in the areas of fiscal policy, science and technology, international economics and trade and human resources.

The following article is adapted from the Council's vision statement that developed out of consideration of the information infrastructure for the next century. Participating in this project were cable companies, regional Bell operating companies, long distance carriers, cellular firms, computer hardware, software and service companies, banks, broadcasters, publishers, labor unions and universities. Among cable and telecommunications representatives on the project were Bellcore, BellSouth, CableLabs, Corning, Hewlett-Packard, McCaw Cellular Communications, Pacific Bell, Nynex, Tele-Communications Inc. and US West.

The vision statement addresses the need for an advanced information infrastructure in the United States. The following six questions are focused on: 1) Why is information infrastructure important? 2) Where do we stand? 3) What is our vision? 4) What are the roles of government and the private sector? 5) Where do we go from here? 6) What are the next steps? Part 1 of this article covers the first three questions and Part 2 will consider the rest.

Information infrastructure is more than simply computers, data bases and communications networks. It is an engine for economic competitiveness and jobs. It is a means of addressing pressing social concerns. It is the foundation for other types of infrastructure. And it is the basis for a wide range of diverse products and services. The U.S. private sector has already invested hundreds of billions of dollars in the development of this infrastructure. As it evolves, it will redefine the way that people interact with each other and the world around them.

There is no doubt that information infrastructure helps create jobs and drive economic growth. Information networks are dramatically improving the performance of existing industries, such as banking, and paving the way for new ones, such as videoconferencing. In addition, they provide the backbone for the education and training programs that are so crucial to a high-performance American work force. By helping to keep the U.S. industrial base healthy, opening new markets and strengthening the skills of U.S. workers, the information infrastructure has a big impact on our ability to compete in world markets and to generate good jobs in the United States.

The information infrastructure also provides a means of addressing urgent social problems. Health care and education are prime examples. By establishing an automated record and billing network for health care providers, for example, the United States could substantially reduce its health care costs, saving over $30 billion, according to some estimates. Moreover, new applications such as telemedicine could dramatically improve public access to health care. Education also stands to reap enormous benefits. An advanced information infrastructure could make it practical to do such things as link biology students in high schools across the country with world-class biotechnology experts who could show them the miraculous new world of biotechnology. And it could provide rural and inner city schools with access to a broad array of education programs that are currently beyond their reach.

In addition, a robust information infrastructure is the foundation for all other forms of infrastructure. The ability to deploy intelligent vehicle highway systems, to monitor the environment and to deliver data electronically all depend on information technology. Because the quality of our information infrastructure is so important to our success in these other areas, its value to the national economy cannot be overestimated.

For most Americans, however, the most important issue is the impact of information on their everyday lives. While teleconferencing and the routine use of electronic bulletin boards may still seem like remote possibilities to many people, the appliances of the information age — telephones, fax machines, TV sets and computers — are familiar to almost everyone. Networks that link these appliances

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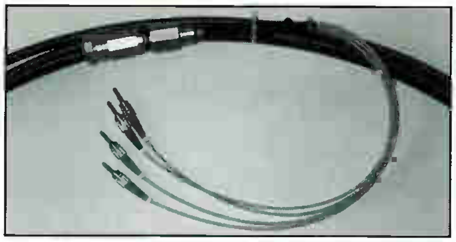

Fiber Optic CATV Drop Cables

Radiant offers a full line of fiber optic cable plant products. The company guarantees drop cables with back reflections of –60dB for ultra polish terminations and –70dB for angle polish terminations. Available from 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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Cost-Effective Systems Transmit Baseband Video/Audio Over Fiber

Several cost-efficient systems that transmit Baseband video/audio over fiber are now available from Radiant Communications. Whether your requirements call for one-way transmission with broadcast quality (RS250), or bi-directional (two-way) transmission using one fiber, Radiant has the solution. In addition, data or stereo audio are available options. These systems are now in use by all major MSO's nationwide in applications including college seminars, town meetings, direct feeds from broadcast studios or remote antenna sites, video conferences and CCTV.

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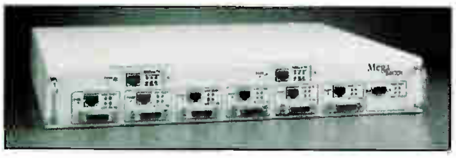

New Unique Fiber Optic Ethernet System Eliminates Data Collisions

Radiant introduces the most cost effective and technologically advanced method of connecting remote ethernet hubs together. The series DL200 allows transmission distances up to 100Km and data throughputs of 100Mbs. It can be used for any size system — large or small. Typical applications include interconnecting large metropolitan school districts or remote college or industry locations. Budgetary cost is less than $3000 per location.

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byte "cells" and then moving the cells to their destination at high rates of speed, ATM networks can efficiently scale in size, speed and distance. ATM is designed to support a variety of speeds, from 25 megabits per second to as much as 10 gigabits per second as the technology evolves. Ethernet throughput, by comparison, is typically much less than the 10 megabits/second wire speed.

"ATM networks are actually very similar to the telephone network."

ATM traffic management

FDDI-II and Ethernet, meanwhile, add extra lanes that can be dedicated to desktop video collaboration so that traffic on these dedicated lanes may avoid the commuter crunch. ATM also offers the ability to deliver "bandwidth-on-demand" to efficiently utilize precious network resources. It provides scalability and flexibility, from the backbone to the desktop, to support the requirements of both today's and tomorrow's networks.

ATM networks are actually very similar to the telephone network. In fact, key parts of the ATM local area network (LAN) standard are drawn from telephony standards. The telephone network is a switched network, allowing many users to place calls concurrently and have dedicated circuits to the people they are calling. ATM also is a switched network, although the circuits are virtual rather than dedicated. These virtual circuits (VCs) enable many users to share the same medium without degradation of service as users are added to the network.

High-speed connections and mega-bandwidth have great potential, but are ineffective unless properly managed. One of ATM's inherent strengths is the power to efficiently manage the bandwidth of the network by providing the ability to establish different quality of service (QOS) classes, each having varied bandwidth thresholds, priorities and billing rates. A service provider can establish subscriber tiers that add value to an entire business, academic and residential community. By setting up various QOS tiers, bandwidth minimums and maximums can be established for each user, allowing traffic of different sizes with very different characteristics to coexist without impacting each other.

Because ATM has great promise for corporate productivity, it demands different methods of developing its technology than any network before it. National and other ATM vendors are changing the ways they do business to accommodate ATM users' requirements.

ATM users today

While ATM products have been

together are redefining how people interact with the world around them. By connecting people to offices, stores, schools and each other in new ways, these information networks are changing the way that Americans work, shop, learn and play.

The significance of America's information infrastructure goes beyond our geographic boundaries. Because markets are increasingly global, the nation's information infrastructure must be able to interact easily with those of other nations. Not only has the global marketplace arrived, but also the global village.

In order to make the most out of our growing reliance on information technology, we need to strive for a more advanced information infrastructure that will help make us more innovative and more productive than other nations. To do so, we must assess where we stand, outline a clear vision of where we want to go, identify a process that will get us there, and clarify the roles of the major players. Because it is impossible to predict the exact path that technology will follow, or the products and services that consumers will demand, flexibility must be the hallmark of the U.S. approach. Throughout, we must strive to make sure that public policies complement market forces and take into account consumer needs.

Where do we stand?

The first step in the development of an advanced information infrastructure began over 30 years ago when digital technologies began replacing analog. The telecommunications industry is presently in its second major phase, deploying high-capacity, digital transport media such as wireless, integrated services digital network (ISDN) and fiber communications. The evolution on the telecommunications side has been paralleled by developments in data communications and computing, which have shifted from proprietary, low-speed, analog systems to nonproprietary, high-speed, digital systems.

We are presently in the beginning of a critical third phase — substantially upgrading the intelligence of the telecommunications network and moving toward open computer systems. The fusion of communications and computing capabilities that is taking place in today's network is setting the stage for an advanced information infrastructure that will reduce costs, enhance services and create an astonishing array of new applications.

At present, the overall variety and quality of America's information services and communications networks are unmatched anywhere else in the world. Moreover, the United States leads in the computer systems, software and many of the technologies that are at the heart of the information revolution. Ultimately, however, it is not technology but the ability to harness it in the form of practical applications that will determine international leadership.

Other countries have realized the tremendous economic potential of an advanced infrastructure and also are moving aggressively, particularly in the telecommunications area. Attempts to deregulate and privatize parts of the telecommunications

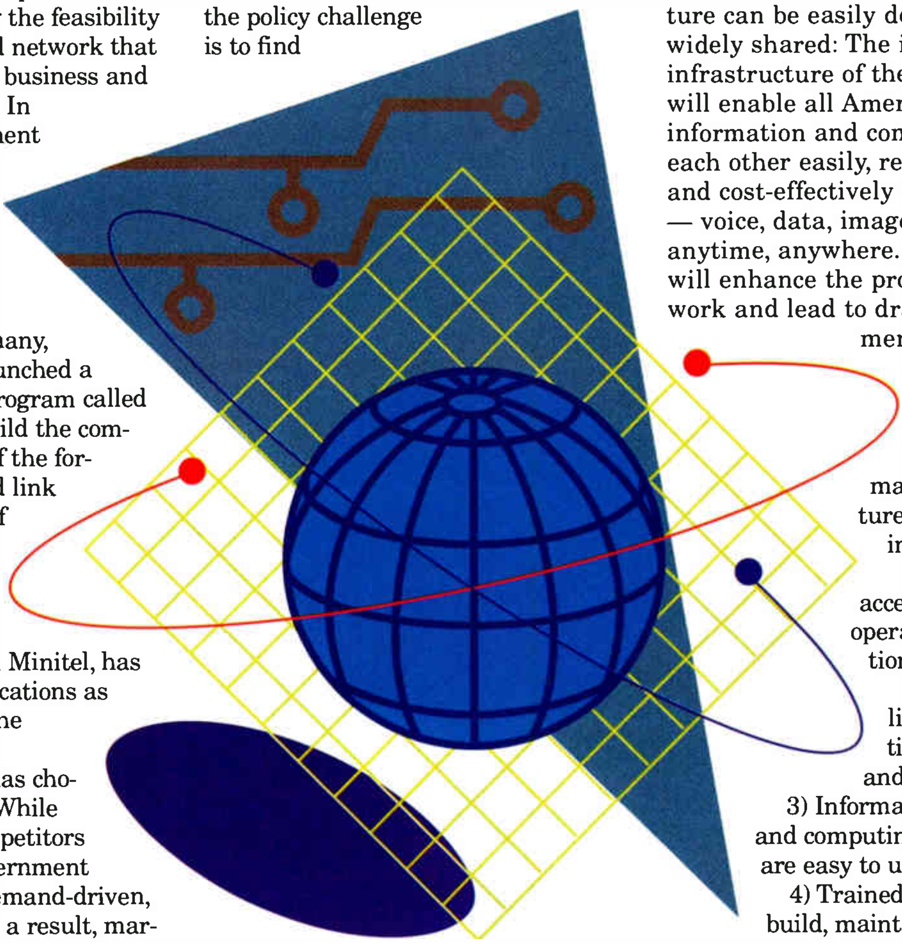
industry in Asia and Europe are being carried out as part of broader, national economic development plans. Governments in these regions have embarked on ambitious long-term modernization programs for their telecommunications industries. They are defining major R&D projects, backing them up with serious funding, and using standards and interface definition to support them.

In Japan, Nippon Telephone and Telegraph is examining the feasibility of building a broadband network that will reach every school, business and home by the year 2015. In Singapore, the government has announced its "Vision of an Intelligent Island" to accelerate the deployment of an advanced information infrastructure. In Germany, the government has launched a major modernization program called "Telekom 2000" to rebuild the communications network of the former East Germany and link it to the western part of the country. And France, which already has established an advanced information network in Minitel, has identified telecommunications as its "Great Project" for the 1990s.

The United States has chosen a different course. While many of our major competitors rely on centralized government planning, we rely on demand-driven, competitive policies. As a result, market forces tempered by regulatory restraints drive the deployment of new technologies in the United States. The market environment has made U.S. industry extremely flexible and responsive to changing consumer demands and new technologies. It is essential that we preserve this strength.

In doing so, however, we must not ignore the need for public policy reform. In many respects, the U.S. regulatory framework, particularly in telecommunications, is a hold-over from the 1930s. America's legal and regulatory bodies are fragmented and have trouble keeping up with advances in technology. The Federal Communications Commission and the 53 public utility commissions disagree about key issues, and Congress and the National Telecommunications and Information Agency are weighing in with their own proposals.

The policy issue facing the United States is not centralized government planning vs. decentralized markets. The nation has reaped enormous benefits from its market-oriented, competitive strategy and will undoubtedly continue to do so. Instead, the policy challenge is to find



the appropriate balance of regulation, competition and cooperation. While we have structured a system of keen competition in the United States, we are poorly organized when it comes to government/industry cooperation on issues affecting the broader national welfare.

This lack of cooperation may well be America's Achilles' heel when it comes to rapidly deploying an advanced information infrastructure. Many of the expensive elements, such as long distance fiber networks and computers, are already in place. So are millions of potential users. What is in short supply is the ability of different parties to work together to define and deploy key elements and interfaces.

Because the information infrastructure is so all-encompassing, because the need for interoperability and interconnectivity is so critical, and because other nations are moving so aggressively, it is urgent that the United States find better ways to coordinate its activities.

What is our vision?

The vision for the future of America's information infrastructure can be easily described and is widely shared: The information infrastructure of the 21st century will enable all Americans to access information and communicate with each other easily, reliably, securely and cost-effectively in any medium — voice, data, image or video — anytime, anywhere. This capability will enhance the productivity of work and lead to dramatic improvements in social services, education and entertainment.

The information infrastructure can be divided into four parts:

1) A set of widely accessible and interoperable communications networks.

2) Digital libraries, information data bases and services.

3) Information appliances and computing systems that are easy to use.

4) Trained people who can build, maintain and operate these resources.

Each of these is dependent on the others. The evolution of the overall infrastructure will depend on policies that govern access, cost, use, ownership and competition.

The communications system usually receives most of the attention. Here, too, there is broad consensus among government, industry and the American public. The communications system of the future, like the network of today, will be made of wire, fiber or radio waves, or encompass all of these media. It will be a diverse collection of variable bandwidth, digital, interoperable, interactive, commercially provided,

organic networks that are easy to use and universally accessible:

• Diverse because different networks serve different needs and have different characteristics.

• Variable bandwidth because they must carry not only voice, but also image, video and high-speed data.

• Digital because of the ease and accuracy with which digital information can be stored, transferred, moved and managed.

• Interoperable because different networks must be able to communicate easily.

• Interactive because of the need for point-to-point communication.

• Commercially provided because a competitive marketplace ensures the widest range of services and products to the greatest number of users at affordable prices and because private capital is needed for the investment.

• Organic because they will develop at different times and places depending on market needs.

• Easy to use so that they can serve the needs of the broad public.

• Universally accessible because every American should be able to utilize them.

Describing the communications networks alone, however, fails to capture the full scope of the information infrastructure. What is important is the ability to assemble all the necessary technical elements on demand to satisfy a specific market need. The networks are critical because they can make that assembly possible with relative ease in a cost-effective way. They do not, however, take into account issues related to the data banks, computing systems and human resources that are critical elements of the information infrastructure or to the economic development and quality-of-life goals that must drive it.

Although it may be easy to describe the physical characteristics of communications networks, it is very difficult to conceptualize the information infrastructure in its entirety. The infrastructure is more than just electronic equipment and components, it also is the system of services, relationships and activities that are built around them. Just as the interstate highway system would be useless if it did not have local roads, automobiles, gas stations, motels, driving rules, police, insurance companies, maps and road signs, so too will communications networks be useless unless they are supplemented with training programs, data bases, computing capabilities, software protocols, standards, security systems, intellectual property laws and services that support economic growth and societal well-being.

In order to develop public support for the many diverse elements of the information infrastructure, it will be necessary to demonstrate its utility to the American public. Many documents have described its revolutionary impact on such fields as health care, entertainment, manufacturing, transportation and education. There is no doubt that an advanced information infrastructure will fundamentally change these sectors, but its full implications go beyond the impact on any one industry. →

In many ways, the most important aspect of the evolving information infrastructure is the new system of services, social concepts and international connections that it will enable. In basic ways, it will transform people's habits, perceptions, values and relationships. Just as the industrial revolution served as an agent of massive cultural change a century ago, so too will the ongoing information revolution. An advanced, easy-to-use information infrastructure will be the vehicle for much of this change.

These developments are as hard to quantify as they are to predict, but several trends are worth noting:

"Rather than take people to services, services will come to people."

- First, rather than take people to services, services will come to people. Instead of going to libraries to do research, students will access data from information appliances. Instead of going to a physician's office for routine check-ups, patients will communicate with doctors and exchange vital data electronically. Instead of going to City Hall and waiting in line, citizens will be able to access the necessary information from their homes, their offices and their schools.
- Second, personal communications will be available to people anytime, anywhere. New systems will go beyond mobile telephones and pagers to include devices that combine portable computing, video and communications systems.
- Third, different business activities, both within a single company and across different business enterprises, will be integrated regardless of geographic location. Within companies, marketing, R&D, finance and manufacturing will be able to communicate easily and instantly, despite the fact that they use different equipment, deal with different kinds of problems and may be thousands of miles apart. Perhaps even more importantly, companies will be able to form new kinds of alliances, consortia and joint ventures. The virtual enterprises that result will represent an entirely new business model that will have a major impact on the organization of work.
- Fourth, individuals will be able to access unique equipment that is often continents away, such as specialized manufacturing design tools, telescopes, supercomputers and sophisticated measurement devices. This access will allow individuals to remotely manipulate, measure and interact with these resources. In the process, it will put the power of advanced technology into the hands of many who cannot afford it today.
- Fifth, as more and more people gain access to technology, new waves of innovation will be unleashed. As entrepreneurs realize the potential of an advanced information infrastructure, they will use it to develop a host of new products and services. And as scientists and engineers realize its capabilities, they will use it to drive R&D and new applications.
- Sixth, there will be far-reaching economic implications. As information assumes a more pivotal role in the economy, those without access to it or training to use it will find themselves disenfranchised. This division between information haves and have-nots represents a potential dark side of the information revolution. All Americans share a responsibility to avoid a more severe polarization between the privileged and underprivileged. As a result, both government and the private sector must pay careful attention to issues of equity, affordability and access.

These six changes will not only have a major impact on the everyday lives of Americans, but also on our relationships with other countries. As U.S. public policy attempts to come to grips with these challenges, the government should bear in mind the fact that the best way to enable the creation of an advanced information infrastructure is to let competitive forces work constructively in the marketplace. The following six principles are helpful rules of thumb:

1) *The user comes first.* The main goal of public policy should be to provide users with the maximum possible levels of choice, service and mobility, with due respect to privacy, confidentiality and security. It must also address the need for fair and open access.

2) *Affordability and ease of use are essential.* Public policy should continue to encourage the private sector to minimize costs and maximize choice and quality across all segments of the infrastructure. It also should encourage the development of systems that are easy to use, widely accessible and interoperable.

3) *Flexibility and responsiveness to market demand are key to success.* Although some features of the near-term information infrastructure are clear, others are not, as is to be expected from a rapidly evolving technology base and changing market needs. A key goal of public policy should be to facilitate the ability of industry to take advantage of new technical developments and address shifting market needs.

4) *The regulatory process must be even-handed.* The policy context should be industry-neutral and technology-neutral so that it impartially promotes those applications that are efficient and affordable for individual consumers and companies of all sizes. It also should be structured so that it encourages systematic private sector investment.

5) *A coordinated, systems-level approach is crucial.* Just as companies must coordinate the activities of different divisions, so too must the government coordinate its R&D programs, procurement polices, regulatory decisions and pilot projects both with each other and with the private sector.

6) *Domestic programs must be sensitive to international concerns.* U.S. public policy must take into account the international dimensions of information infrastructure, including such issues as connectivity, intellectual property, competitiveness and the evolution of U.S. networks compared to those overseas. **CT**

By Caitlin Bestler

Part 1: Conditional access control systems for HFC

The cable TV system operator is faced with a wide variety of new digital service options. However, despite their hype, new digital services can be cost-effectively deployed only if they supplement, rather than replace, existing analog services. Supporting a variety of decoding devices (analog, analog interactive, digital, hybrid analog/digital and data modems) requires a single consolidated conditional access control system. This is Part 1 of a two-part article.

The expanding scope

The conditional access control system (CACS) has traditionally been referred to as the addressable set-top control system. With the expansion of new digital services it will be dealing with devices beyond the classic "set-top box" (STB) and with a far wider range of services. As the range and complexity of the accessed controlled services expands, the CACS must expand with them.

The simplest possible addressable control system would be one managing a subscription-based one-way cable system with out-of-band messaging to individual decoders. The functions of such a system can be very simple:

- Edit an authorization bitmap for specifically addressed decoders.
- Specify which bit controls descrambling of a specific channel. In fact the control system does not even have to know what channel it is, only a scrambler address is required.

Then add pay-per-view (PPV) support and in-band addressing can be used to reduce set-top cost and increase security. Now the CACS must:

- Dynamically map specific bits in the authorization bitmap to PPV events.
- Dynamically change the instructions to the scrambling equipment on a real-time basis.
- Repeat circulation of authorization edits to allow eventual reception by decoders that are not tuned to an encoded channel at the moment.
- Use background circulation to deauthorize bits it decodes after PPV events have finished.

This evolution has continued as the CACS has had to deal with electronic program guides (EPGs), real-time impulse-PPV (IPPV) ordering, store-and-forward collection of self-authorized IPPV purchases, channel monitoring, status monitoring, downloadable software, back-to-back PPV on multiple channels (rather than one or two events a month) and evolving conditional access protocols trying to add new features and be more pirate-resistant while maintaining control of decoders already in the field.

Part of this expansion dictates the shift from the terminology of an STB control system. The conditional access controls far more than STBs, and it controls them in ways far more profound than simply allowing or disallowing access to specific programs. For that reason this article will refer to "subscriber terminals" when dealing with the whole functions of the STB and "decoder" when referring to those functions related solely to conditional access. To be precise, the "decoder" is just one part of the whole subscriber terminal.

The true common denominator is control of access to material that is distributed in a multicast or broadcast fashion, as opposed to via a switched system. This material is no longer just NTSC channels, but can include digital data in many formats. It is no longer directed solely to a box that sits on top of a TV set. Targets include data modems, addressable cable-ready devices, set-back descramblers and interactive decoders that provide a variety of services through on-screen displays beyond simple access to the broadcast material.

As new digital services are added to cable systems the role of the CACS will continue to expand. What those expansions are — and why they are expansions rather than a separate control system — will be explored. However, to do so we should survey the likely service mix after the addition of digital services to an existing cable system.

Analog/digital service mix

Deployment of hybrid fiber/coax (HFC) architectures and new digital technologies combine to present a wide variety of potential new CATV services:

- Digital point-to-point, or switched digital, services such as video-on-demand (VOD) and other intensely interactive multimedia applications requiring point-to-point client/server sessions between video server and the set-top decoder.
- Broadcast digital applications, such as near-VOD, digital movie channels, multiplayer games, program-associated data services. (For example, *Monday Night Football* with user-selectable statistics and multiple camera angles, or play along with *Wheel-of-Fortune.*)
- Telephony services.
- Data modems for home PCs.

These typically provide local area network (LAN)-like connectivity. They can be symmetrical, aiming at fuller service such as "work-at-home," or for the more complete hobbyist; heavily asymmetric "download-only" modems intended largely to download data from bulletin boards to the home PC.→

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on the market for only a short while, the number of products available is growing at a fast pace. In fact, market analysts claim the ATM market will grow from $415 million in 1995 to over $5 billion in 1999. Early adopters include users in a variety of industries: aerospace manufacturing, agencies within the Department of Defense, the entertainment industry, financial institutions, high tech firms, petroleum companies, pharmaceutical firms, publishing companies and universities.

These early adopters share some common traits. Their networks are mission-critical. Their business suffers financial loss if networks are not fully operational and capable of delivering high-speed and required bandwidth.

Early adopters typically have very large, cumbersome networks using many different protocols and linking many locations. Twenty-thousand nodes or more are not uncommon. Typical of the complexity of networks is one user's description of his desktop that includes a Macintosh using

Networking alphabet soup

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operating at 16 kbps, to be carried over a single twisted-pair copper wire.

Broadband: Any communications system able to deliver multiple channels or services of video, voice or data to its users or subscribers using RF spectrum.

CAP (competitive access provider): An alternative carrier that competes with telephone companies in carrying traffic.

CBR (continuous bit rate): A higher priority ATM traffic type that guarantees that a sustained traffic rate is guaranteed across the network.

CCITT (Comitre Consultatif Internationale de Telegraphique et Telephonique): An international group operating under the auspices of the International Telecommunications Union and charged with establishing telecommunications standards. The name was changed to ITU-TSS (International Telecommunications Union-Telecommunications Standards Sector).

CDMA (code division multiple access): A transmission scheme used by some cellular carriers derived from spread spectrum techniques used by the military. Claimed to be more efficient than other systems and to offer up to 20 times more call handling capacity than analog cellular systems.

Cell relay: A packet switching technique that uses cells of uniform length. Cell relay is well-suited to video transmissions, where the predictable arrival of packets in proper order is important.

Central office: The telephone company facility housing the switches and other equipment that provide telephone service for customers in an immediate geographical area.

Circuit switching: The type of signal switching traditionally

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• Traditional analog services, including basic, subscription and IPPV services.

Services unrelated to conditional access

The CACS does not have to be involved in all services on the cable system. Nor should it. Frequency division multiplexing (FDM) can allow multiple services to exist largely independent of each other. Management plane configuration must assign frequencies to given applications; the services can manage on their own after that.

There is little benefit to having the CACS manage telephony services that happen to occur on the same HFC plant. A telephony control system is part of a vast distributed end-to-end system, and its primary requirements are in dealing with those existing interfaces. More importantly, telephony is generally a point-to-point switched service. Unauthorized material does not enter the home. There is no need to descramble or decrypt the material.

There are, however, many HFC services that naturally benefit from being under the same control system. As will be explained later in this article, control of all set-top decoders, whether analog and/or digital, is the primary example of this.

Other services also can benefit from broadcast conditional access delivery. There is no reason that downloading of data cannot be broadcast to multiple homes. Computer LANs are mostly broadcast conditional access systems. The Ethernet line passing your PC carries far more data than is addressed to your machine.

Control of data products has traditionally been separate from set-top control systems. However, deployment of high-speed digital modulation techniques, such as 16-VSB or 256-QAM, can benefit both digital set-top decoders and data modem products. Support of download-only data modems and/or sharing of downstream capacity within a 6 MHz channel are potential benefits of cooperation and/or merging of the set-top and data services control systems.

Digital services cannot simply replace analog ones. Even if replacing all current analog set-top decoders were feasible, customers still would be entitled to connect their cable-compatible TV sets directly. This requirement will probably continue for as long as there are NTSC broadcasts.

Cable-compatible TV sets will not be the only analog devices connected to the network. Analog subscriber terminals (STs) will remain a cost-effective part of the service mix. Replacing analog premium services cannot be justified with the current economics of digital delivery and decompression. The inherent premium of digital capability for an addressable ST is \$200 to \$300. Even allowing a generous 100-month pay-back schedule, a digital-capable ST would require an extra \$2-\$3 of profit per month from every customer of premium services. That would typically translate into an additional \$4-\$6 of material sold per month from every premium customer.

As direct broadcast satellite (DBS) systems have demonstrated, there are definitely videophiles who will will-

ingly pay the premium for the benefits of digital delivery and/or vastly improved quality and selection. But there are far more customers who will just want to subscribe to HBO and buy two or three IPPV movies a year.

material is a more viable option:

• The amount of simulcast material could be reduced drastically.

• A greater portion of premium material may be available from satellites in MPEG format anyway.

"New digital services can be cost-effectively deployed only if they supplement, rather than replace, existing analog services."

Digital delivery may give cable system providers several hundred extra channels, but can they get $4-$6 per month from every customer for the *last* few hundred channels in the lineup? The question of coexistence of analog and digital services comes down to the following:

• Existing cable-ready customers are not going to buy digital TV sets just to allow you to convert.

• Most of your existing customers for premium services are best serviced with analog or analog interactive subscriber terminals.

• A minority will benefit from digital services and can justify digital set-top decoders. While they are a minority they are willing to pay for delivery of digital services.

Analog and digital coexistence

Both analog basic and premium services will continue to be part of cable plant spectrum. It will be a hybrid analog/digital plant. But how will digital customers access analog services? Ultimately there are three options:

1) Simulcast analog material in digital format for digital customers.

2) Allow the digital ST to receive the analog material.

3) Bypass the analog material to later devices.

Bypassing *all* material requires a two set-top solution, or at best a digital set-top and analog set-back. This is clearly a consumer-unfriendly solution. Simulcasting all material would be expensive both in terms of bandwidth required and headend real-time MPEG encoding equipment. It does, however, allow the simplest digital set-top decoder. Simulcasting all premium

• Security for digital delivery is inherently superior.

• The best way to deliver material that arrives in MPEG format is in MPEG format.

The major alternative to simulcasting analog premium services is to require the digital set-top decoder actually be a hybrid analog/digital set-top decoder that includes the ability to descramble controlled analog channels. This will increase the cost of the set-top decoder by as much as $50, but may be cost-justified compared to the cost of increasing the capacity of an existing plant.

Bypass human factor problems

Bypassing any analog material is inherently consumer-unfriendly. With the bypass approach, consumers access analog services with their TV set or VCR and only use the set-top for premium digital services. To switch between analog and digital services the viewer must turn the digital set-top on or off. This is a *deliberative* step. It probably requires switching remotes, or at least flipping a mode button on the remote.

"Channel up" and "channel down" functions will not surf between digital and analog modes. Once using digital services a viewer will be prone to continue viewing digital services. More importantly, once digital services are turned off there is little to remind a viewer to check out what is available there. Viewers may reduce their network viewing, but they will not eliminate it.

Bypass also interferes with VCR control and electronic program guide (EPG) functions. Consumers want to be able to use their STB to schedule taping of *any* program, not just digital premiums. A program guide that only lists some of the channels available is of little use. Similar problems exist for "favorite channel" and "parental control" functions. Consumers will not like having to perform these functions twice.

One of the key advantages that cable TV has over DBS is providing a complete entertainment delivery system. DBS already offers the consumer unfriendly, non-unified access to local material. This is an opportunity for the cable TV provider to offer an improved service.

Hybrid analog/digital STs

Given the consumer-friendliness factors and the high cost of a complete simulcast, clearly the best solution for the cable system operator is to have a hybrid analog/digital set-top decoder with the following capabilities:

• The ability to select and tune digital and non-premium services.

• The ability to use an on-screen display over analog or digital video.

• The ability to access analog premium services either through headend simulcasting or by incorporation of the analog descrambling and conditional access logic. (Simulcast of all analog premium services reduces the set-top decoder cost, but increases the bandwidth requirements of the plant. Which is more cost-effective will depend on the value of the last 6 MHz channels available, the cost of increasing the plant's downstream capacity, and the number of hybrid set-top decoders that would be ordered. If hybrid set-top decoders are a significant minority, say under 5%, then simulcasting would not be cost-effective.)

Broadcast and/or point-to-point?

Advocates of digital services frequently talk as though digital delivery was synonymous with digital point-to-point delivery. A switched digital delivery system does indeed provide a very flexible system for delivering a wide variety of services to a customer. (A three-shift crew of personal chauffeurs also is very flexible. The question is whether it is cost-effective enough for mass deployment.)

Even for point-to-point delivery, a broadcast conditional access system can be an effective solution, particularly until digital penetrations become

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very high. Switched delivery reduces subscriber terminal cost, but increases network cost considerably. This equation is unfavorable unless the network equipment is charged to virtually every home passed.

A telephone provider may find this attractive if it is intending to charge the cost of the switching system to its captive telephony customers. A cable TV provider will not have such high penetrations of digital services, and already owns a broadcast distribution system. Further, a broadcast conditional access system supports point-to-point delivery well, even while being optimized for multipoint delivery. However, even within a broadcast conditional access system, point-to-point delivery has some inherently bad economics in its definition:

• Some video and/or application servers have at least a portion of their capacity tied up delivering programming to a single customer.

• The network is tying up delivery resources carrying a signal to a single customer.

• This end-to-end service still has to compete with the local video rental store. Their cost of delivery is under a dollar per hour of delivered movie.

The cost of the video server and delivery resources is simply too high to support playing movies for single customers. This equation can be corrected in one of two ways:

1) Increase the value of the material being presented. Offer services other than movies. A multiplayer game could be structured as a low-priced alternative to an arcade and still command more per hour than a movie. Phone 900 services command the same or higher prices a minute than the market will bear for renting an entire movie.

2) Increase the number of people the material is delivered to (i.e., broadcast it).

DBS systems have shown that there is a market for digitally delivered prescheduled movies. How much consumers will pay for the convenience of having a movie *instantly* is still speculation. How much consumers will pay for other advanced interactive multimedia applications is still speculation. DBS has demonstrated a proven market. Therefore a cost-effective way to deploy digital services is on a broadcast conditional access basis. To the extent that it can be done without increasing costs, allowing the addition of point-to-point services is a valuable growth option.

System requirements

At first glance it would be tempting to simply add a set-top decoder control system for each totally new class of decoding devices. However, doing so may lead to several disadvantages. The need for a single control system managing analog, digital and hybrid addressable decoders can be easily summarized:

• Any single decoder should be managed by a single addressable CACS. Hybrid decoders would access both analog and digital premium services.

• Any single premium service should be managed by a single addressable CACS. Analog premium

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services are received by both analog and hybrid decoders.

Further advantages of a single consolidated system will become apparent as we discuss other functions of the CACS. The functions of the CACS that will be discussed are:

- Transport stream mixing.
- Customer navigation — How does the viewer access the services desired?
- Conditional access — Ensuring that only authorized STs can receive specific material.
- Real-time upstream — Control of the real-time two-way system is typically bound with the addressing logic of the conditional access protocols. The primary purpose of the real-time two-way system has ultimately been the sale of IPPV programming.
- IPPV ordering — Real-time transaction processing to purchase/cancel IPPV programs. Requiring all orders to pass through a subscriber management system or other cable system provider computer will produce an unacceptable bottleneck. A real-time CACS can process IPPV orders at phenomenal speeds.
- Application support for downloaded ST applications.
- Plant/ST status monitoring. Every downloadable two-way ST is a piece of real-time plant monitoring equipment. Used properly the cable system provider can know when there is something wrong with the plant — and fix it — before customers know something went wrong.

Transport stream mixing

Before the addition of digital services the CACS had a very simple model of the routing of signals:

- It controlled NTSC scramblers that received either IF or RF input. The potentially scrambled output would be delivered to STs at a stable, configured frequency.
- It might have to download a "channel map" to the STs. At worst it would support different channel maps for different sections of the plant.

The CACS did not have to worry about IF and RF routing for the simple reason that cable system providers did a capable job of managing it themselves. Functions such as ad insertion were generally performed transparently to the CACS and the STs. This model can still be applied for all analog feeds; MPEG transport streams are a different story, however.

MPEG transport stream mixing

Continuing to manage digital services routing on a 6 MHz channel basis would be possible but certainly not desirable for many reasons:

- Material may be provided that is distributable as a 6 MHz channel, but it is a fairly large chunk of programming. If the material must be accepted on a take-it or leave-it basis the cable system provider has lost control of the packaging of the services provided to customers.
- All allocations must be in multiples of a full 6 MHz. What if local material requires 40 Mbits? If either 16-VSB or 256-QAM modulation is used, then most of second channel allocated is wasted.
- All allocations are static. Dynamic or time-of-day adjustments are not possible. Usage of data services and TV entertainment services could be inversely related, especially if there are corporate users of data services.
- Satellite feeds are carrying more than just the MPEG A/V material — there are MPEG directories along with network directories and EPG data. If material is accepted from multiple sources, the network directories and EPG data can easily be in different formats.

The cable TV network provider should be free to deal with all of the following types of MPEG material:

- *Primary* feeds are those that the source provided as complete MPEG transport streams. They contain full MPEG directories and typically network directories to give logical channel lineups. They also may contain EPG data. The full directories are especially likely to be present in stable feeds that are supplying multiple logical channels on a continuing basis. On-demand feeds, used for VOD and other point-to-point applications, are more likely to supply only the required MPEG directories.
- *Ad insertion* feeds supply MPEG transport streams for digital ad insertion. This material must be synchronized within the headend component of the control system to replace the default ad from a primary feed at the specific "splice" points without requiring the ST to change anything about what it is viewing. Note: Downloaded applications also can support *targeted* advertising where the ST deliberately and actively selects a different ad feed based on demographic and/or viewer preference data. But that is another application.
- *Advanced TV* (ATV) feeds are feeds from digital broadcasters (for example, high definition TV). These feeds will be 8-VSB Trellis modulated. If remodulated to 4-VSB they can be passed through without modification or jitter. If remodulated to 16-VSB they can be passed through without modification or jitter, but additional material can be mixed into the same 6 MHz channel.
- *Data router* feeds carry data in MPEG transport packets that can be jittered, but should be routed as quickly as possible. The port would be configured as to which elementary streams (such as the program IDs, or PIDs) the data router could use, and the peak and sustainable rates that can be relied upon. The data router will probably have additional 6 MHz channels fully under its control, but these feeds allow allocation of downstream capacity in increments of less than a full 38.6 Mbits.

Transport streams

To understand mixing of MPEG transport streams, it is important to distinguish three different types:

1) The *source transport stream* is the transport stream as it is input to the mixing process.

2) The *frequency-specific transport stream* contains the end result intended for 6 MHz delivery. It combines one or more indivisible source transport streams.

3) An *indivisible source transport stream* is a subset of a source transport stream that must be delivered on a single frequency-specific transport stream to provide one or more cohesive services. It can be specified either as one or more ongoing logical services or as specific MPEG programs. Typically it represents a series of single MPEG programs.

Source transport stream mixing is ultimately done on a packet-by-packet basis guided by the PID of each packet. However this low level mechanism needs to know which PIDs should be routed to which frequency-specific

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transport stream. Doing this requires first identifying indivisible source transport streams and then assigning them to frequency-specific transport streams.

Indivisible source transport streams

Indivisible source transport streams could be identified in any of the following ways:

- In source-specific manner according to that source's network directories. (For example, a satellite feed may be structured to concurrently support both 64-QAM and eventual 256-QAM deployment.)
- Based on logical or viewer-perceived channel assignments within the source network directories.
- Based on MPEG program IDs (PIDs) and prescheduled assignments.
- Based on MPEG program IDs and ad hoc real-time assignment. Each MPEG program is declared to be an indivisible source transport stream and given a designation equivalent to the "logical channel carrying MPEG Program #579."

Note that individual elementary streams (and hence PIDs) may be part of more than one indivisible transport stream. This is generally avoided when possible since it requires duplication of those PIDs. It would always be avoided when the elementary stream contains audio/video data.

Indivisible source transport streams assigned

Each indivisible source transport stream can be assigned to a frequency-specific transport stream or it can be marked for deletion. With spontaneously identified single MPEG program "logical channels" this may have to be based on a formula and availability.

MPEG transport stream mixing

Mixing of MPEG transport streams can be supported at three different levels:

- *Not at all.*
- *Split with limited addition.* Each primary feed goes to a single frequency-specific transport stream, or if required is split into *N* frequency-specific transport streams. MPEG directories are split if required, but no modifications are made to source PIDs. Additional material can be added only if the source can be instructed by the CACS on which PIDs to avoid.
- *Full mixing.* Each frequency-specific transport stream can be filled as close to capacity as possible based on the peak and sustained rates for each indivisible transport stream. Directories must be fully reconstructed. Additional network directory entries must be added to allow applications to access material even if they only know the original directory information.

Viewer navigation

Just delivering MPEG transport streams to the subscriber terminal is inadequate. The ST must know how to present the material that is available and how to navigate it. The ST software responsible for this function acts as a client of the CACS and is an integral part of it. One method assigns these functions to separate subscriber terminal software modules:

- One module deals with the basic viewer control for selecting and accessing material. It changes channels, turns the set on and off, mutes the sound, etc. It is designed to be indifferent to any effects of MPEG transport stream mixing.
- The other module is responsible for understanding network services, including how to see through the effects of any MPEG transport stream mixing and deliver the desired material under its source designations.

The viewer control software module wants to know the following about each logical service:

- If it is directly selectable (a channel name and logical channel number.)
- At the current time, any program description of the service.
- At the current time, what conditional access constraints are on the channel, and if the ST's decoder is not authorized for it, what alternate material should be accessed.
- Whether there is any downloadable behavior associated with the program. **CT**

Part 2 will run in a future issue.

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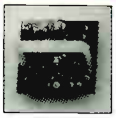

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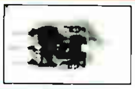

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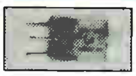

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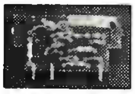

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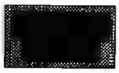

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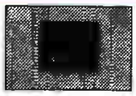

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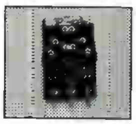

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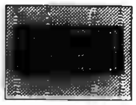

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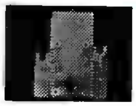

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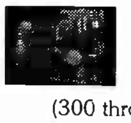

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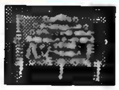

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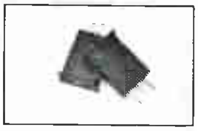

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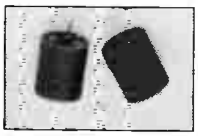

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> **"Market analysts claim the ATM market will grow from $415 million in 1995 to over $5 billion in 1999."**

Appletalk for printer sharing, an Ethernet connection to the company LAN, and IRMA board to communicate to an IBM mainframe. His office also has a PBX. None of these network solutions connect to one another. If one network topology could replace all of this equipment, then, to this early adopter, it has justified its cost.

Most early adopters have a need for widespread communication throughout large regions and to remote locations. As with many large networks, they find that their current networks are overloaded and carry a high price for management and maintenance. One hub or router per 10 ports is not uncommon.

Additionally, these users need a robust network and access to networks that can handle transmission of uncompressed images. Such files are very large and can take about an hour to transmit over existing networks. During that hour, document receivers experience frustration and lost productivity. ATM provides the capability to schedule the transmission of large files throttling to avoid affecting the throughput of other users.

Some early adopters also plan to integrate voice into their networks because current expenses for voice transmission are typically double that spent on data transmission. These costs can be

Networking alphabet soup

(Continued from page 61)

used by telephone companies to create a physical connection between a caller and a called party.

Client/server: A distributed computing architecture in which numerous dispersed terminals, each of which has its own central processor and memory, communicate with centralized processing, storage and output resources. In a client/server network, the client is a front-end resource for a user, while the server represents the back-end set of resources. Servers include devices such as mainframe computers, mini-computers, personal computers, hard disk and other types of memory devices. Clients typically are personal computers. Client/ server also is a concept used by software programs running on distributed computing platforms. In a cable TV context, a client is a set-top terminal or other intelligent device at a customer premises.

CPE (customer premises equipment): The telecommunications equipment located on a customer's premises. Usually refers to key systems, private branch exchanges (PBXs), telephones, etc.

DLC (digital loop carrier): A digital transmission system designed for subscribers loop plant. Multiplexes a plurality of circuits onto very few wires or onto a single fiber pair.

Ethernet: A data communications protocol operating at up to 10 Mbps.

ESP (enhanced service provider): The Federal Communicaitons Commission defines enhanced services as "services offered over common carriers transmission facilities ... which employ computer processing applications that act on the format, content, code, protocol ..." Therefore an enhanced service provider operates, in one way or another, on the information being transmitted.

FDDI (fiber distributed data interface): A standard

By Bruce A. Weintraub

Service calls: Get it right the first time

This is the first article in a three-part series. Parts 2 and 3 will cover installations and preventive maintenance, respectively.

Ten years ago, service calls, although serving the same purpose as they do today, were not treated as a true requirement of staying in business. Attitudes ranged anywhere from, "Our technician is on vacation for two weeks and will take care of your problem as soon as he returns," to the more realistic, "Whaddya mean you have snow on your TV set? It's the middle of summer!"

Obviously, today, those companies would be out of business.

"The technician should listen patiently to the customer's explanation of the problem."

Customer service is no longer just answering phones and taking orders, or registering complaints. Every member of a cable company is involved in servicing the customer base, particularly the service technician. Typically a customer only has three kinds of contact with the cable company. First, at the point of sale; second, and arguably the most important, the point of installation; and third, when the customer has a problem. It is the cable company's response to that problem that will determine whether or not we have a long-term customer or whether we will lose that customer to a local competitor.

This article is addressed not only to the technician but to the support group that has the responsibility to ensure that our customer contact personnel have the tools to do the job and —*get it right the first time!*

Preparation

In addition to the obvious (clean pressed uniforms, neat professional appearance and well-spoken manners), service technicians must exude confidence not only in their abilities to solve a problem but in the company's capability to keep a problem from occurring again. In order to accomplish this, the technician must be trained both in industry specifications and test equipment procedures. Each service tech should have a basic complement of tools that includes the following:

- Tool belt/hand tools
- Volt ohm meter (VOM)
- Field strength meter (FSM)
- Test TV set
- Signal leakage meter (SLM)
- Toner
- Locator
- Time domain reflectometer (TDR)
- Measuring wheel

Additionally, for cleanup you'll need:

- Glass cleaner/wipes
- Tie wraps
- Small trash bag
- Shoe/boot covers

Prior to arrival at a new job, an attempt should be made to contact the customer, not only to make sure he is at home but to ensure he is still experiencing the same problems as reported.

Initial fact finding

Upon arrival and confirmation that a service problem does exist, the technician should listen patiently to the customer's explanation of the problem and ascertain the following:

- Nature of the problem
- Date problem began
- Time of day problem began
- Is the problem on all TV sets (if additional outlets are involved) or just one set?

After obtaining this information, have the customer show you the problem as he or she experienced it prior to performing any corrective actions. I will not get into specific solutions to problems (I don't think this magazine is large enough to handle that, nor do I have the time), but I do want to describe specific troubleshooting methods and preventive practices that will not only keep referrals and return visits down, but will leave the customer pleasantly surprised and pleased with the service obtained.

Analyze the situation

Are pictures snowy or nonexistent? Does the TV set/converter turn on? Is the problem related to distortion products such as ingress, ghosting or beats? Once this basic information is ascertained, begin troubleshooting the problem by

Bruce Weintraub is vice president of engineering and operations for SBC-Media Ventures, based in Rockville, MD. He also is the chairman of the Society of Cable Telecommunications Engineers' Subcommittee on Maintenance Practices and Procedures.

blocking out the trouble area. There are three basic areas to be concerned with in a basic service call. These are:

- Tap to ground block
- Ground block to wall plate
- Wall plate to TV set (including the converter if utilized)

Since you are already inside the home, begin by taking signal readings at the wall plate for problems such as snowy or no pictures. Signal strength at this point should be 0-6 dBmV at both high and low frequencies. Depending on the length of the drop, this may vary somewhat in range due to attenuation at your high frequencies, but under no circumstance should the input to a TV set be less than 0 dBmV. If signals are lower than this level, then it's time to go outside and check the ground block. If signals at this point do meet specification, then verify all connectors are correctly prepared and the TV set/VCR tuner is properly fine-tuned.

If pictures are still noisy check the carrier-to-noise ratio (C/N) using your FSM, or use a test TV set to verify that the noise is coming from the cable system and not being generated by the customer's TV set itself. If in fact your C/N is less than 44 dB at the tap, notify your supervisor to refer the call to a line/maintenance technician. (FCC specifications call for 44 dB C/N at the TV set.)

Before checking the signals at the ground block, ensure that the drop has been properly bonded to a local utility ground or a (confirmed) metal cold water pipe (not PVC). After confirming proper bonding or installing it as necessary, briefly examine the area between the tap and the ground block, looking for any irregularities (frayed cable from trees, squirrels, etc.) in an aerial area or landscaping/construction in an underground area. If there is nothing obvious, take the next step and check levels at the ground block on the input side of the ground block, thereby isolating the area between the ground block and the TV set. Utilizing the same measurement methods at this location verify levels at the input. If levels are good at this point (nominally 3-9 dBmV), then check and repair/replace the defective components in between, including but not limited to the ground block, fittings, splitters, wall plate or connecting cable. If levels are not good at this point, then it's time to check output levels at the tap.

When checking levels at the tap, first roughly calculate the required level needed to service this particular residence. You should be familiar with the types of cable used (RG-6, RG-59 or RG-11) and know their respective attenuation at the high and low frequencies on your system. Typical design parameters call for tap outputs to be at least 12 dBmV at the high frequency — and in many cases greater than that depending on drop size and length. If your measured levels are less than that required to provide a measured 3-6 dBmV at the ground block then there is a problem somewhere on the distribution system and the call should be referred to a maintenance technician. If possible, you should work with the referral technician in order to learn more about troubleshooting distribution systems. If you find a good, quality signal at the tap, then you have narrowed your problem down to the drop, or one of the connectors at either end.

Since you have already ensured that the connector at the ground block end was in good shape, first verify the connector at the tap and repair if necessary. If this is found to be in good shape also, then it is time to examine the drop. If the drop is aerial, some defects will be visible to the naked eye, such as lightning damage or squirrel-chewed cable. However, if it is in an underground environment, the use of a TDR will be required. This device is used as a fault locator and will identify either a short or open in the cable. Depending on the quality of the TDR it also may display conditions such as water damage. Typically, the TDR will display a footage readout to enable the technician to easily locate the problem, expose the cable in that area and, if possible, repair the break or damage by splicing in a good piece of drop cable. If damage is extensive, an order to replace the cable should be placed with your dispatcher.

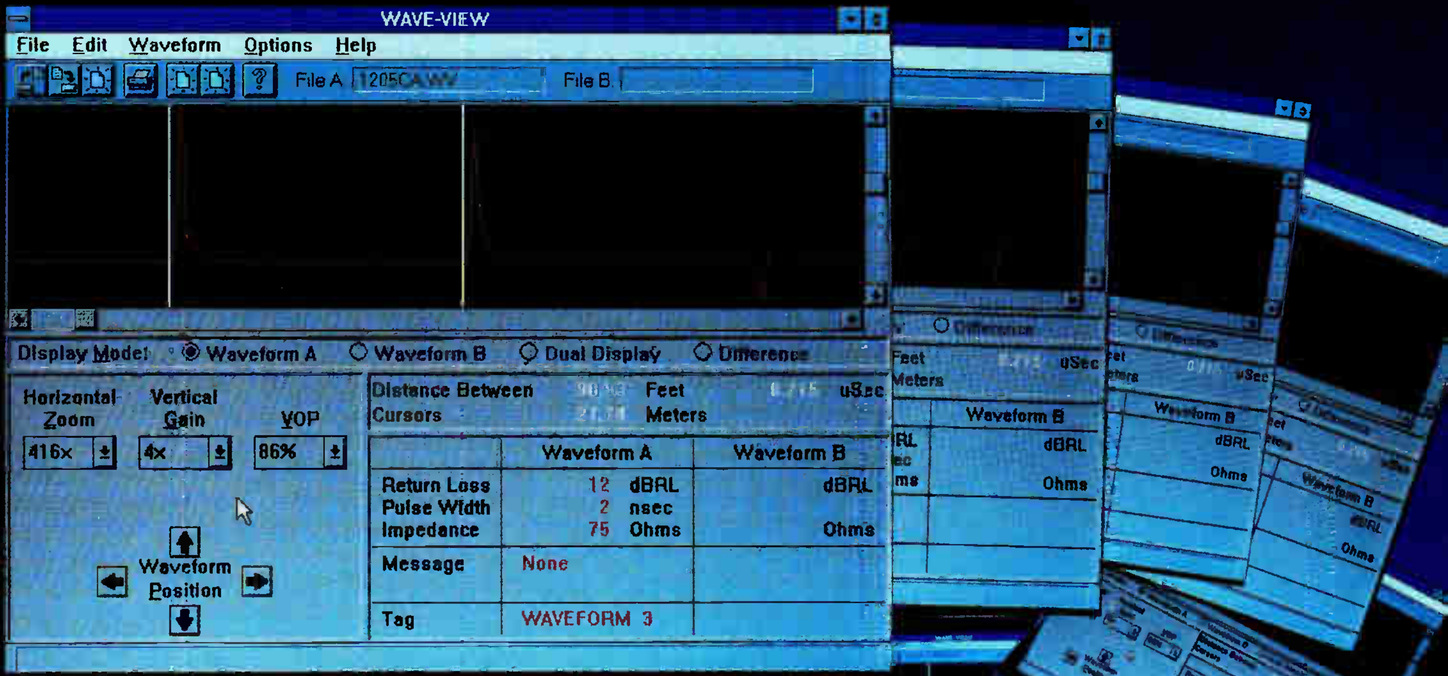
Cleaning up

Prior to leaving each job, after assuring that the customer is satisfied with your performance and the quality of service provided, take the time to do the following:

1) Make sure all fittings are tight and secured.
2) Check all ground connections for clean contacts.
3) Pick up all debris from your work area.
4) Using an appropriate cleaner or wipe, dust off the customer's TV screen. (This is not standard in all cable systems.)
5) Check all labels and tags to ensure that the drop is properly identified for that account.
6) Ensure that all ports on the tap are terminated, and that the terminators are all tight.
7) Make note of any distribution problems you may have seen at the job — such as broken ports, loose lashing wire, improper grounding of plant — and report them to your supervisor. **CT**

Ultimate TDR and Software package.

Model 1205C TDR and WAVE-VIEW Software, a powerful combination resulting in the mos versatile, user friendly TDR available today! Standard with the Model 1205C, the WAVE-VIEV software is one of the unique and exclusive features of Riser-Bond Instruments' TDRs.



✪ Use your computer and WAVE-VIEW for Windows® as an extension of your Riser-Bond TDR. Waveform information can be archived, documented, manipulated, compared, or analyzed on your PC while your TDR goes back into the field, working for you! Teach technicians how to use a TDR without leaving the classroom or taking a real TDR out of service!

✪ Unlike any other TDR's software program, WAVE-VIEW not only allows you to recall stored waveform on your PC, but it also displays the TDR's function keys. You can actually increase the vertical gain, zoo in and out, manipulate the waveform, adjust the cursors, and change VOP, right on your computer!

✪ Utilize your manpower more efficiently. Less experienced technicians can document the cable plar with the TDR while more experienced personnel download, analyze, and compare the waveform informatio on a computer. The TDR goes back to the field. *TRY THAT WITH ANY OTHER TDR!!!*

This is just one of the super features you get with a Model 1205C.

800-688-TDRs 402-466-0933 *Fax: 402-466-0967*

Call for a demonstration today!

Riser Bond
INSTRUMENTS

Reader Service Number 103

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.

☛ *Digital Compression: Expanding Channel Capacity While Enhancing Video and Audio Quality* — This features Thomas Elliot (moderator), H. Allen Ecker Ph.D., Richard Prodan, Ph.D. and Geoff Roman. Cost-effective digital video compression is closer than ever and will provide new opportunities for services and revenue. This program deals with the realistic goals and benefits to be derived from digital video compression. It covers trade-offs such as pix quality vs. data rate vs. cost, data rate vs. ruggedness vs. cost and features vs. value vs. cost. Digital video compression architectures, performance of various digital techniques and DigiCipher and DigiCable products also are discussed. (80 min.) Order #T-1111, $45.

☛ *Technical Compliance: How FCC Reregulation Will Impact Your System Operations and Maintenance Practices* featuring Steve Ross (moderator), Wendell Bailey, Jonathan Kramer and John Wong — With FCC reregulation a reality, this presentation seeks to provide an overview of the new regulations, as well as define key parameters including classes of signals covered, channel boundaries, aural standards, visual signal levels, signal-to-noise, signal-to-coherent disturbances ratio, hum modulations, color signals, testing requirements (including the number of test points required) and when tests are to be conducted. The federal/local relationship, as well as many other topics also are discussed. (85 min.) Order #T-1112, $45.

☛ *Cable System Technology Meeting Subscriber Expectations* featuring Margaret Combs (moderator), Jonathan Kramer and Thomas Robinson — "Your franchise administrator can be one of your effective subscriber retention representatives." This presentation explores the issue of what the cities want and need to deal with cable operators properly. It clearly defines a "key role" that technical managers can and should play to help ensure good relations with the franchising authorities. Ask yourself: "Who is telling my franchising authority about the factors necessary in delivering a quality signal?" Then view this and find out. (45 min.) Order #T-1113, $30.

☛ *Current Events in Cable TV Technology: Fiber Optics, HDTV, PCN and Outage Reduction* featuring Thomas Jokerst (moderator), Edward Callahan, James Chiddix and Thomas Elliot — This offers a vision of how we will use increased bandwidth, including HDTV, personal computer networks, possible 16:9 NTSC and how new consumer equipment may drive the service. (78 min.) Order #T-1114, $45.

Distribution system

Today's engineers face a major problem with space allocations in their headend facilities. Planning for equipment entails wiring bundles to ad insertion gear. To help eliminate space headaches, Standard Communications has developed the Stratum Series network — the only 80-channel broadcast-quality distribution system fully housed in a single, 6-foot high rack, according to the company.

Using NAM550 frequency agile modulators, the Stratum Series will accept and combine a variety of audio, video and IF inputs, providing optimum rebroadcasting quality and spurious-free RF performance from 54-550 MHz.

Permitting monitoring, adjustments and level setting via an easy-to-access front panel (or by remote computer control), its backup system ensures no downtime during transmission and requires no external computer or human intervention. Should a failure be detected within a rack, the backplane automatically routes all input/output signals from the faulty modulator to the next modulator on the standby daisy chain.

The advance network modulator system is primarily designed for the new digital ring architecture.

Advancing headend standardization, the Stratum line features a common menu of controls and adjustments, so simple that replacement of equipment can be accomplished by nontechnical personnel.

Backed by the company's Gold Standard support program (a seven-year guarantee and lifetime loaner program), the Stratum modulation system is said to meet or exceed all NTSC-7 standards.
Reader service #312

MPEG encoder

Vela Research Inc. unveiled its Centaur MPEG encoder, an extension of the company's encoding systems, which can compress raw source video into MPEG-1 or MPEG-2 compliant data streams. New features include support for serial D-1 and AES/EBU inputs, closed captioning and enhanced confidence monitor.

A pause/resume feature also has been added for easier long-program (movie) encodes, as well as a multiclip function for short programs (commercials). A new, smaller chassis facilitates installation in confined environments, while dual-redundant power supplies provide reliable power distribution. Centaur is offered in both MPEG-2 adaptive field frame and a low-cost frame-only version.
Reader service #311

Audio/video modulator

Leaming says its new AVM-1 mono audio/video modulator provides CATV, SMATV, private and wireless cable systems with an affordable, high-quality, NTSC mono audio/video modulator in one-third the rack space. The product generates a TV channel output from video and audio baseband signals.

Built-in features include: frequency agility from 50-450 MHz (to 550 MHz optional), 60 dBmV output, SAW filter, and BTSC stereo and SAP-compatibility. With this unit's compact design, three units can be mounted per standard 19-inch rack (1.75 x 19 inches).
Reader service #310

Fiber-optic platform

The new System 70 fiber-optic platform from Scientific-Atlanta is designed for a variety of applications, including cable telephony, low-cost broadcast delivery of basic programming, targeted service delivery to small pockets of subscribers, ring interconnection, and headend consolidation. The modular design of the System 70 offers RF, optical and powering redundancy for improved network reliability. The platform features universal AC and -48 VDC power supplies, and supports all major channel formats, such as NTSC, PAL-1 and PAL-B/G.
Reader service #309

Digital transmission chip

The cost of manufacturing digital cable TV set-top boxes could b-

EXFO FIBER OPTIC NEWSLETTER

Volume 1, Number 4, '95

Frequency Modulation vs. Digital Transmission in Optical Talk Sets

VCS-20A Fiber-Optic Talk Set

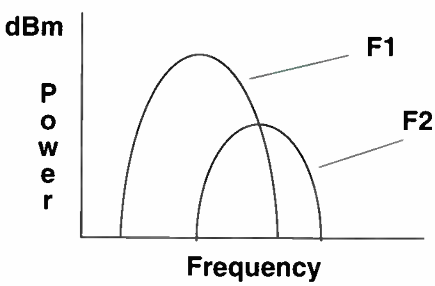
With the demand for broadband services in the market today, fiber is being deployed at increasingly higher rates. Similarly, the demand for fiber testing and data management also increases. An important aspect of fiber testing is uninterrupted communication between technicians. A common scenario in the field is during test of a rural fiber route where cellular phones are beyond range of the cell site. Another example is testing in an underground vault where cellular and wireless radio communications are not possible as the vault acts as a shield for both devices. The practical alternative is a fiber optic talk set.

When comparing single fiber, full-duplex optical talk sets, it is important to look carefully at the product's transmission technology. Frequency modulation (FM) and digital transmission are two of the more popular technologies employed. The following is a description of these two technologies, particularly in reference to reflection susceptibility which can impose limitations on their use.

Both frequency modulation (FM) and digital transmission are affected by reflections which are caused by Rayleigh backscatter and Fresnel reflection. (The cumulative sum of all reflections at the transmitter is called optical return loss or ORL). Rayleigh backscatter is that light which is scattered opposite to the direction of light propagation due to slight material variations in the fiber. Fresnel reflections are potentially much stronger and are caused by an abrupt change in the index of refraction of the fiber such as at discrete components in the link. Connectors are usually the greatest concern in the link. In addition to the connectors, bare fiber adapters and mechanical splices are reflective.

Frequency modulation experiences more white noise or distortion due to reflected light than digital transmission.

A single fiber, full-duplex optical talk set combines a transmitter and receiver in one optical port. Both the transmitter and receiver operate continuously and one influences the other. Reflected power from the transmitter interferes with useful incoming signals received at the detector in such a way that it reduces the talk set signal to noise ratio (S/N). This quantity is measured by emitting a carrier wave along with a 1 kHz signal, and analyzing the relationship between the launched power of the newly created frequency and that obtained at the detector. This allows the evaluation of the sound quality of the talk set. Typically, frequency modulation has S/N of 12 to 25 dB while digital transmission has a better ratio of 25 to 30 dB.



Frequency Interference

Frequency modulation, employed by various talk sets, modulates a carrier wave at a certain frequency in order to transmit in one direction, and modulates the carrier wave at a second frequency to transmit in the opposite direction. The graph below displays two frequencies. F1 is the transmitted signal from Transmitter 1 to Detector 2, and F2 is the reflected signal from Transmitter 2 returning to Detector 2. F2 is interfering with our signal transmission.

(Continued on page 7)

EXFO Electro-Optical Engineering

In This Issue:

EMC Certification for CE Compliance

With the increased importance of telecommunications, electromagnetic compatibility (EMC) testing for test equipment manufacturers is becoming more common; in particular, a regrouping of European companies has occurred in order to offer more control of electromagnetic traffic. Beginning December 31, 1995, all fiber optic test equipment entering most European countries will have to comply with European Community requirements. Compliance with these standards is noted by a CE seal. EXFO test equipment shall comply with these requirements.

EMC norms comprise a series of tests which are needed to verify electromagnetic immunity, electrostatic discharge, emission levels, and security.

Electromagnetic interference, or EMI, is the introduction of unwanted electrical signals into a system due to electric current in another electrical system (figure 1) EMI may be transmitted by either conduction or radiation. The conduction mode occurs when an electrical current path is provided by inductive or capacitive coupling between two components thereby providing a circuit path for unwanted current flow. Common sources of conductive interference are switching transistors and diodes in power converters/power supplies and digital logic circuits due to fast switching producing transient noise. The radiation mode arises where electric currents release EM fields which couple to another electric system through the ambient environment. Examples are current flowing through a wire or cable (figure 2).

Emissions tests include conducting emissions and radiating emissions, electrostatic discharge by contact and electrostatic discharge by air, electromagnetic immunity, electrical fast transients, immunity to magnetic fields. Security testing includes fire and irradiation, electric shock, and energy.

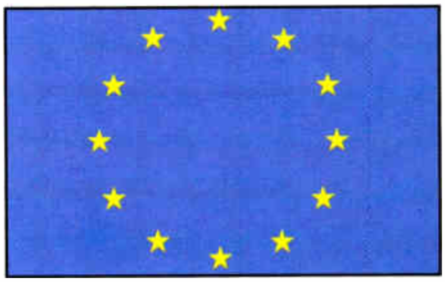
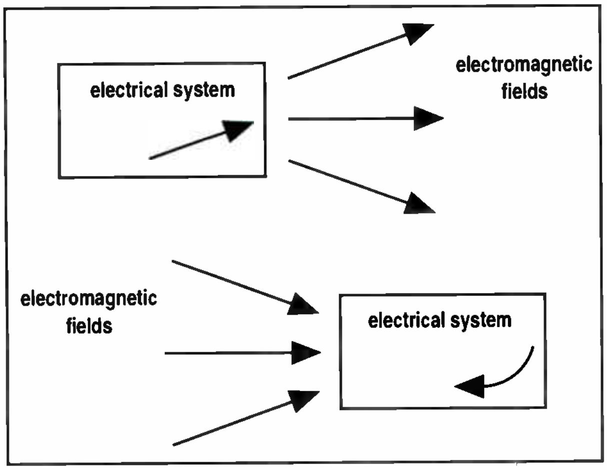
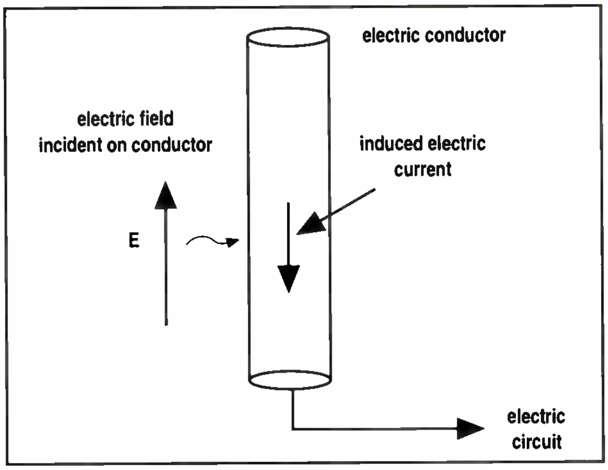


Figure 1



EMI in Electrical Systems

Figure 2



EMI Transmitted by Radiation

FTB-300 Universal Test System for Built-In Flexibility

FTB-300 Mini-OTDR

The first full-featured mini-OTDR

Flexibility and adaptability are vital in the fiber-optic world. Consequently, test and measurement solutions must be powerful, innovative, and remain cost-effective. EXFO's new FTB-300 Universal Test System responds to these characteristics and to the users' ever-changing needs. The flexibility of the FTB-300 is built into its compact modular test platform while the power lies within a series of high performance, field-interchangeable optical test modules. Up to three modules can be plugged into the platform simultaneously. OTDR and power meter modules are now available. The power meter module may be represented by our automated FASTEST power meter with ORL meter, visual fault locator (VFL), and talk set capabilities. The FTB-300 is designed to grow with fiber optic testing and measurement innovative requirements.

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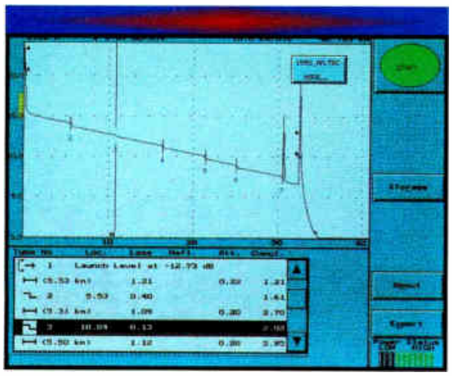


FTB-300 Mini-OTDR Main Screen

FTB-300 Mini-OTDR Modules

Modularity provides the added value to the powerful FTB-300 system base. With plug and play connections, an OTDR station can expand into a multi-application test station. Modules can be quickly and easily inserted and removed in the field, and no special tools are required.

The Open Architecture design of the FTB-300 increases efficiency and productivity; at the heart of the system is a 486 micro-processor. This open architecture permits the user to profit from commercial software such as spreadsheets, word processors, and others. Data can be stored in several ways including hard drive, floppy disk, and optional PCMCIA interface. The connector panel houses modem, parallel, serial, external VGA monitor, and keyboard ports. The FTM/DocuNet test data management system is also available responding to a need for efficient, timely fiber test data management.

User-Friendly Operation and individual test application software combine to make the ToolBox software flexible and versatile. The graphical user interface loaded with timesaving features takes the guess work out of testing. ToolBox is easily upgradable, including module application software, so that the user doesn't have to worry about obsolete test equipment.

The FTB-300 Touch Screen user interface simplifies testing and contributes to its rugged construction. The 9.4" 640x480 full dot screen, one of the largest in the industry, speeds up testing as it provides direct access to the control layout.

Modules now available include OTDR, Optical Loss Test Set, and Optical Switch. The OTDR exhibits > 32 dB of dynamic range and 5 and 20 meter event and attenuation deadzones respectively. The loss test set module features FASTEST automated testing with > 55 dB of range and includes ORL measurement, voice communication, and visual fault identification options. The optical switch is a 1x12 channel switch with 0.7 dB insertion loss and -80 dB of crosstalk. And there are more modules to come...

designed to allow traffic of up to 100 Mbps to be transmitted in a local area network.

FITL (fiber-in-the-loop): Used generally to refer to the deployment of fiber between the central office and the subscriber.

Fiber-optics: The rapid transmission of light pulses in a coded digital format through the fiber cable. In a fiber-optic transmitter, a light source such as a laser or light-emitting diode (LED) is connected to the fiber cable. This light source converts an electronic input signal into a series of light pulses (representing bits) by blinking on and off millions of times per second. This stream of light pulses is the combination of many lower rate bit streams formed using digital multiplexing techniques. At the other end of the fiber, receivers capture the light pulses for conversion to electrical signals.

Frame relay: A data transmission technique similar to the X.25 protocol that features the use of a flag as a start bit, an address to indicate intended destination of the message, the actual payload to be delivered, an error detection sequence and a flag indicating end of the packet.

Gbps (gigabits per second): Giga is the prefix representing 1 billion. For example, 10 Gbps means 10 billion bits per second.

ISDN (integrated services digital network): In its simplest form, called basic rate ISDN, it provides a means of transmitting two voice channels (each operating at 64 kbps) and one data channel (operating at 16 kbps) over a single pair of twisted-copper conductors. The two voice channels are called bearer (B) channel and the single data channel is the (D) channel. A more complex form of ISDN is called primary rate ISDN. In this system there are 23 B channels operating at 64 kbps and one D channel operating at 64 kbps. Thus the transmission capability of basic rate is 144 kbps, and that of primary rate ISDN is 1.5 Mbps.

IDLC (integrated digital loop carrier): A digital loop carrier system that connects directly to a central office switch.

kbps (kilobits per second): Kilo is the prefix representing 1,000. For example, 384 kbps means 384,000 bits per second.

LAN (local area network): A limited distance network connecting a defined set of terminals. It could connect workstations within an office, offices in a building or buildings within a campus, etc.

LATA (local access transport area): The geographic area that is the domain of the local exchange and carrier. Regional Bell operating companies (RBOCs) are generally precluded from carrying traffic across LATA boundaries; this traffic must be handed off to an interexchange carrier.

Local loop: The portion of the telecommunications network that connects a subscriber's phone or business's PBX to the local central

(Continued on page 64)

EXFO and The Light Brigade Team Up for Training Seminars

EXFO is pleased to announce that The Light Brigade, a renowned company specializing in fiber optic training seminars, and system design, installation, and maintenance, will be featuring EXFO test equipment at several of their training sessions in 1996. The seminars are interactive and combine lecture, video tapes, instructional manuals, and hands-on practice. These four-day, comprehensive seminars include fiber optic theory, installation, testing, restoration, connectors, patch panels, splicing, and system design.

Session dates:

- February 20, 21, 22, 23
  Honolulu, Hawaii
- February 20, 21, 22, 23
  Tampa, Florida
- March 4, 5, 6, 7
  Atlanta, Georgia
- March 11, 12, 13, 14
  Cleveland, Ohio
- March 18, 19, 20, 21
  Anchorage, Alaska
- March 19, 20, 21, 22
  Seattle, Washington
- March 25, 26, 27, 28
  Vancouver, B.C.
- April 2, 3, 4, 5
  Burbank, California
- April 8, 9, 10, 11
  Sunnyvale, California
- April 9, 10, 11, 12
  Salt Lake City, Utah
- April 16, 17, 18, 19
  Denver, Colorado
- April 23, 24, 25, 26
  Washington, D.C.
- April 29, 30, May 1, 2
  Boston, Massachusetts
- July 23, 24, 25, 26
  Montreal, Quebec
- July 29, 30, 31, Aug 1
  Toronto, Ontario

Call 1-800-451-7128 or (206) 251-1240 for more information and a complete course outline.

OFC '96 Preview

As February approaches, the all-important Optical Fiber Communication Conference (OFC) '96 in San Jose, California edges closer and closer.

OFC is the major North American conference on optical fiber communications and related systems. This year's conference will feature new scientific and technical information on fibers and passive components; active optoelectronic and integrated optical devices; components and systems technologies; subsystems and networks using these components.

Technical conferences as well as 200 company exhibits offer a unique gathering opportunity for global leaders in telecommunications research, production, and systems development.

OFC represents the cutting edge of research and technology in the area of fiber optics such as fundamental research, systems applications, and manufacturing criteria.

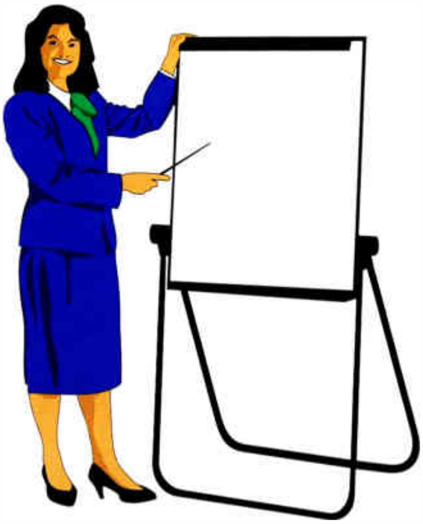
Once again, EXFO will be present at OFC this year with our existing products and perennial favorites plus all our new products at the cutting edge of fiber optic test and measurement technology.

These products include additions to the already popular IQ-200 Family, a modular test system designed for lab and research testing environments. In addition to the existing modules — power meter, light source, variable attenuator, back-reflection meter, optical switch — we have added new modules such as an optical spectrum analyzer, DFB lasers, calibration power meters, and multiple configuration optical switches.

The new FTB-300, offering greater levels of flexibility and performance in a single platform modular mini-OTDR, will also be on display. The FTB-300 is a > 32 dB mini-OTDR with full OTDR performance based on a new modular "plug and play" design with touch screen technology. The FTB-300 loaded with OTDR and our patented FasTest modules becomes a highly efficient tool that performs single or dual-wavelength OTDR and loss testing for both singlemode and multimode applications. No other mini-OTDR provides you with such an open architecture and guarantees the flexibility you require to face the constantly changing world of fiber optics.

OFC '96 will also see EXFO introduce the innovative, rack-mounted Fiber Maintenance Bay (FMB). This unique testing concept consists of a modular architecture for OTDR and ORL testing along with optical talk set, optical switch, and multi-channel power meter modules. The FMB permits integrated testing from one central location such as a central office or head end.

As you can see, this year OFC should be quite a showcase for EXFO's most recent high performance technological advancements. So, while you're browsing through the exhibits in February, drop in at **booth #1030** to see the latest in fiber-optic test and measurement equipment.



Customized IQ System Applications

IQ-200 (rack-mounted)

The IQ-200 team now includes an applications department complete with on-line application service and full application programming.

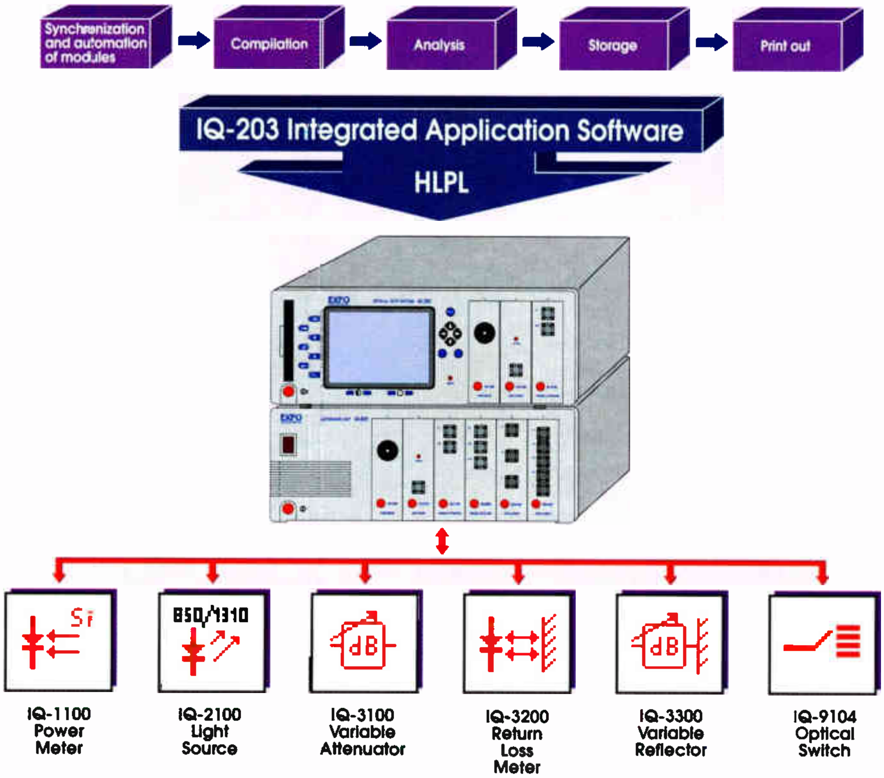
Qualified technical support personnel are ready to answer any questions regarding IQ modular applications using a variety of IQ Power Meters, Variable Attenuators, Return Loss Meters, Optical Switches, and many more. Specialized application engineers remain on-line for immediate application development coordination.

High Level Programming Language

EXFO's High Level Programming Language (HLPL) is the key to greater application integration using wide-ranging modular application programming, designed according to each specific user's need. The HLPL software package will dictate how instruments will interact within any IQ or existing lab test system, what readings will be taken, how they will be analyzed, when and where results will be stored, and what kind of print-out will be produced.

The HLPL option allows for extensive application combinations designed to facilitate testing procedures such as power meter calibration, light source and attenuator certification, optical return loss (ORL) measurement, ORL meter linearity, power loss testing, optical switch device testing, and other customized testing.

Along with user-specific application software, the HLPL option will include an application library containing existing state-of-the-art solutions for environmental component/fiber testing, system testing, and instrument calibration testing.



IQ-200 HLPL Integration

GPIB Compatibility

The IQ-200 system surpasses the expectations of a typical optical test system. In addition to the IQ-200 Family's exceptional modular flexibility, the IQ-200 turnkey system also offers complete GPIB (IEEE-488.2-SCPI) compatibility for integration into any existing manufacturing or lab test setup.

As a GPIB device under external control the IQ-200 system can communicate with a central computer system. The IQ-203 and IQ Series modules are fully compatible with any actual setup through the use of a GPIB device card (IEEE-488.2-SCPI) inserted directly into the IQ-203 mainframe.

As a GPIB main controller of test instruments, the IQ-203 mainframe demonstrates its built-in intelligence by simultaneously managing multiple instruments. The IQ-203 mainframe can control numerous external test devices from different manufacturers using a GPIB controller card installed in the IQ-203. While the IQ-203 controls IQ Series modules and external instruments, the operation of the hardware can be automated to provide unprecedented ease of use and speed.

(Continued on page 7)

New Product Review

Over the past year, we have introduced a number of new and exciting products. Our commitment to innovation and quality can be seen in the new products and major upgrades released during this tenth anniversary year. To name a few:

IQ, EXFO's Product of the Year

One of the most significant products launched in 1995 was the IQ-200 Family. As most of our readers already know, the IQ-200 Family is a modular test system comprised of a mainframe, expansion unit, and several test modules. The IQ has been designed for any test environment that requires high precision such as manufacturing, research, production, and engineering. The capacity of the test system can be extended by adding up to four expansion units for a total of 27 single-slot test modules. Modules now available include programmable optical power meters, light sources, variable attenuators, optical return loss testers, variable backreflectors, and optical switches. All modules run on our friendly WINDOWS™ application software for easy programming and testing.

Multimode and Improved Singlemode Fiber Tool Box (FTB)

Nineteen ninety-five also saw the already industry approved Fiber Tool Box (FTB) mini-OTDR get better. We introduced a single and dual wavelength multimode version along with a new 10 ns pulse on the singlemode version. The multimode FTB is great for OTDR testing of fiber-optic LANs and in any multimode fiber environment. The new, shorter pulse on the singlemode FTB reduces the dead zone and makes finding events near the front-end connector and between connectors in the fiber span easier. The FTB now has 8 pulse widths to choose from: 10 ns, 30 ns, 100 ns, 275 ns, 1 µs, 2.5 µs, 4 µs, and 10 µs.

In addition to these great hardware improvements, we launched a new version of our "extremely user-friendly" application software for the FTB, ToolBox 4.1. This impressive, new software features auto analysis improvements, the ability to change test parameters while taking an acquisition, autozoom, mass trace and bigger trace print-out, and multilingual software and translator. We also made it compatible with attenuation and ORL data making it the first mini-OTDR in the industry with this capability.

Fiber Test Manager Offers Centralized Test Data Management

The Fiber Test Manager (FTM) centralizes all test data taken from the field with DocuNet. This central data base server automatically creates a data base of test results based on the user's own fiber network topology. The FTM runs on a dedicated computer and is compatible with EXFO's OTDR and power meter/ORL products.

FLS-235: New SC Connector Now Available

The popular Pocket Pal Visual Fault Locator now offers visual troubleshooting to SC connector users at a very affordable price. As more companies turn to rectangular "plug-in" type connectors like the SC, EXFO is among the first to offer them as inexpensive means of tracing breaks, bends, pinches, and other causes of attenuation. Starting at $US500 the Pocket Pal is sure to please the budget-minded installer or technician. Also offered with ST or FC connectors, at 635 or 670 nm version, the FLS-235 brings visual fault location within your reach.

New Test Kits in 1995

EXPERT'S TRIO

In 1995, we introduced several new test kits for users confronted with multiple needs and limited budgets. The following is a brief description of some of the new kits offered:

Duo A
FOT-910, visual fault locator, accessories.
(back-reflection optional)

Duo B
FOT-910, talk set, accessories.
(back-reflection optional)

EXPERT'S TRIO
FOT-910, visual fault locator, talk set, accessories.
(back-reflection optional)

TK-30
LAN Installation kit at 850/1300 nm includes FOT-02 power meter, FOS-124A LED source, VCS-10 Hands Free Talk Set, accessories.

LFD-100, Live Fiber Detector with Power Meter

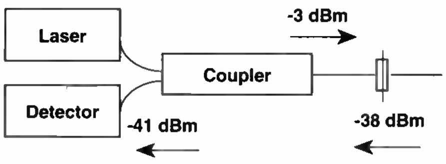
LFD-100, Live Fiber Detector

The new LFD-100 Universal Live Fiber Detector from EXFO can safely identify live and unused fibers. This field-portable instrument recognizes traffic as well as test signals (CW or modulated), and indicates both the core power level and the direction of the light in the fiber. As per Bellcore TR-NWT-000764, it uses a safe macrobending approach to minimize the risk of service interruption and avoid fiber damage induced by stress. To provide maximum flexibility, a single, non-removable head adapts to 250 (m coated or 900 (m tight buffered fibers and 3 mm jacketed test jumpers or patch cords.

(Continued from page 1)

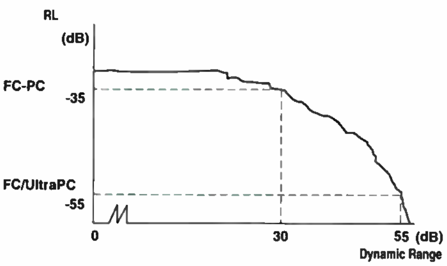
Frequency modulation talk set performance is specified as a function of back reflection. This is crucial considering that ORL values poorer than 35 dB can reduce the dynamic range by 15 to 25 dB.

For example, a talk set with an FC/PC connector would have an initial reflectance of -35 dB. The launched power, measured after the coupler, is -3 dBm and the connector returns -38 dBm of optical power back towards the detector. However, the light must pass through a coupler, losing half of its power equal to a 3 dB loss. The reflected optical power at the detector is -41 dBm, [-3 dBm -(35 dB) - (3 dB) = -41 dBm]. See diagram below. If the unit were connected to a bare fiber adapter or mechanical splice, the reflected optical power at the detector could exceed the specifications of -35 dBm.



Reflected Optical Power at Detector

Frequency modulation experiences more white noise or distortion due to reflected light than digital transmission. The graph below illustrates how dynamic range deteriorates with increased reflected optical power. A technician would experience signal distortion on the fiber as the return loss worsens. Also, FM being an "analog" transmission technology, noise increases gradually as the link loss approaches the usable dynamic range of the talk set. Both these factors are considered minor inconveniences for some, and yet major drawbacks for others. For example, in long distance restoration situations — which use the full dynamic range of the talk set — clear communication over fiber becomes essential.



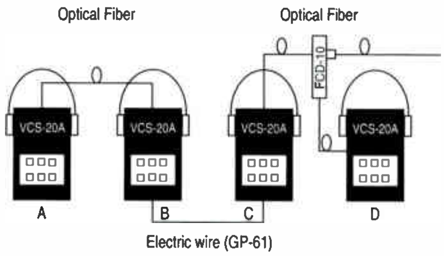
Return Loss vs. Dynamic Range

Digital transmission uses a series of light pulses representing ones and zeros to transmit information. Reflected optical power is still a concern; however, digital technology is able to effectively eliminate distortions caused by reflected signals. Using a series of start and stop bits and a sophisticated synchronization algorithm, the talk set is able to differentiate between an actual signal and a ghost reflection. During operation, the detector turns itself off and on very quickly eliminating interference from ghost signals. As the signal power becomes attenuated, the recovered signal remains clear until the very end of the talk set dynamic range. This is a distinct advantage of digital transmission over frequency modulation.

EXFO provides two classes of optical talk set products both high end and low end which each employ digital transmission and frequency modulation respectively.

To summarize, both technologies are valid options for fiber optic communications. Frequency modulation in single fiber, full-duplex talk sets is susceptible to reflections which can significantly reduce the specified dynamic range, while digital transmission filters out any interference from reflections. Also, bare fiber adapters, mechanical splices, and non-polished connectors effectively limit frequency modulation performances.

EXFO provides two classes of optical talk set products both high end and low end which each employ digital transmission and frequency modulation respectively. The EXFO VCS-20A talk set series is a handheld digital designed talk set which offers full-duplex communication over a single fiber. It is configured in LED and Laser options with up to 40 dB dynamic range capability. The talk set unit additionally operates as a back-up stabilized light source and as a 2 kHz signal generator and detector for fiber identification applications.



Multi-Party Communication

Multi-party conferencing is also supported by the VCS-20A series; the number of operators is unlimited as the units are daisy-chained in sequence at each branch location. The unit is powered by a rechargeable NiCd battery pack, 9V batteries, and AC adapter.

In addition to the VCS-20A talk set, EXFO offers the VCS-10 series talk set for short haul operations. The VCS-10 sets feature both push-to-talk and voice activated transmission. Fiber identification applications are also covered via the 2 kHz tone generation and detection functions. The VCS-10 series is available in LED light source configurations and is very competitively priced!

(Continued from page 5)

New Demo Disk

To better acquaint clients with the benefits of the IQ-200 Family, we are preparing an informative, easy-to-use demo disk. The presentation will be divided into two sections and will demonstrate the flexibility and performance of the IQ-200 system.

The first section will present a brief corporate profile and an overview of the IQ System including the mainframe and modular aspects of the IQ-200 system. The second section will demonstrate in detail a major IQ application using scientific diagrams and step by step application window procedures.

The entire presentation is fully interactive, easily downloadable to any PC, and now available.

To receive your free demo disk, data sheets, demo disk, screen saver, and training video, or for additional information on HLPL or any other IQ component, please call 1-800-663-EXFO or 1-418-683-0211. In addition, we can now be reached through our Internet address: exfo@riq.qc.ca.

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How to reach EXFO

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Tel.: 1-800-663-3936
Fax: 418-683-2170

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Customer service from the main office is available between 7:30 am and 8 pm EST. For technical assistance, product information, prices, delivery... Call us at 1-800-663-3936 or 418-683-0211.

Products in stock!

We have substantially increased our stock levels over the summer months! Contact us for your immediate testing needs. We will be able to provide next day delivery on FOT-10A, FOT-20A, FOT-90 power meters, FOT-30, FOT-40, loss test sets, FLS-130A, FLS-210A light sources, FLS-230A visual fault locators. (Availability subject to configuration.)

Demos For Sale

A large quantity of demo models now available at aggressively discounted prices, including last year's models! Discounts range from 20% to 50% off the list price. Call customer service for used OTDRs, power meters, light sources, attenuators, ORL testers and more at 1-800-663-3936 or 418-683-0211.

Trade Shows

Come see us at:

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Date: December 5-7 '95

COMNET '96 in Washington
Washington DC, booth #2938
Date: January 30 - February 1 '96

PHOTONICS WEST in San Jose
California
Date: January 30 - February 1 '96

EXPO COMM '96 in Mexico City
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In this issue:

☐ OTDR Test Kits
☐ FTB Mini-OTDR
☐ Loss Test Set Kits
☐ IQ-200 Lab Instruments
☐ VCS-20A Optical Talk Sets

Other EXFO products:

☐ Hand Held Power Meters
☐ Hand Held Light Sources
☐ Programmable Attenuators
☐ ORL Testers
☐ Visual Fault Locators

Application

☐ Telco ☐ Laboratory ☐ Military ☐ Educational
☐ LAN installer ☐ CATV/MSO ☐ Other ____________

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greatly reduced, with a new integrated QAMLink digital transmission chip. The product is a result of a partnership between Hewlett-Packard and Broadcom Corp.

The BCM 3115 QAMLink chip is a dual-channel receiver with forward error correction (FEC) and QPSK demodulation. It also includes adaptive equalization and de-interleaver RAM. The FEC feature is compatible with DigiCipher II for North American digital cable transmission and conforms to the ITU 64-QAM standard. The QPSK receiver in the chip provides a fixed frequency 2 Mbps control channel.

Company spokespersons say the chip reduces the number of chips required in digital set-top boxes, thereby reducing manufacturing costs.

Hewlett-Packard has earmarked the chip for its Kayak System digital set-top cable box. The company has committed to purchase 500,000 of the chips from Broadcom to support initial orders for the Kayak box, which will be available in mid-1996.
Reader service #308

Amplifier

Quality RF Services Inc. introduced the QRAM750, a rack-mounted amplifier designed to support state-of-the-art headend applications.

The unit provides quadra-power output technology along with a variety of gains to enhance flexibility. The amplifier is capable of driving up to four lasers with the highest available 750 MHz technology.
Reader service #307

Drop cable box

Times Fiber Communications announced the TimeSaver box to handle and dispense Series 59 and Series 6 drop cable. The box features a clear, smooth, protective coating that enhances box strength even in high humidity.

The TimeSaver features handle strength three times greater than the current box, according to the company. The unit also is easier to assemble and is 100% recyclable.
Reader service #306

Intermittent fault detection

New from Riser-Bond Instruments is an intermittent fault detection mode (IFD) for the Model 1205C TDR. The IFD feature monitors the cable for intermittent problems and captures any change in the waveform, helping locate even the hardest to find problems such as noisy lines or bad connectors.

A unique function of the IFD feature is that the waveform can be manipulated, repositioned, zoomed in or out and the cursors moved — all without affecting the IFD function.
Reader service #305

Audio/video switch

Monroe Electronics' new Super Trunk switch provides redundancy for up to three separate trunk lines, and automatically switches to an alternate signal source in case of primary source failure. The Super Trunk uses a video sync pulse to automatically control 2 x 1 audio-follow-video switching. The switch includes buffer amplifiers for all output connectors. Applications include remote antenna and head-end interconnection, headend interconnects for program sharing and multiple system interconnects for advertising insertions.
Reader service #304

1GHz amplifier

Pico Macom introduced the PDA 30, a 1 GHz amplifier, which provides SMATV, CATV, TVRO and MMDS systems with +30 dB gain across the 50-1,000 MHz bandwidth. A low-noise linear distribution amplifier, the PDA 30 is available in three versions: forward path only, forward with amplified return path, or forward with reverse return path. An external power supply allows for use with all international power systems, and the amplifier also can be used for all TV standards.
Reader service #303

Multimeter

The new Video Window from ComSonics is a digital video multimeter for NTSC and PAL formats. The device conducts some 40 separate tests, including differential gain, differential phase, chrominance/luminance delay, sync analysis, YRB components, color match, and run status. Test results can be viewed on Video Window's alpha-numeric backlit display.
Reader service #302

CD-ROM cable directory

Phillips Business Information Inc. introduced the *Cable Industry Directory* on CD. The CD-ROM is an interactive marketing, planning and sales tool, giving users direct access to over 10,000 leading industry decision-makers.

The CD provides detailed listings of the top MSOs, profiles of the leading broadcasters and telecommunication companies in cable, and over 4,000 product manufacturers and distributors.

Users also receive extensive coverage of new products, programmers, equipment and service providers, associations and regulators in the cable industry.

Every word on the CD is searchable, and Boolean, proximity and phrase searches can be conducted. Output formats include report, data file and mailing labels, in country and ZIP order.
Reader service #301

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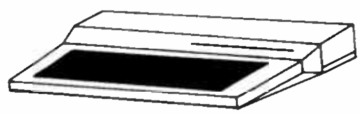

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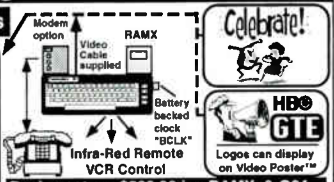

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BCLK	$ 69.95	Battery clock (with RAM) restores time & date if power fails
PK8	$179.95	Controls 8 relays + DVM2; "WX1 & WSDM "+ IR inputs
WX1	$189.95	Temp.+Humidity ; WX1B $249.95 inc. barometric pres.
WSDM	$279.95	Anamometor Wind speed and direction; (Req. PK8)
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Networking alphabet soup

(Continued from page 63)

office. Also known as the last mile.

Mbps (megabits per second): Mega is the prefix representing 1 million. For example, 10 Mbps means 10 million bits per second.

MPEG (Moving Pictures Experts Group): An international standards-setting group working under the supervision of the International Standards Organization and the International Electrotechnical Commission, MPEG's mission is to develop standards for compressed full-motion video, still image, audio and other associated information. The MPEG effort primarily is concerned with requirements for coding and decoding the video and audio, and storing and transporting the video.

Multimedia: The integration of at least two of five information types for presentation on a TV set, desktop computer screen, personal information manager or other computer-driven device with a screen interface. Multimedia information can include text, still graphics, animation, audio, full-motion video or still photos.

Multiplexer: Equipment that permits simultaneous transmission of multiple signals over one circuit.

NGDLC (next generation digital loop carrier): Commonly used acronym for integrated digital loop carrier (IDLC).

Packet: A bundle of data packaged for transmission over a network. Packets can be various lengths, ranging from about 40 bytes up to 32,000 bytes on the Internet, but typically about 1,500 bytes in length.

Protocol: A set of rules about how computers are to act when talking to each other. The protocols, such as Ethernet, IEEE 802.5 token ring, X Modem or Kermit.

QOS (quality of service): A contracted data rate that is negotiated between two ATM end points that guarantees throughput and data delivery.

Synchronous transmission: A method of sending information over a transmission line and separating discrete characters and symbols by a precise separation in time. Synchronous transmission offers higher throughput because it does not require the start-stop bits used by asynchronous methods. Synchronous transmission is more expensive, however.

VBR (variable bit rate): An ATM traffic class of service that is typically of secondary priority. In VBR, the peak and sustained cell rates can be reduced through negotiation.

WAN (wide area network): An integrated data network linking metropolitan or local networks over common carrier facilities. **CT**

reduced by integration with the ATM network.

As service expands, ATM customers need to increase the size, speed and scope of their networks while reducing network complexity and its associated management and maintenance costs. They are willing to pay a high price for their LANs if these LANs deliver on their promise. Users, however, do not want to spend large amounts of money on the tariffs associated with using the wide area network (WAN).

Existing technologies do not scale properly and there are significant cost performance trade-offs that must be made to expand service. Today's ATM customers are looking for high performance today and they are willing to wait a few years for low prices and new applications.

These early adopters will shape the future deployment of ATM for tomorrow. As ATM-equipped companies experience exponential productivity gains, market dynamics will demand that their competitors also install ATM. At this stage, ATM prices will be driven down, eventually reaching a price-point that allows mainstream users to adopt the technology.

Productivity factors

Two additional factors will drive ATM acceptance: increased computing power and network growth.

Each time a user or the MIS manager upgrades a computer to provide greater performance,

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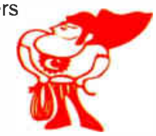

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These positions provide technical support to Philips customers via telephone and/or at the customers field site, domestically and internationally. Position scope includes customer training, acting as liaison between customers and our sales and engineering functions. This position is based at our Syracuse, NY area office and will require approximately 50% travel. The successful candidate will have an A.A.S. in electronics and at least 5 years experience in the areas of Fiber Optics and RF systems as they pertain to multichannel television telecommunication systems (Cable TV). Knowledge of baseband signals, amplifier distortions. Computer proficiency helpful.

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Interested candidates should have an A.A.S. degree or equivalent 2-5 years of Fiber Optic design experience and 5-10 years of RF System design experience required. Ability to evaluate proposal designs and implement a design solution that meets the customers needs as well as the desire to travel with sales representatives to present proposals.Knowledge in CAD and drafting software–AutoCad Rel 11-13.

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This challenging position includes all phases of fiber optic system design and project management. Successful candidates will have 2+ years experience in fiber optics design and/or implementation and strong communication and PC skills. Experience in AutoCAD a plus.

■ COMMUNICATIONS ADMINISTRATOR

In this challenging position you will be responsible for certification and trouble-shooting broadband systems in a manufacturing environment. Successful candidates will have 2+ years experience as well as knowledge of cable TV system design and equipment operation. Strong communication PC skills are also required.

For consideration, please fax your resume (indicate desired position) and salary requirements to (810) 524-6147, or mail to:

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8-10: SCTE Conference on Emerging Technologies, San Francisco Hilton andTowers, San Francisco. Contact SCTE national headquarters, (610) 363-6888.
9: SCTE Pocono Mountain Chapter seminar, Holiday Inn, Hazleton, PA. Contact Anthony Brophy, (717) 462-1911.
9-11: SCTE Wheat State Chapter meeting, BCT/E exams to be administered, Wichita, KS. Contact Joe Cvetnich, (316) 262-4270.
10: SCTE New England Chapter meeting, Installer exams to be administered, Worcester, MA. Contact Tom Garcia, (508) 562-1675.
11: SCTE Satellite Tele-Seminar Program, "Emergency Alert Systems" from Expo '95 in Las Vegas, NV, to be shown on Galaxy 1R, Transponder 14, 2:30-3:30 p.m ET. Contact SCTE national headquarters, (610) 363-6888.
11: SCTE Gateway Chapter seminar, telephone basics, Overland Community Center, Overland, MO. Contact Don Widaman, (314) 272-3900.
15-16: SCTE Regional Training Seminar, Introduction to Telephony, Sheraton Hotel, Newport Beach, CA. Contact SCTE national headquarters, (610) 363-6888.
17: SCTE Big Sky Chapter seminar and annual meeting, Little Big Man Pizza, Laurel, MT. Contact Marla DeShaw, (406) 632-4300.
17: SCTE Dakota Territory Chapter seminar, new emergency alert systems regulations, BCT/E and Installer exams to be administered, Holiday Inn, Aberdeen, SD. Contact Tony Gauer, (605) 426-6140.
17: SCTE Oklahoma Chapter seminar, Moore/Norman Vo-Tech Center, Norman, OK. Contact Oak Bandy, (405) 364-5763, ext. 249.
17: SCTE Piedmont Chapter seminar, digital compression, test equipment and other digital services, Winston/Salem, NC. Contact Mark Eagle, (919) 220-3889.
17: SCTE South Florida Chapter seminar, BCT/E Category III tutorial—transportation systems, BCT/E and Installer exams to be administered, Ft. Lauderdale, FL. Contact Jim Jones, (407) 478-5866, ext. 409.
17-19: SCTE Regional Training Seminar, introduction to Fiber Optics, Sheraton Hotel, Newport Beach, CA. Contact SCTE national headquarters, (610) 363-6888.
18: SCTE Big Sky Chapter seminar and annual meeting, Jackson Creek Saloon, Helena, MT. Contact Marla DeShaw, (406) 632-4300.
18: SCTE Central Indiana Chapter seminar, installations, Holiday Inn, Indianapolis, IN. Contact Al Orpurt, (317) 825-8551.
18: SCTE Michiana Chapter meeting, BCT/E exams to be administered, LaPorte, IN. Contact Russ Stickney, (219) 259-8015.
18: SCTE Penn-Ohio Chapter seminar, technical basics for the installer technician, Installer Certification tutorial on practical exams, Sheraton Inn, Warrendale, PA. Contact Marianne McClain, (412) 531-5710.
20: SCTE Cactus Chapter meeting, BCT/E exams to be administered, Phoenix. Contact Chris Radicke, (602) 948-4484.
20: SCTE Cascade Range Chapter meeting, BCT/E exams to be administered, TCI office, Portland OR. Contact Cindy Welsh, (503) 667-9390.
25: SCTE Central Florida Chapter seminar, hands-on fiber training, cable preparation, splicing, enclosures and test equipment, Sheraton Inn East, Tampa, FL. Contact Pam Kernodle, (813) 371-3444.
26: SCTE Wheat State Chapter meeting, BCT/E exams to be administered, Great Bend, KS. Contact Joe Cvetnich, (316) 262-4270.
31: SCTE North Country Chapter seminar, BCT/E Category I tutorial—signal processing centers and BCT/E Category V tutorial—data networks and architectures, Anoka Technical College, Wadena, MN. Contact Bill Davis, (612) 646-8755.

Planning Ahead

Feb. 13-14: Idaho CableTelecommunicans Association Winter Show, Boise, ID. Contact (208) 375-7836.
Feb. 21-23: Texas Cable Show, San Antonio Convention Center, San Antonio, TX. Contact (512) 474-2082.
Feb. 25-Mar. 1: OFC '96, San Diego. Contact (202) 223-8130.
April 15-18: NAB '96, Las Vegas, NV. Contact (202) 429-5300.
April 28-May 1: Cable '96, Los Angeles. Contact NCTA, (202) 775-3629.
June 10-13: SCTE Cable-Tec Expo, Nashville, TN. Contact (610) 363-6888.

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25	51	77	103	129	155	181	207	233	259	285	311
26	52	78	104	130	156	182	208	234	260	286	312

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C. Please check the category that best describes your job title:
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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
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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

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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

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96. ___ more than 2 years

M. How many miles of plant are you upgrading/ rebuilding?
97. ___ up to10 miles
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By Bill Riker

SCTE and *CT*: Growing together

Readers of *Communications Technology* will be familiar with the tagline "Official Journal of the Society of Cable Telecommunications Engineers" that appears on the cover. I am frequently asked about this line — the nature of SCTE's relationship with *CT*, how it was established and just how involved the Society is in the production of the magazine.

To answer these questions, and provide a behind-the-scenes glimpse of our interaction with Phillips Business Information, publisher of *CT*, I would like to briefly tell you about the history of our relationship.

During the early 1980s, the Society's monthly newsletter, *Interval*, had temporarily ceased publication. As the organization had fallen on hard times and did not have the finances to fund its printing and mailing, SCTE had to seek alternate methods of getting its news out.

Fortunately, the SCTE Board of Directors began a relationship with Paul Levine, a well-known CATV publishing professional who was starting up *CT* to provide the industry with a journal addressing the technical aspects of system operations. In short, it was a magazine aimed squarely at our membership and potential new members.

Paul generously offered to take on the responsibility of resuming *Interval*'s publication by binding it into the center as a regular insert in each issue of *CT*. This was truly a win/win situation: Our information would get out to our members and the industry as a whole, and the magazine would benefit from aligning itself with a professional Society that provided training and services that complemented its contents.

With *CT* now billed as the Society's "official trade journal," SCTE and *CT* grew together, with our membership figures expanding thanks in part to our increased exposure in the magazine, and *CT* gaining subscribers due to the influx of SCTE members. Interval, published as a half-page size eight-page booklet, was an integral part of each issue of *CT*.

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

Naturally, growth spurred change. By 1990, it was clear that SCTE had too much news to fit into eight small pages. *CT* graciously offered to let us return *Interval* to its original status as a stand-alone publication, published independently of the magazine and mailed only to our membership. Through a generous arrangement, *CT* would continue to fund the printing and mailing of each issue, even though *Interval* was no longer a part of the magazine. This unique arrangement remains in effect.

Also in 1990, we upped the page count of each monthly *Interval* to 12 pages from the previous eight. That figure was again increased, this time to 16 in 1992. Over time, the expansion of SCTE's in-house publishing capabilities has enabled our staff to take on all layout and production duties for each issue, delivering *Interval* each month to Philips' Potomac, MD, office on a disk as a complete, ready-to-print project. But *CT* continues to play an integral part in the preparation of each issue, as every issue is sent to its editorial staff in rough form prior to final production, to allow *CT* to make its comments and proofread the material for style and content.

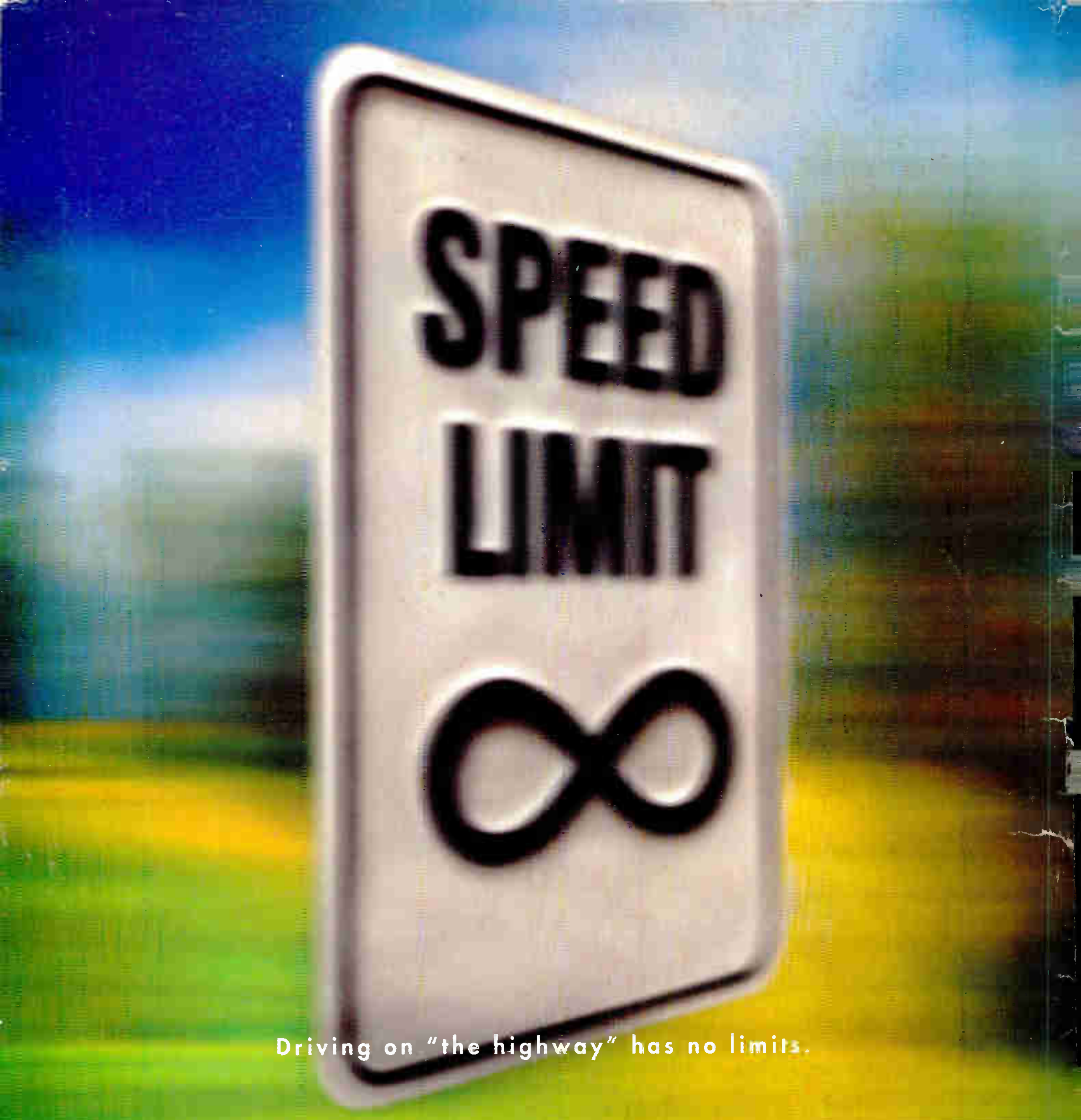
But our relationship with *CT* does not hinge solely on *Interval*. PBI provides full-page color ads in each issue of *CT*, as well as its sister publication, *International Cable*, allowing the Society to promote upcoming events, training offerings and other noteworthy SCTE programs and services in a national forum. Every issue of *CT* also contains: "SCTE News" (see page 11 in this issue) — a regular column containing our latest press releases and current information, "SCTE Bookshelf" (see page 76) — a listing of our training publications and videotapes with ordering information; and this column, which allows me to speak to the indus-

try each month, bringing specific facets or offerings from the Society to your attention and to provide an open forum for communication with our members and the entire cable telecommunications industry.

We frequently receive phone calls and correspondence at SCTE national headquarters from people believing we are the publishers of *CT*. While SCTE does not publish *CT*, we certainly participate in its operation. Editorial Director Alex Swan has graciously kept the Society staff updated on the many changes the magazine has been undergoing in its recent period of transition and revision, seeking our input on key issues as a new direction is forged.

With the recent appointment of Rex Porter as editor, I am confident that our relationship with *CT* will be closer than ever. Rex has played an integral part in the Society since its formation. In fact, he was at the first-ever SCTE meeting in 1969, and has been a driving force in the organization ever since, spearheading our scholarship program and participating at numerous national events. Rex is a true friend to the Society and one of its most valued members, and I am certain that his presence will be a great asset to the magazine.

I do believe that *CT* is in fine hands. I had the opportunity to meet with its new publisher, John O'Brien, at the 1995 Western Cable Show in Anaheim, CA, and came away from the meeting with this belief. John pledged the company's continued support and solicited my ideas for improving the magazine, and it is gratifying to know that our organizations will continue to grow together. **CT**


SPEED
LIMIT
Driving on "the highway" has no limits.