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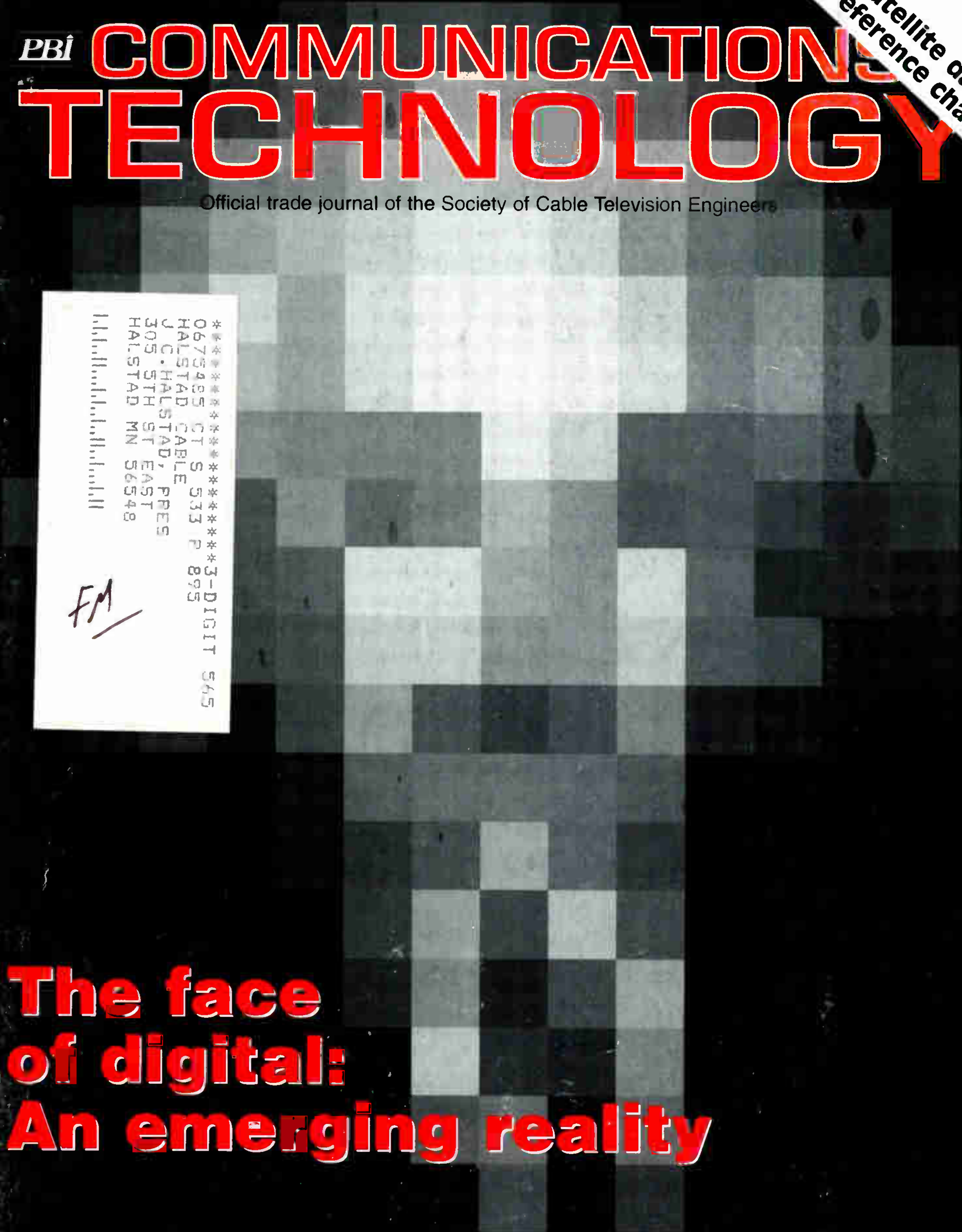

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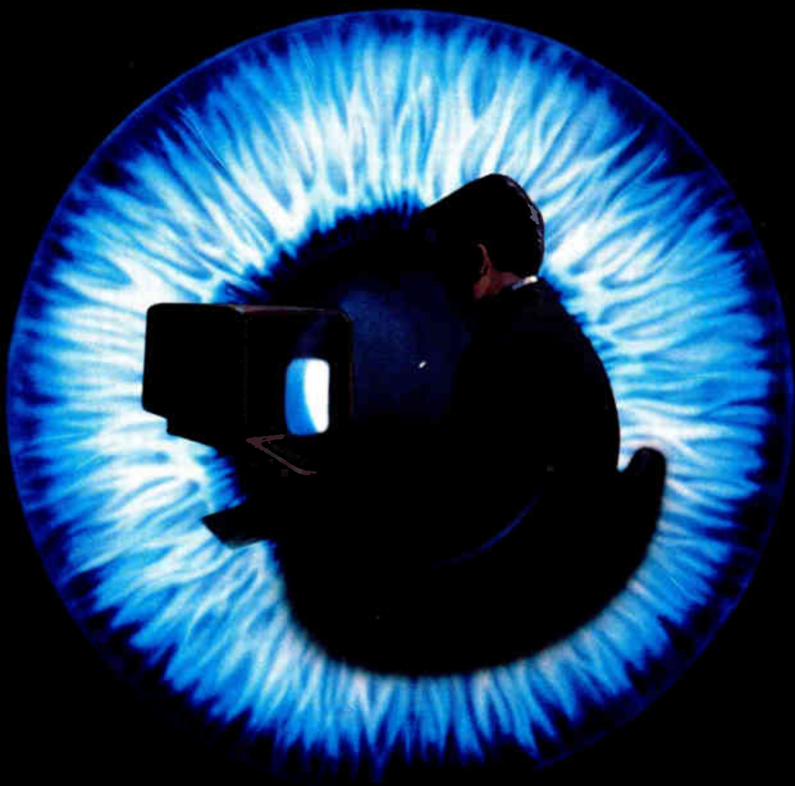

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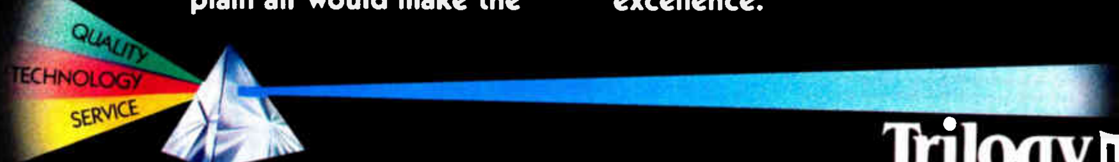

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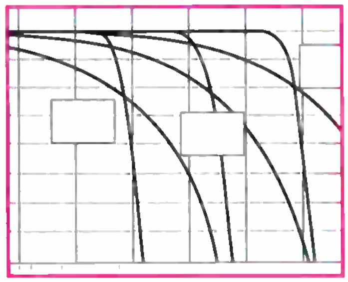

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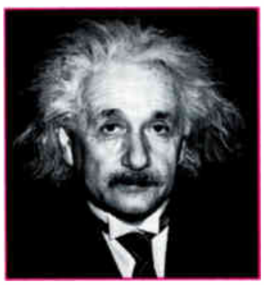

Charles White III

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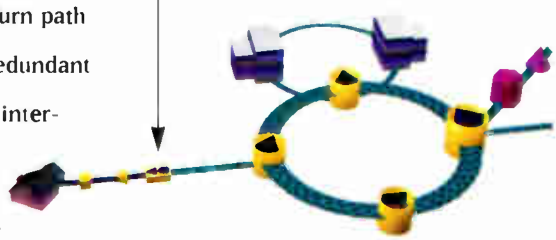

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Is convergence unraveling?

It wasn't all that long ago that cable TV and telephone companies were regarded as fierce rivals in the telecommunications picture. Remember the hype? The telcos were going to overbuild competitive services via their own networks. A lot of folks in the cable industry were in many ways afraid of the potential of the substantial "patient capital" the phone companies have access to. Then suddenly it seemed as if we had been lifelong buddies, given all of the proposed mergers and joint ventures that appeared almost overnight. Time Warner/US West, TCI/Bell Atlantic, Prime Cable/Bell South, Viacom/Nynex, Cox Cable/Southwestern Bell, Hauser/Southwestern Bell and Bell Canada/Jones Intercable — convergence was underway!

But is convergence coming apart? TCI and Bell Atlantic have called off their merger, and shortly before this was written, Cox and Southwestern Bell decided to call it quits. Both of these failed mergers have been attributed — at least in part — to the Federal Communications Commission's decision to roll back cable rates further. I suspect there were other factors as well, such as internal politics, power struggles and outright culture clash, but cable's inevitable reduced cash flow as a result of mandated lower subscriber rates certainly didn't enhance the merger picture. One question I have is whether or not other mergers will crumble in the wake of these two.

Who's seen our books?

But another, perhaps more important question looms in my mind. What of the knowledge these failed mergers have given to our once perceived competitors? Consider that during the merger process, our books have likely been wide open to the telcos. After all, any time one company acquires another, a lot of due diligence must take place just to ensure that one gets what one is paying for.

They know what our P&Ls look like, how much we pay for operating costs, cash flow, debt structure and just about every other intimate part of our business. And what did this valuable information cost? Perhaps several hundred thousand, or at most a few million dollars for attorneys, consultants, etc. Not a bad price to pay for so much information about the competition, eh?

While I doubt that was their original intent (I'm still convinced that convergence of some sort is inevitable), it certainly is a tremendous side benefit of the whole process, at least for the telcos. And like cable executives, telco executives talk to one another: at trade shows, over lunch and so forth. The telephone industry works, inside and out. Whether or not this information can or will be effectively used to compete in areas where the two industries have not come together remains to be seen.

Should more mergers come apart, it's conceivable that we could be competing against some of the telcos. And if this happens, you can be sure that they will be better prepared for competition than they were before all of this merger-mania. I for one hope this doesn't happen. Both industries stand to gain a lot from working together in the telecommunications business.

Ronald J. Hranac
Senior Technical Editor


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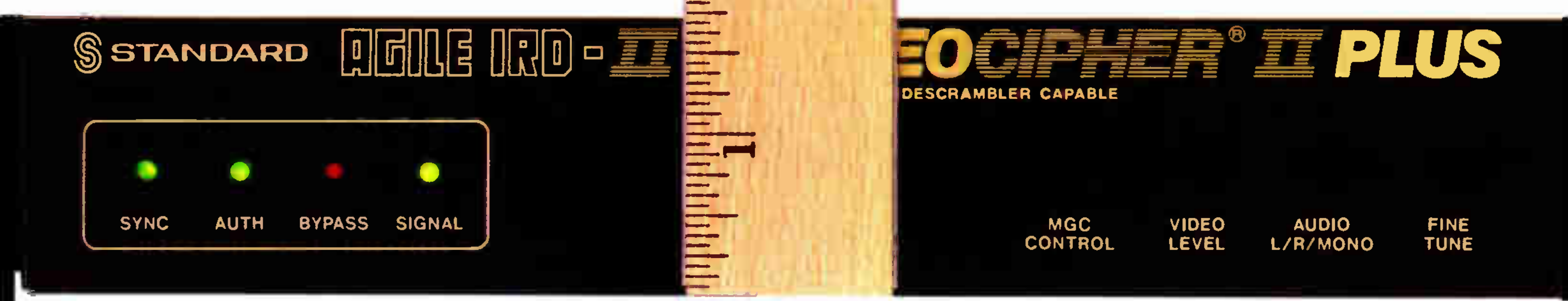

Highlights from OFC '94

SAN JOSE, CA — About 5,000 people attended the 1994 Optical Fiber Communication Conference held here in late February. There were a number of events pertinent to the cable industry ranging from success with digital/analog optical transmission techniques, to the commercial availability of a new generation of lasers and optical amplifiers based on rare-earth doped fiber technology.

A number of different groups gave presentations on transmitting analog and digital signals on the same optical fiber. X. Lu from AT&T Bell Labs said that they had developed a technique for determining the bit error rate of a digital signal using only a spectrum analyzer instead of using error detectors or other digital detection equipment. In a post deadline presentation, Lu announced that his group developed the first broadband AM-VSB/64 QAM hybrid lightwave CATV system that can provide 60 conventional AM-VSB channels (55.25-439.25 MHz) and ten 64 QAM (90 Mb/s each) channels (525-439.25 MHz) using a single DFB laser. It should be pointed out that this system has not yet been tested on a real cable TV network with in-home wiring and live consumers.

At a presentation given by researchers at Bellcore, a team led by Shlomo Ovadia announced the results of an experiment that compared DFB and YAG lasers for digital communication. The group directly modulated the DFB laser and externally modulated the YAG using a single 16 QAM signal centered at 539.25 with 60 AM-VSB CATV signals at 55.25-445.25 MHz. They found that the externally modulated YAG had an order of magnitude lower link penalty due to clipping when both lasers had the same modulation index.

Richard Bodman, chairman of AT&T Development Corp., gave his perspective on the development of the information highway. He said it is time to let the industry decide how the information highway will be built. "My advice to Al Gore is to declare that we won, then stand back and see what happens."

But at the same time, he acknowledges the shortcomings in making this work. Bodman said that about six months ago he ordered a 56 kb/s line for his home so that he could telecommute. Within a few hours Bell Atlantic had pulled the fiber right into his basement to a 4- by 7-foot board. Bodman is appalled that something so simple as a 56 kbps optical link could take up so much space, but then again, it was installed by a phone company. Bodman appealed to the fiber industry to create a smaller interface device that is easy to use in homes like his. He pointed out that in the end, "It is us, not the judges in Washington that have to deal with the users."

On the show floor, optical amplifiers were the hottest new development. Highlights included the first generation of commercial praseodymium amplifiers, fiber lasers and the first commercial optical amplifier selling for less than $15,000.

1,310 amplification

The ability to amplify light signals using doped fiber was first discovered about six years ago. Since that time, erbium has taken off as the dopant of choice thanks to its ability to amplify light at 1,550 nm. However, there has been intense interest in developing an amplifier capable of operating at 1,310 nm, which is more suitable for most fiber and equipment in operation today.

Hewlett-Packard (formerly BT&D), based in Wilmington, DE, announced a commercial praseodymium doped fiber amplifier (PDFA) operating in the 1,310 nm window capable of 18 dBm of output power and a 30 dB gain. Although Synchronous Communications of San Jose, CA, announced a PDFA last December, that one will not be shipping until the second quarter of 1994.

These two amplifiers are probably too expensive for the field today. Both cost over $60,000 each. But the fact that they are beginning to appear in the commercial marketplace indicates that some of the problems associated with building them are being overcome.

For example, with PDFAs silicon fiber cannot be used as a substrate because it inhibits amplification. Instead, the praseodymium is doped into a fluoride glass. This makes it more difficult to splice into an existing fiber link because there is a 1,300°C difference between the fusion splicing temperatures of the two kinds of fiber. H-P used angle-polish and active alignment techniques to splice the fluoride fibers to the silica ones.

The doped fiber used for optical amplifiers also can be used in high-powered lasers for communications or experimentation. United Technologies Optical System (UTOS), based in West Palm Beach, FL, announced Flaser, the first commercial fiber laser ready for field deployment. The $18,000 device is capable of outputting 15 mW of continuous power in the 1,550 nm range. The Flaser has a line width of only 100 Hz vs. as much as 20 kHz for a DFB laser. This makes the Flaser suitable for multiplexing large numbers of wavelengths together onto a single fiber.

Another benefit of the Flaser is that it can be tuned more precisely than DFB lasers. Richard Feaster, manager of photonic systems at UTOS, said wavelength dependent losses over long fiber-optic links enable certain wavelengths within the 1,550 nm window to travel farther on a given fiber. Consequently, telephone companies need to physically test a number of DFB lasers to determine which one performs best on the link because the DFB laser wavelength cannot be precisely controlled.

During manufacture, the Flaser can be tuned to the exact wavelength desired in the 1,530-1,550 nm range using a holographic technique that creates a Bragg grating inside the fiber. In the field, the wavelength can be manually adjusted ±1 nm to compensate for drift.

Today, the Flaser is still more expensive from a dollars/watt perspective than a DFB laser. However, a second version will be introduced in July capable of continuous operation at 50 mW with a cost of about $25,000. At this price, the Flaser will become more economic than other lasers for analog applications such as CATV.

Cutting costs

Although optical amplifiers are relatively simple, they are still quite expensive. Most commercially available models start at about $20,000. The

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highest single cost component is the pump laser, which now sells for as much as $8,000 for single quantities, according to vendors at the show.

However, much of that cost is for pigtailing components to the laser chip, so that it can be integrated into the amplifier. The pump laser chip itself sells for only about $3,000, according to one vendor. The price of optical amplifiers is likely to come down significantly if the cost of integrating these components together can be reduced.

IRE-POLUS, a Russian firm with offices in Chicago, is currently selling the lowest cost EDFA on the market. Its model FA-2N sells for $14,600 and is capable of outputting 60 mW of power. Company officials said the company is able to maintain these low costs because it produces everything from the laser chips to the finished product, and all of its labor is done in Russia where wages and other costs are significantly less than in the U.S.

The company also is selling a new line of low-cost optical amplifier modules, which are pumped by an external Nd:YAG or Nd:YLF laser. One model, the $5,600 EFM-010 is capable of outputting 1 W of power at 1,550 nm when pumped by a 4 W laser. However, the noise figure for this type of amplifier is far too high for most telecommunications applications. — *George Lawton, West Coast Correspondent*

Another gigamerger bites the dust

As reported by *CableFAX*, Cox and Southwestern Bell scrapped their $4.9 billion deal, citing the second wave of Federal Communications Commission rate rules that will result in decreasing cash flows. The companies already had been forced by the regulatory environment to renegotiate the venture, which was to entail the operation of 21 Cox systems (valued at $3.3 billion, with over 1.6 million subscribers), with Southwestern Bell contributing $1.6 billion in cash. The companies said they will continue to aggressively pursue their cable partnership in the U.K.

☛ Mountain Cable Industries Inc. signed an agreement with Netlink USA to supply 80,000 to 100,000 DBS satellite installation kits to be deployed nationwide over the next 12 months. The kit will be used to install the cabling from the satellite dish to the customer decoder box inside the house. →

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☛ TCI's test of advanced services via a two-wire, 124-channel system in Mt. Prospect, IL, will use next-generation Jerrold CFT 2900 converters, supplied by the GI Communications Division of General Instrument Corp. The test will include pay-per-view services, multiple pay channels, a la carte programming services and 24 channels of Your Choice TV. The channel capacity will be reached by activating an additional 62 channels on top of the 62 already in use. In other news, the company chose Sybase client/server technology for its customer service data network, a new internal information service designed to provide high-speed information processing to support digital compression, new programming and customer service.

☛ CableLabs and Pioneer Electronic Corp. announced their intention to develop a feasible method for digital signal transmission technology for North American cable TV systems. Pioneer will take part in the technical development of transmission technology and special large-scale integration (LSI) chips. CableLabs will provide technical facilitation and testing assistance. Results are expected by the spring of 1995.

☛ General Instrument Corp. has licensed its DigiCipher II video compression mode to C-Cube Microsystems. C-Cube plans to incorporate the DigiCipher II compression mode into its multimode video decoder and VideoRISC video encoder chips, which will also support the MPEG-2 standard. Also, GI announced a letter of intent with Standard Communications Corp. whereby Standard will be licensed to incorporate DigiCipher II technology into its satellite IRDs for educational, private and broadcast networks. Specific terms of the agreement were not disclosed.

☛ Bell Atlantic will invest $250 million to build a fiber network in Delaware over the next five years, expediting the delivery of interactive, multimedia home shopping and other information services to state residents.

☛ According to Scientific-Atlanta Inc., it is the first supplier of MPEG-based digital video compression to receive an order for a frequency division multiplex system, which allows signals to be uplinked from several different locations over a communications satellite transponder and distributed to hundreds of sites. The $2.7 million order was received from Marvin H. Sugarman Productions Inc., in order to deliver racing events from over 20 race tracks to bettors in over 700 North American off-track betting sites. In other news, S-A selected C-Cube Microsystems as a supplier of digital video compression circuits.

☛ Hyperion Telecom and TKR Cable are constructing a fiber competitive access network in the greater Louisville, KY, area. The network will be capable of carrying any data including real-time motion video, computer data and telephone signals.

☛ Time Warner Communications has begun an expanded effort in the competitive local exchange access business with the filing of a tariff on behalf of eight affiliated operating companies. These affiliates will begin offering interstate point to point (special access) and switched access transport services. The tariff allows the companies to compete directly with local telephone companies for access connections between long distance companies and end user customers.

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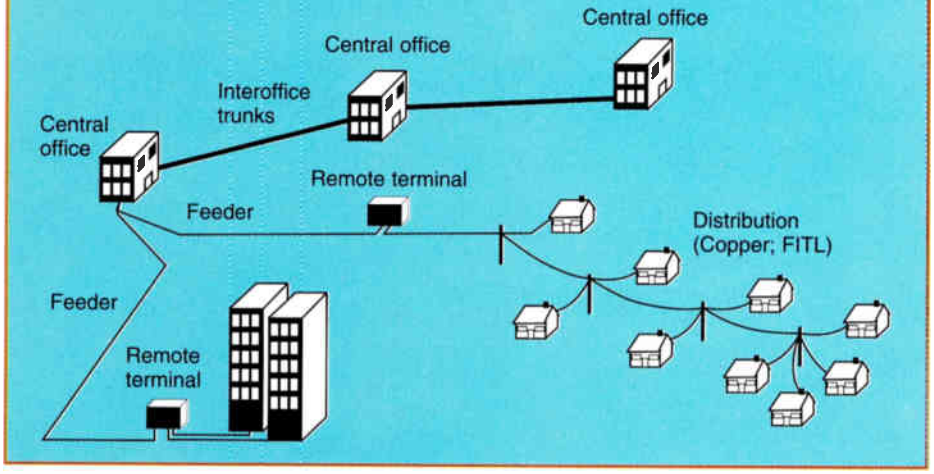
Figure 3: Telco residential network



terconnected with optical fiber supertrunks to improve reliability and lower operating costs. Today's fiber supertrunks typically employ AM, FM or digital transmission technologies depending upon service, cost and operational requirements. A typical fiber-based cable TV system is shown in Figure 2 on page 52.

The fiber trunk portion of the cable system transports the program signals from the headend to the neighborhood via an optical fiber link. Its primary goal is to preserve the high signal quality originating at the headend and deliver it to remote optical receiver nodes placed within neighborhoods for distribution over coaxial cable to the home. Approximately 15% of a cable TV system's total mileage consists of the trunk portion of the system, with each fiber trunk serving typically less than 500 homes.

The coaxial distribution plant provides for a high-bandwidth delivery system from the optical receiver node to the home. It consists of two types of cable: a larger, more rigid feeder cable (typically 1/2 inch or larger in diameter) and a smaller, flexible drop cable (about 5/16 inch in diameter). Cable TV feeder cable makes up approximately 40% of the system's cable mileage, while drop cable comprises the remaining percent of the total cable usage. Although drop cable typically is passive (no active components), cable TV feeder cable usually employs the use of one or two specialized amplifiers (line extenders).

Most new construction or coaxial plant rebuilds of cable TV systems in this country now routinely use a hybrid fiber/coax architecture. This type of architecture has evolved from the all-coaxial, tree-and-branch networks deployed over the last 46 years, and provides cable TV operators the immediate benefits of improved signal quality and reliability as well as reduced operating and maintenance costs.

Although first introduced for supertrunk applications, fiber has quickly become cost-effective for backbone overlays by reducing the long cascades of coaxial amplifiers in the system. As commercial prices for optical video transmitters have come down, fiber has continued to prove cost-effective for smaller and smaller subscriber serving areas. Today's preferred cable TV architecture replaces the existing coaxial trunks with fiber trunks and reduces the subscriber serving area to less than 500 homes. This architecture is commonly referred to as fiber-to-the-feeder (FTF).

The current trend in system rebuild practices is to reduce the number of coaxial amplifiers used within the distribution plant and provide even smaller subscriber serving areas per optical receiver node. As a result, node sizes have fallen dramatically from 2,000-5,000 homes passed a few years ago, to 100-500 homes passed now and in the near future.

The telco residential network

Today's fiber-based residential LEC network is similar in physical topology to that of a fiber-based cable TV system. (See Figure 3.) Like a cable TV headend, the central office (CO) acts as the central processing point for all incoming and outgoing voice and data signals.

Voice and data traffic is routed between COs on interoffice trunks that use high-speed digital transmission equipment. The routine use of single-mode fiber for upgrading these interoffice trunks began several years ago and is nearing completion.

The feeder part of a telephone network refers to the section of plant that runs from the central office to a remote terminal and is similar to cable TV's fiber trunk. Fiber was introduced in the LEC feeder plant more than 10 years ago to support digital loop carrier (DLC) systems. DLC systems reduced operating costs by permitting previously dedicated all-copper facilities to be replaced with lower-cost shared fiber transport facilities. In addition, multiplexing functions of the DLC provided flexibility to handle future growth of services as well as a more immediate reduction in operating expenses. The use of fiber to replace or upgrade existing copper feeder cables is now standard operating procedure at all of the large telephone companies.

The remote terminal equipment generally is located in a small building (hut) or equipment vault and contains all of the necessary digital time division multiplexing and demultiplexing equipment to support a "carrier serving area" of between 1,000 and 2,000 homes.

The distribution portion of a LEC network plant refers to the section between the remote terminal and customer residence. This outside cable plant typically consists of dedicated copper twisted-pairs carrying analog voice traffic from the remote terminal to the home. However, the dedicated twisted-pair copper wire from the remote terminal to the home continues to be a bottleneck to providing revenue generating services like video. As a result, a major effort was launched in the mid to late 1980s to evaluate and cost justify fiber-to-the-home (FTTH) and fiber-to-the-building (FTTB). Although technically feasible, FTTH proved to be cost-prohibitive for the near future, which led to the adoption of a fiber-to-the-curb (FTTC) architecture. FTTC provides a high-capacity switched digital network over fiber to optical network units (ONUs) that typically serve between four and 48 homes. ONUs house the necessary equipment to convert the optical digital signals to electrical signals and distribute them to their respective homes over copper twisted-pair. FTTC systems can be upgraded to support broadband services by a variety of technologies, including coaxial overlay, wave division multiplex-

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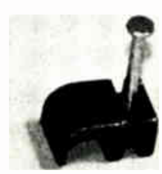

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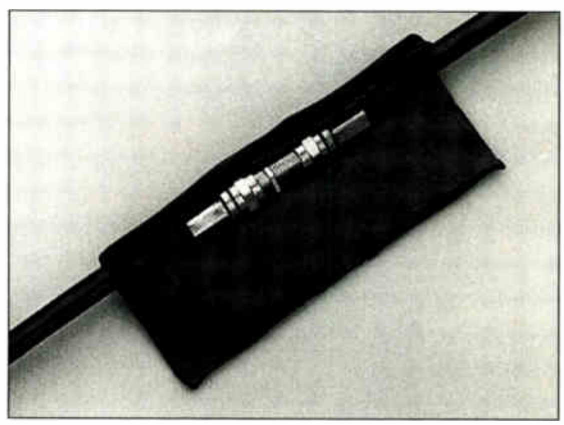

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Members elect national directors

March 28 marked the official closing of the Society's annual election for eight open seats on the Society's 1994-95 board of directors. With 24% of eligible members voting, the results of this year's election are as follows.

Re-elected to their current positions on the board are: At-Large Director Tom Elliot, TCI; Region 7 Director Terry Bush, Trilithic, serving Indiana, Ohio and Michigan; and Region 10 Director Michael Smith, Adelphia Cable Communications, serving Kentucky, North Carolina, Virginia and West Virginia.

Newly elected to the board are Region 3 Director Andy Scott, Columbia Cable, serving Alaska, Idaho, Montana, Oregon and Washington; Region 4 Director Rosa Rosas, Lakewood Cablevision, serving Oklahoma and Texas; Region 5 Director Larry Stiffelman, Comm/Scope, serving Illinois, Iowa, Kansas, Missouri and Nebraska; Region 8 Director Steve Christopher, Comm/Scope, serving Alabama, Arkansas, Louisiana, Mississippi and Tennessee; and Region 12 Director John Vartanian, HBO, serving Connecticut, Maine, Massachusetts, New York, New Hampshire, Rhode Island and Vermont.

These individuals will join the seven existing board members currently serving their 1993-1995 terms including At-Large Directors Wendell Bailey, National Cable Television Association and Wendell Woody, Sprint; Region 1 Director Steve Allen, Jones Intercable, serving California, Hawaii and Nevada; Region 2 Director Pam Nobles, Jones Intercable, serving Arizona, Colorado, New Mexico, Utah and Wyoming; Region 6 Director Robert Schaeffer, Star Cablevision, serving North Dakota, South Dakota, Minnesota and Wisconsin; Region 9 Director Hugh McCarley, Cox Cable, serving Florida, Georgia and South Carolina; and Region 11 Director Bernie Czarnecki, Cablemasters Corp., serving Delaware, Maryland, New Jersey and Pennsylvania.

The new board members will take their seats at the next meeting of the SCTE board of directors to be held June 14 prior to Cable-Tec Expo '94 in St. Louis. The board also will elect the Society's officers for the coming year at that meeting.

Membership meeting to be held at Expo

The Society will hold this year's Annual Membership Meeting on June 15 from 4:30-6 p.m. in Hall 1 of the Cervantes Convention Center in St. Louis.

The meeting will include an introduction of the 1994 board of directors, the annual report on the state of the Society and input from local chapters through the House of Delegates. All members are urged to attend.

Rick Bechtel: Chapter development

The Society is pleased to announce the appointment of Rick Bechtel as manager of chapter development. He is scheduled to begin his tenure on May 2.

A 13-year veteran of the cable industry and an SCTE member since 1983, Bechtel was one of the founders and a former vice president of program development of the Penn- Ohio Chapter. His interest in the or-

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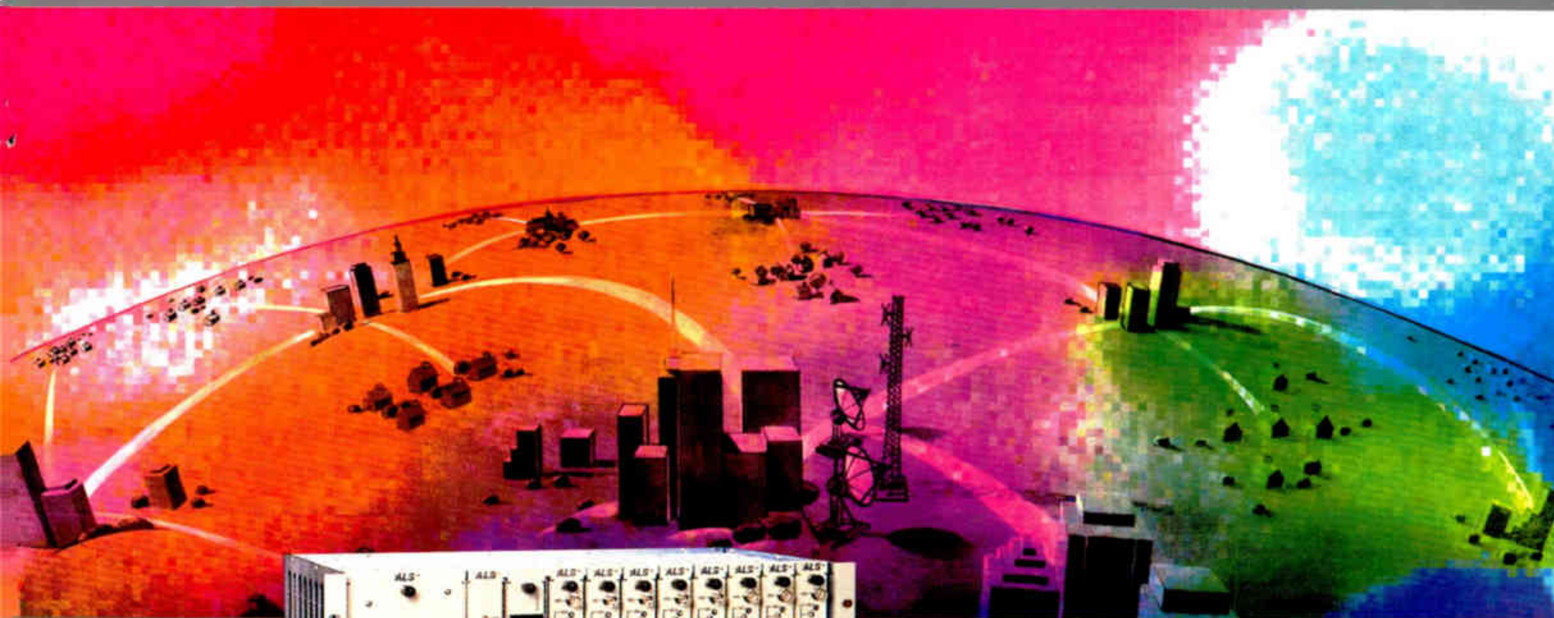

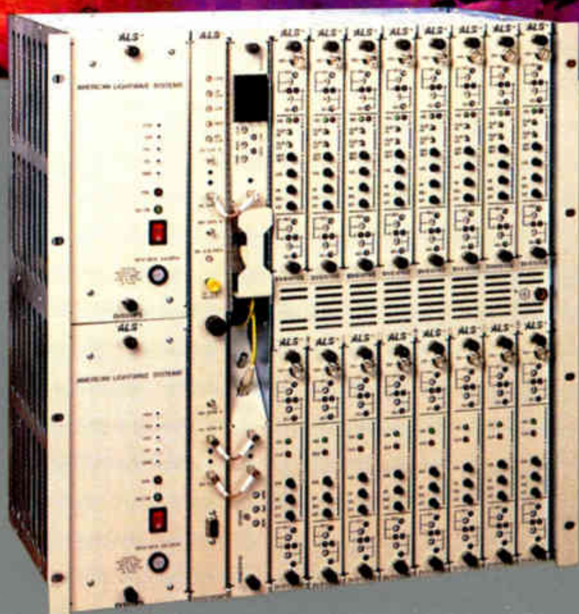

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ganization developed because he felt there was a lack of proper training for technical workers in the industry. He comments, "I saw SCTE as filling a great void in this area at a minimal cost to management."

In his position as manager of chapter development, Bechtel will provide chapter support services from his base at national headquarters in Exton, PA, as well as through visitations to the Society's 73 chapters and meeting groups. Bechtel states, "The SCTE has grown rapidly under Bill Riker's direction during the past nine years. As part of its continued growth, I hope to encourage chapters and meeting groups to become more successful and efficient in their training efforts for industry personnel."

Society co-sponsors Northeast conference

SCTE and the New York State Commission on Cable Television will be co-sponsoring the 20th Annual Northeast Seminar and Trade Show to be held June 27-29 at the Roaring Brook Ranch in Lake George, NY.

"Technology Update '94" is the theme of the conference that will feature a variety of presentations. These include "Engineering, Management and Professionalism" with Bill Riker, president, SCTE; "One GHz Systems" with Paul Gemme, vice president of engineering for Time Warner; "System Architecture, Review and Analysis" with Ted Hartson, director of engineering for Post-Newsweek Cable; "Technical Standards and Proof-of-Performance Testing" with Wendell Bailey, vice president science and technology for NCTA; "Integrated Overview of Telecommunications" with Tom Staniec, director of engineering for NewChannels; "Consumer Interface Devices" with Dr. Jeffrey Krauss, author/consultant *Communications Engineering Digest* and "Video Testing" with Mark Everett, Product Manager for Videotek.

In addition, BCT/E and Installer exams will be administered and SCTE staff will be available for consultation throughout the conference.

For further information contact: Albert Richards, of the New York State Commission of Cable TV at (518) 474-1324.

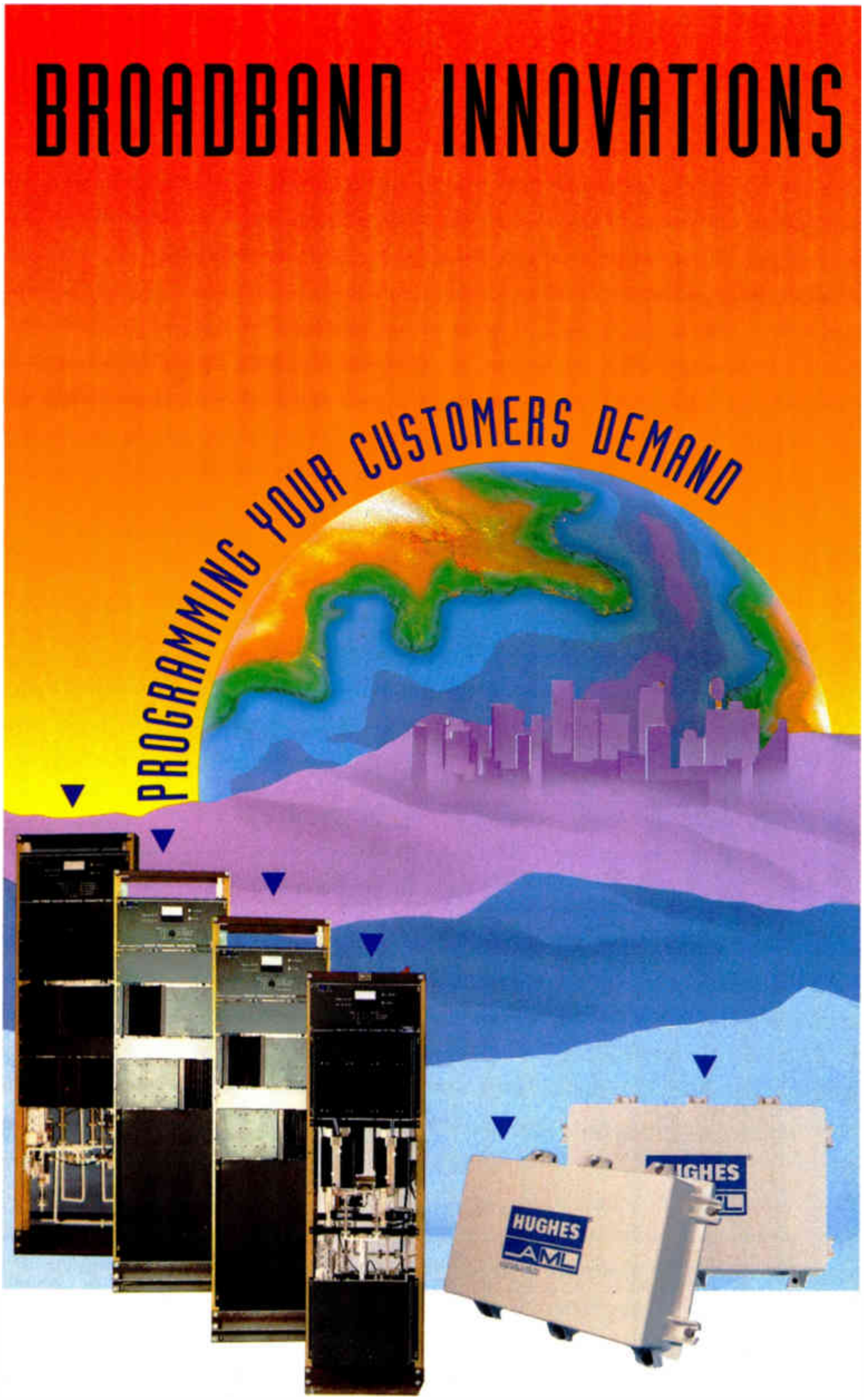
Multimedia Cablevision offers incentive program

The Society recently received a letter signed by Kansas Regional Operations Manager Percy Kirk of Multimedia Cablevision in Wichita, KS, concerning an ongoing tutorial of the seven categories covered on the BCT exam for its employees.

The letter states that Multimedia has now made it a requirement of the job that technicians become certified within a two-and-a-half year time period, three years for a new employee. Kirk says, "We believe that the SCTE training and certification at the technician level will be a necessity as our industry becomes more technically complex and demanding."

The letter continues, "In addition to providing training on company time for the categories, employees are rewarded with a bonus day off for each category passed. Our company also pays for enrollment into the program, ongoing membership dues, testing and also providing them time with pay while they are testing. Our chapter and company have put together an extensive library to help our members prepare for the topics."

Kirk also notes that in the Kansas area, 25 individuals are certified at the technician level and seven at the engineering level, for a certification rate of over 35%. His final comment is, "We have adopted this approach because we feel that our employees' involvement in SCTE will benefit not only themselves but the company as well."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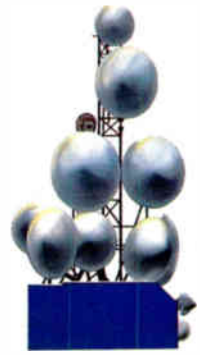


Picture Phone on cable?

Lawrence W. Lockwood
President, TeleResources
East Coast Correspondent

Figure 1: CCITT (TSS) H.320 (p x 64)

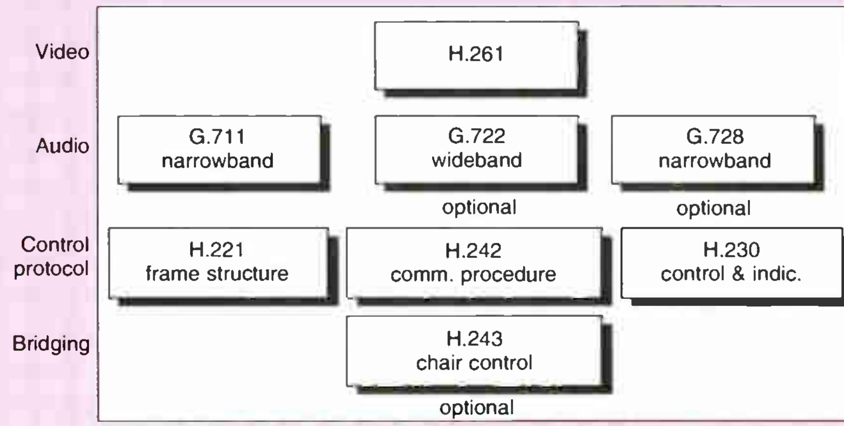
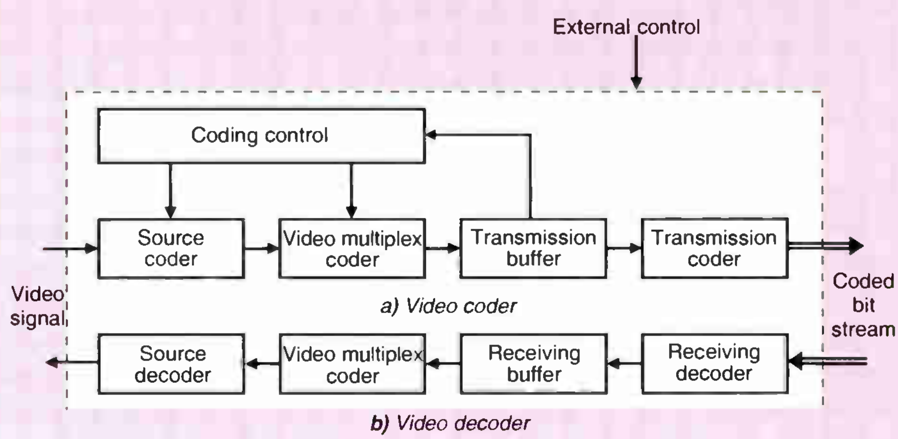
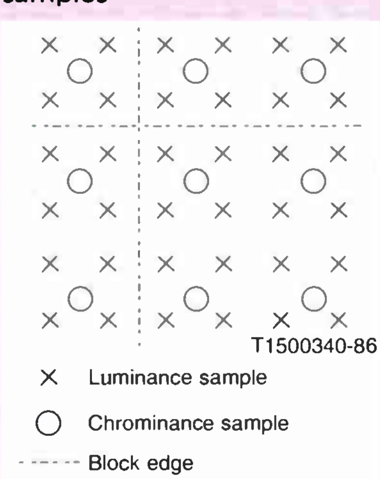


Figure 2: Block diagram of an H.261 codec



A candidate for the as-yet-undefined new business additions to arrive in the oncoming rush of the 500-channel interactive universe might well be video telephony. It could be provided to cable customers as an inexpensive add-on option to their regular service. The set-tops are already going to have MPEG decoders in them and the international standard for video conferencing decoding (H.261) is based on the same principles as MPEG, i.e., discrete cosine transform (DCT) and therefore the H.261 decoding could be incorporated into the MPEG decoder. Hence the add-on option could consist of a microphone, camera and an encoding chip (or embedded encoding software). The set-top mother board could be made with an empty socket to receive the encoder chip — much like PCs that have an empty socket to receive an optional math coprocessor chip. As an example, Integrated Information Technology Inc. (IIT), Santa Clara, CA, makes a chip that handles JPEG, MPEG and the entire H.320 suite.

Figure 3: Positioning of luminance and chrominance samples



Chronology of video telephony

At the 1964 New York Worlds Fair AT&T demonstrated the Picture Phone with the prediction that face-to-face communication was the next big step in telephony. It didn't happen quite that way. In those days there was no fiber-optic cable, not even satellites much less any digital compression. At that time period AT&T (the only communications game in town) had limited broadband capabilities consisting of a combination of coaxial trunking and terrestrial microwave that had been installed because of the requirements of broadcast TV networking — there were no other requirements for wideband transmission. Since the Picture Phone was an analog full bandwidth TV scheme, this proposal as big business lay dead for years.

It wasn't until the mid-1980s that

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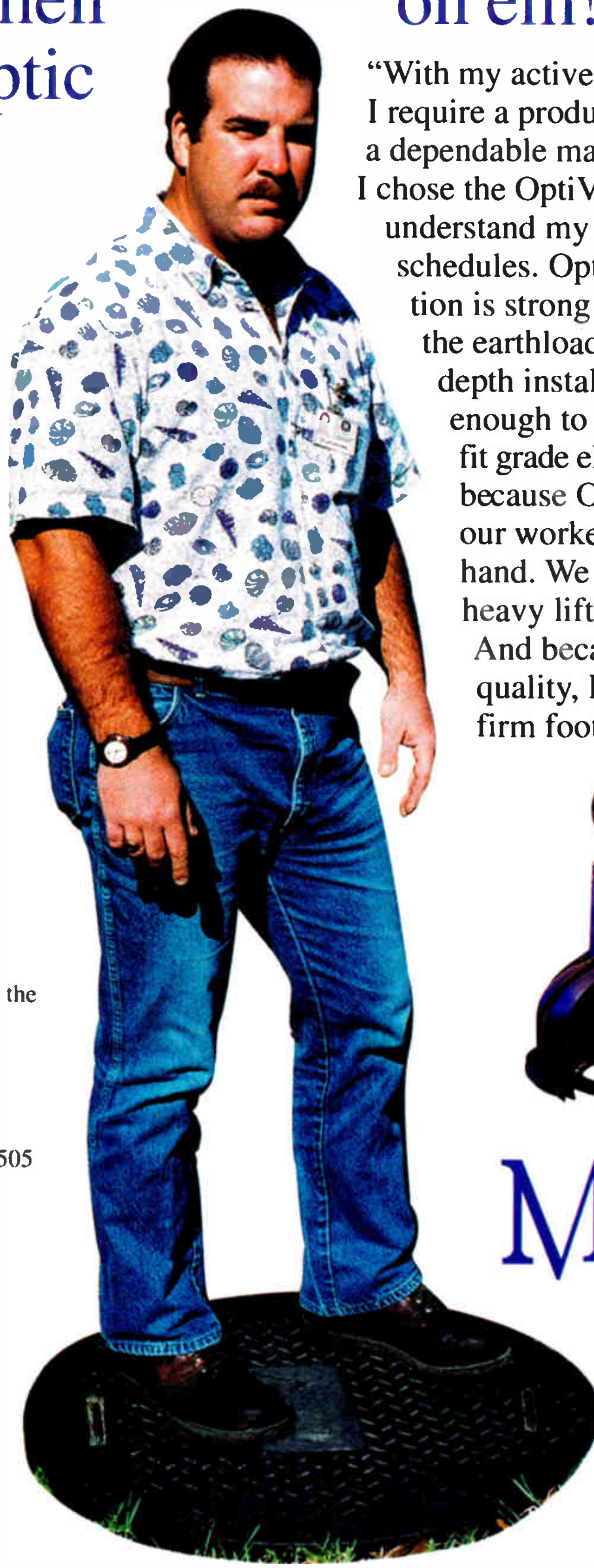

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Figure 4: P x 64/H.320 audiovisual terminal

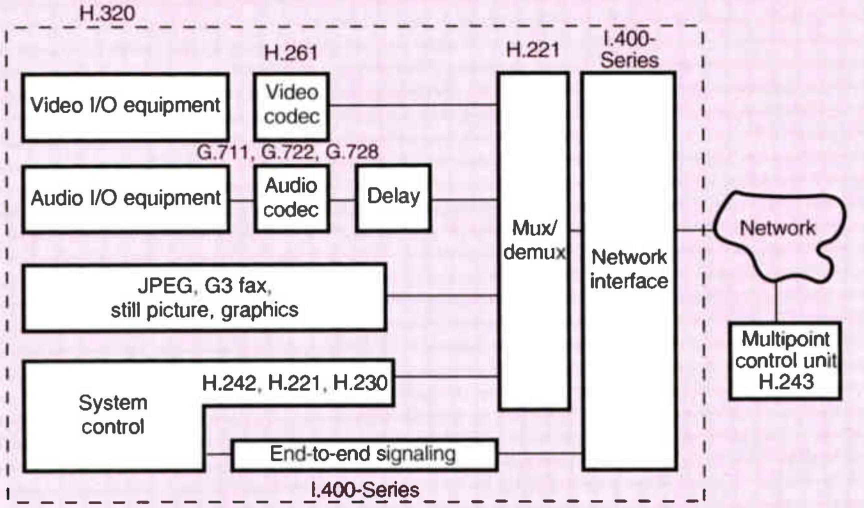

Figure 5: PictureTel model 50

Figure 7: PictureTel LIVE PCS 100 model

Figure 6: VTEL MediaMax model

the situation began to change. New cbdigital compression technologies permitted acceptable video quality at data rates as low as 768 kbps. International work on compression standards was started and in 1984 what was then the CCITT (International Telegraph and Telephone Consultative Committee) established a Specialist Group on Coding for Visual Telephony with a charter to develop recommendations for video transmission at m x 384 kbps (m = 1 to 5).[1] Later as the compression technology improved and lower video rates became feasible, standardization at p x 64 kbps (p = 1 to 30) also was considered, resulting in the CCITT Recommendation H.261, "Video Codec for Audiovisual Services at p x 64 kbps."

H.261 was approved in December 1990. At the same time, the H.320 (Narrowband Visual Telephone Systems and Terminal Equipment) standard was approved.

H.320

H.320 is really a family of standards (including H.261) covering video and audio compression and decompression, graphics, multipoint video conferencing, encryption, etc. (See Figure 1 on page 22.) In 1993 the CCITT underwent a name change — it is now the ITU Telecommunications Standardization Sector (TSS).

H.261 is the video compression decompression standard (see below).

G.711/G.722/G.728 — G.711 details the digitization and compression of 3 kHz or toll quality audio to 64 kbps. G.722 details the digitization and compression of higher-fidelity audio signals of 7 kHz to 64 kbps. G.728 was added after G.711 and G.722 and it provides for the digitization and compression of 3 kHz audio to 16 kbps, an important savings in data transmission bandwidth.

H.221 defines how all of the audio and visual information should appear in a data frame that is transmitted from one video conferencing location to another.

H.242 defines the protocol that instructs H.320 compliant equipment on the "handshakes" needed to send compressed audio and video between locations.

H.230 defines other information passed between H.320 codecs such as that needed for control functions.

H.243 defines a multipoint control unit (MCU) so it can link three or more H.320 video codecs for a multipoint conference.

H.261

A block diagram of an H.261 codec[2] is shown in Figure 2 on page 22. The source coder operates on 29.97 frames per second incoming television in a Y, C_B and C_R component format. Also the two picture scanning formats are defined. In the first format, common

intermediate image (CIF), the luminance sampling structure is 352 pixels per line, 288 lines per picture. Sampling of each of the two color difference components is at 176 pixels per line, 144 lines per picture. Color difference samples are sited such that the block boundaries coincide with luminance block boundaries as shown in Figure 3 (page 22). The second format, quarter-CIF (QCIF), has half the number of pixels and half the number of lines as CIF. All codecs must be able to operate using QCIF. Some codecs also can operate with CIF.

Means shall be provided to restrict the maximum picture rate of encoders by having at least 0, 1, 2 or 3 nontransmitted pictures between transmitted ones. Selection of this minimum number and CIF or QCIF shall be by external means (for example via Recommendation H.221) and come through the coding controls to the source coder.

The video multiplex coder arranges the data sequence to be transmitted and contains a 5 bit TR (temporal reference) sequence in the picture header that sends the information about the picture rate. The 5 bit number can have 32 possible values. It is formed by incrementing its value in the previously transmitted picture header by one plus the number of non-transmitted pictures (at 29.97 Hz) since the last transmitted one. The transmission coder has a video coding delay to permit synchronization of audio and video since their compression processing times are not the same.

The video decoder performs the reverse process.

Hardware

For a block diagram of an H.320 videoconferencing terminal including the H.261 and other standards outlined previously see Figure 4 on page 24.

In 1986 I wrote a column[3] on the emerging compression techniques as exhibited in an Armed Forces show in Washington, DC, in which I said "several companies joined together to show a communications capability that may well have extensive commercial applications in addition to the military ones pitched at the show." The companies reviewed in that column were Compression Labs and PicTel (now PictureTel).

After AT&T made its prediction about Picture Phone it tried to jump start the business by setting up videoconferencing rooms for rent in major cities. Although that approach was not successful, a few big corporations installed a limited number of conference rooms in some of their facilities. In 1984 the average video conferencing system cost $250,000 per site.[4] Such conditions severely limited the growth of videoconferencing until acceptable video compression arrived on the scene and finally became standardized with the H.261.

PictureTel, Compression Labs and VTEL, in that order, own all but 3 or 4% of the market. The other vendors fighting for the balance of the videoconferencing pie are GBT, BT North America, NEC, Mitsubishi and Hitachi. Compression Labs started out supplying the high-end of the market (e.g., large conference room systems). PictureTel, which was founded in 1984 by two students and an MIT professor, from the beginning aimed at more modest systems as did VTEL (VTEL was originally incorporated as VideoTelecom in 1986). However, now all three vendors are aiming at the same market — small and flexible systems. Figure 5 (page 24) shows a PictureTel Model 50 unit designed for medium to large groups and can be rolled from room to room. It has a zoom camera that can pan and tilt and, when required, focus on a document on the desk. In H.261 it transmits at 10-15 frames per second. This model has a 27-inch monitor and costs about $20,000. Figure 6 (page 24) shows the VTEL MidiaMax model that is an Intel 386 based unit with a 40 Mbyte hard disk and VTEL claims that it is the only software-based open-architecture conferencing solution in the industry. In H.261 it also transmits at a 10-15 frame rate but an option is available for an up to 30 frames per second capability.

The latest development by vendors is supplying PC add-on equipment for video conferencing. Figure 7 on page 24 shows the PictureTel LIVE PCS 100 model. PictureTel LIVE consists of two ISA PC boards, camera, microphone and speaker modules and required cabling. It costs about $6,000 (but you must supply the PC).

Conclusions

Perhaps not all of the H.320 standards would be required if Picture Phone became an optional CATV service (e.g., H.243 for multipoint conference control). Obviously one great advantage for CATV is the generous bandwidth available compared with telcos' capability (to date). The narrower the bandwidth the lower the data rate and the higher the compression ratio. Since under H.261 the display resolution is constant (CIF or QCIF), that means fewer and fewer picture updates can be made as the data rate is reduced. H.261 allows picture rates to vary from 3 to 30 per second. The camera takes at 29.97 fps, but within H.261 frames may be dropped so that the picture update may be of lower values. The display is run at 30 fps so there is no flicker, but with a low picture update there will be "jerkiness" because the picture itself is updated at whatever the transmission rate is.

"One great advantage for CATV is the generous bandwidth available compared with telcos' capability (to date)."

There is one major problem whose specific solution is not yet apparent — networking. Few — if any — would pay for the Picture Phone option if he could not reach outside his cable system. I say specific solution because no one yet knows the specific architecture of the future. What specific role will cable play in the information super highway? Perhaps there will be some type of merging with telcos — it appears certain that there will be more system interconnects. Although the specific nature of networking in the future cannot yet be defined, it seems more than a good bet that systems will be networked in some manner. The difficulty in predicting that specific future might be best summarized with a quote from that great American philosopher and sage, Yogi Berra, who said: "Prophecy is very hard ... especially about the future." **CT**

References

[1] "Digital Video Compression: Getting Images Across a Net," D. Minoli, *Network Computing*, July 1993.

[2] "Video Codec for Audiovisual Services at 64 kbps," H.261, CCITT, 1990.

[3] "Notes from the AFCEA Show," L. Lockwood, *Communications Technology*, August 1986.

[4] "Key Factors in the Videoconferencing Boom," T. Clayton, *Telecommunications*, January 1994.

[5] "PCs Rewrite the Rules for Videoconferencing," E. Gold, *Data Communications*, March 1994.

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Getting ready for the interactive video services revolution: An AT&T perspective

By Edward S. Szurkowski
Head, Interactive Computing Systems
Research Department
AT&T Bell Laboratories

Over the next several years, interactive consumer video services delivered via standard television are expected to present a large new revenue opportunity to system operators, programmers and many others in the CATV and related businesses. Capitalizing on this opportunity will require a well-conceived system architecture capable of delivering a wide variety of services and exploiting synergies between services.

Consumers approach television expecting to be informed and entertained by visually interesting and dynamic programming. To be widely accepted, interactive video services also must meet these expectations. Not only must the subject matter be compelling, but the production values must match those in conventional TV programming or the service risks being perceived as "cheap" or second-rate by comparison.

Substantial investment will be required to deploy systems that can deliver high-quality interactive consumer video services on a large scale. To justify this investment, the systems must be long-lived and based on an architecture carefully designed from the outset to accommodate new services as they are created and to incorporate new technology as it becomes available. In addition, a consumer video services architecture must cleanly integrate with both existing traditional CATV services, such as terrestrial and satellite-delivered broadcast TV, and with new service opportunities, such as telephony and personal communication services (PCS).

AT&T has been actively studying these challenges for several years, and the result is a new Integrated Consumer Video Services (ICVS) architecture and platform that is about to begin trial deployment and market testing in collaboration with a CATV operator and two local telephone companies. This article presents the ICVS architecture, including a high-level overview, descriptions of several of the major components of the system and discussions of the system trials scheduled to begin over the next several months.

ICVS platform architecture

The Interactive Consumer Video Services platform provides a comprehensive end-to-end system for delivering a wide variety of digital video services to consumers. All components of the platform have been defined and prototyped for trial deployment in 1994 and beyond.

The platform is based on international communications and computing standards wherever they exist and are applicable. Where standards do not yet exist, AT&T intends to offer its ICVS platform interface specifications for consideration as standards in the appropriate industry forums.

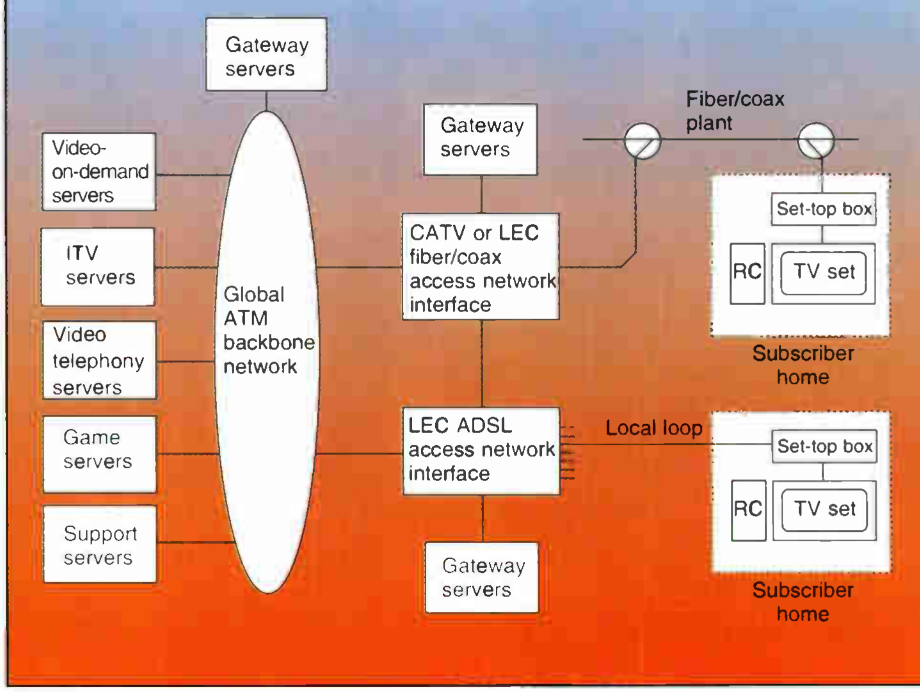
A truly successful interactive consumer video services delivery system will be global in scope, fully interoperable and as broadly deployed as television and telephony. The problems of large-

"Interactive consumer video services delivered via standard television are expected to present a large new revenue opportunity."

scale systems are frequently not technological, but rather ones of logistics, operations, customer support and similar issues. Systems destined for large-scale deployment must be designed to minimize these problems from the beginning. Systems that work for 10,000 or even 100,000 households cannot be easily scaled to serve hundreds of millions of people.

In the ICVS platform architecture (Figure 1) a global broadband asynchronous transfer mode (ATM) backbone network connects distributed server complexes, which provide various services to customer homes via broadband access networks such as CATV fiber/coax plants or local exchange carrier (LEC) copper local loops using ADSL. An unlimited number of these access networks can be driven from the backbone network, provided that sufficient servers have been deployed to meet peak demand for services. As also shown in Figure 1, this architecture requires only a standard TV with a simple adjunct set-top box and remote control in the consumer home.

Figure 1: Integrated Consumer Video Services platform



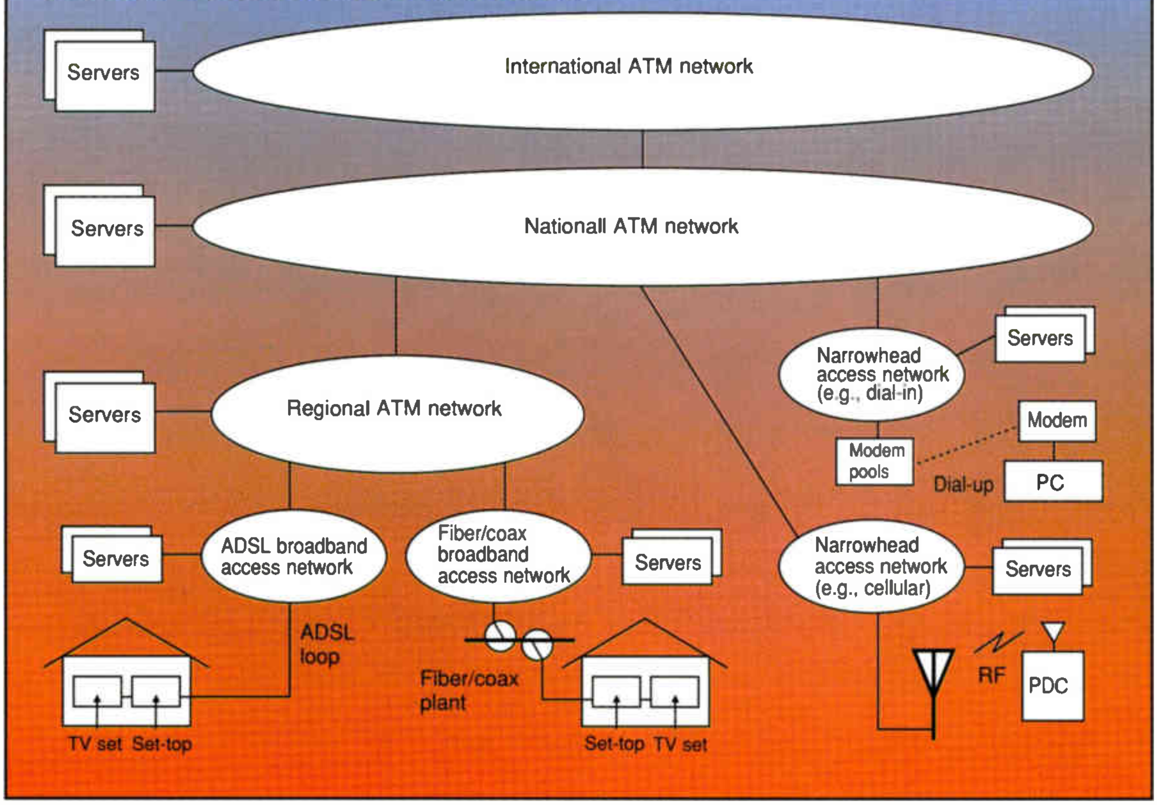
The global broadband ATM backbone network in the architecture is not monolithic. As shown in Figure 2 (page 30), it is composed of a hierarchy of interconnected ATM subnetworks covering various geographic areas. These ATM networks can be owned and operated by regional access network providers and/or long-haul carriers. Just as there will be competitive broadband local access networks over time, there also will be competitive backbone networks and server complexes. ICVS has been designed to accommodate these competitive infrastructures and service providers.

Broadband backbone networks used for consumer video services also must be interconnected to narrowband access networks. This will enable traditional narrowband services, such as electronic mail, to be used with both broadband and narrowband terminal devices. For example, someone with a personal digital assistant (PDA) or personal digital communicator (PDC) could send a text message to another person who could read it using an interactive TV application. This synergy of narrowband and broadband services will become increasingly important.

Customer premises equipment

The cost of new equipment required on customer premises is a prime deter-

Figure 2: Backbone network structure



minant of the market acceptance of new services. The less expensive the customer premises equipment (CPE), the more customers will try the service. In the ICVS platform, this CPE would typically be a set-top box (sometimes also called a home terminal) similar in size and appearance to those widely deployed in traditional CATV systems.

The ICVS platform has been designed to simultaneously support a wide range of set-top capabilities and prices. At the low end, a very basic set-top for a fiber/coax plant would provide the traditional analog functions of tuning and addressable descrambling, along with a single channel of MPEG-2 video decompression, stereo audio decompression and the appropriate digital security mechanisms. These boxes are essentially the same as those being deployed to support digitally compressed broadcast and enhanced pay-per-view programming. An initial target price of approximately $300 has been widely quoted within the industry for this type of set-top for delivery in late 1994 and early 1995.

The platform is capable of delivering a wide variety of interactive services, including movies-on-demand, home shopping, telephony, messaging and games — even with simple low-cost set-top boxes. Advanced functionality is moved out of the home and back into the network where it can be economically shared across a large subscriber base.

The platform also supports set-top boxes, or other CPE, with substantial local processing and video-generation capability. For example, the set-tops being used in the trials of the ICVS platform contain three channels of MPEG-2 decompression, with independent real-time scaling and translation of the decompressed video, eight channels of audio decompression, a RISC microprocessor, two PCMCIA slots and several other features. These boxes represent the high-end of set-top functionality, and

have been designed for the AT&T trials to allow testing of the broadest possible mix of services. Over time, the functionality in this box could be provided at reasonable cost, but currently these boxes cost several thousand dollars each in small quantities. AT&T does not expect boxes of this type to ever be widely deployed outside trial environments.

All set-tops used with the ICVS platform include a data port for connecting external devices, such as PCs or games. The data port allows these devices to share the digital communication infrastructure provided by the platform even if they do not have any direct association with providing interactive video services (as would typically be the case with PCs at home). Providing high-bandwidth data networking capability in the home presents another potential revenue opportunity for the access and backbone network providers.

Networking

The platform uses entirely digital networking. Within the backbone network, all transport and switching is ATM-based with SONET transmission facilities. ATM enables the platform to support a wide variety of services with different communication needs, using a common transmission and switching infrastructure.

The platform transports ATM cells, unaltered, directly into customer residences. ATM virtual path (VP) and virtual circuit (VC) switching in the network is the primary means of connecting subscribers to the various servers without creating bottlenecks. In general, a subscriber set-top box is dynamically assigned a VP on initialization, with the various subsystems with the set-top being assigned VC addresses within that VP. These addressable subsystems include the audio and video decompressors, CPU, data port, etc. This granularity of addressing allows the facilities within a given set-top to be driven by various independent sources in the network without interference.

Within the CATV fiber/coax access networks, 64 QAM RF modems convert standard 6 MHz analog channels in the 50 MHz to 1 GHz spectrum into digital channels. The number of these digital channels is limited only by the unused spectrum in the plant and do not interfere with any of the existing analog services currently on the system. Each digital channel provides an error-corrected 28 Mbit/s stream of standard 53 byte ATM cells. The capacity of these digital channels will increase significantly when 256 QAM modems are deployed within the next few years.

There are two options for upstream transport within the platform. Both operate entirely within the standard 5 MHz to 30 MHz upstream spectrum allocated in a subsplit frequency plan.

The first upstream option uses shared 2.048 Mbit/s TDMA channels. Set-tops are dynamically assigned time slots in this channel during a call setup or initialization phase. Each set-top box can be allocated upstream bandwidth in units of 64 kbits/s. The 2.048 Mbit/s TDMA channels use QPSK modulation and occupy 1.5 MHz of RF bandwidth. This option is particularly attractive if the fiber/coax plant is already configured for offering voice telephony services using AT&T's CLC-500 system.

The second upstream option uses independent narrow bandwidth upstream channels, which are frequency-agile within 5 MHz to 30 MHz. Each set-top box uses one or two of these channels, with frequency assignments being made during call setup and initialization. Each channel provides either 64 kbits/s (for data and signaling) or 384 kbits/s (for

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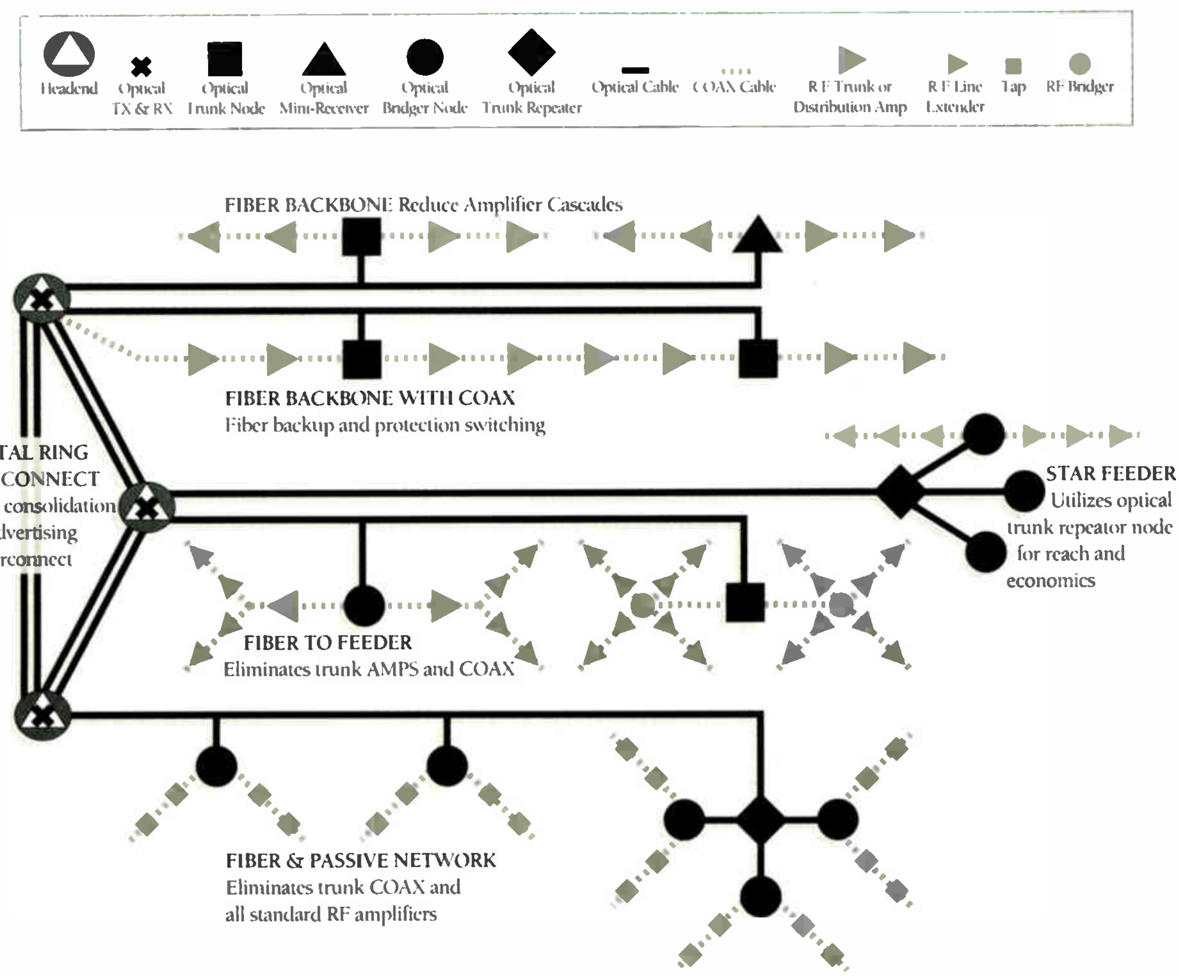

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"A consumer video services architecture must cleanly integrate with both existing traditional CATV services ... and with new service opportunities, such as telephony and PCS."

H.261 compressed digital video telephony) and uses QPSK modulation. This upstream option is attractive if significant portions of the 5 MHz to 30 MHz frequency spectrum are already in use for other services, or if there is significant ingress of interfering signals.

To connect a fiber/coax access network to the backbone network, SONET optical fiber multiplexers and RF modems are placed in the system headend and connected to the plant. This equipment is relatively small and is remotely monitored and controlled using standard telecommunications operations support systems.

Even using 2.4 Gbit/s SONET multiplexers, a substantial number of fibers may be required to connect a large fiber/coax access plant to the backbone network. However, construction to install additional fiber transmission facilities can be prohibitively expensive and may be impossible because of nontechnical factors. To alleviate this situation, the ICVS platform uses dense wavelength division multiplexing (WDM) to create several distinct optical paths on a single physical fiber.

Conventional WDM creates two optical paths on a single fiber using lasers operating at 1,310 nm and 1,550 nm. The dense wavelength division technology used in the AT&T platform can place up to 10 optical carriers within the 1,550 nm transmission window. A passive optical device, called a waveguide grating router, has been developed by AT&T Bell Labs to separate optical carriers with frequency differences of approximately 200 GHz (or 1.6 nm). Other than choosing lasers with the appropriate wavelengths, this WDM technology requires no changes to the multiplexers or other terminal equipment.

The ATM backbone network is com-

(Continued on page 91)

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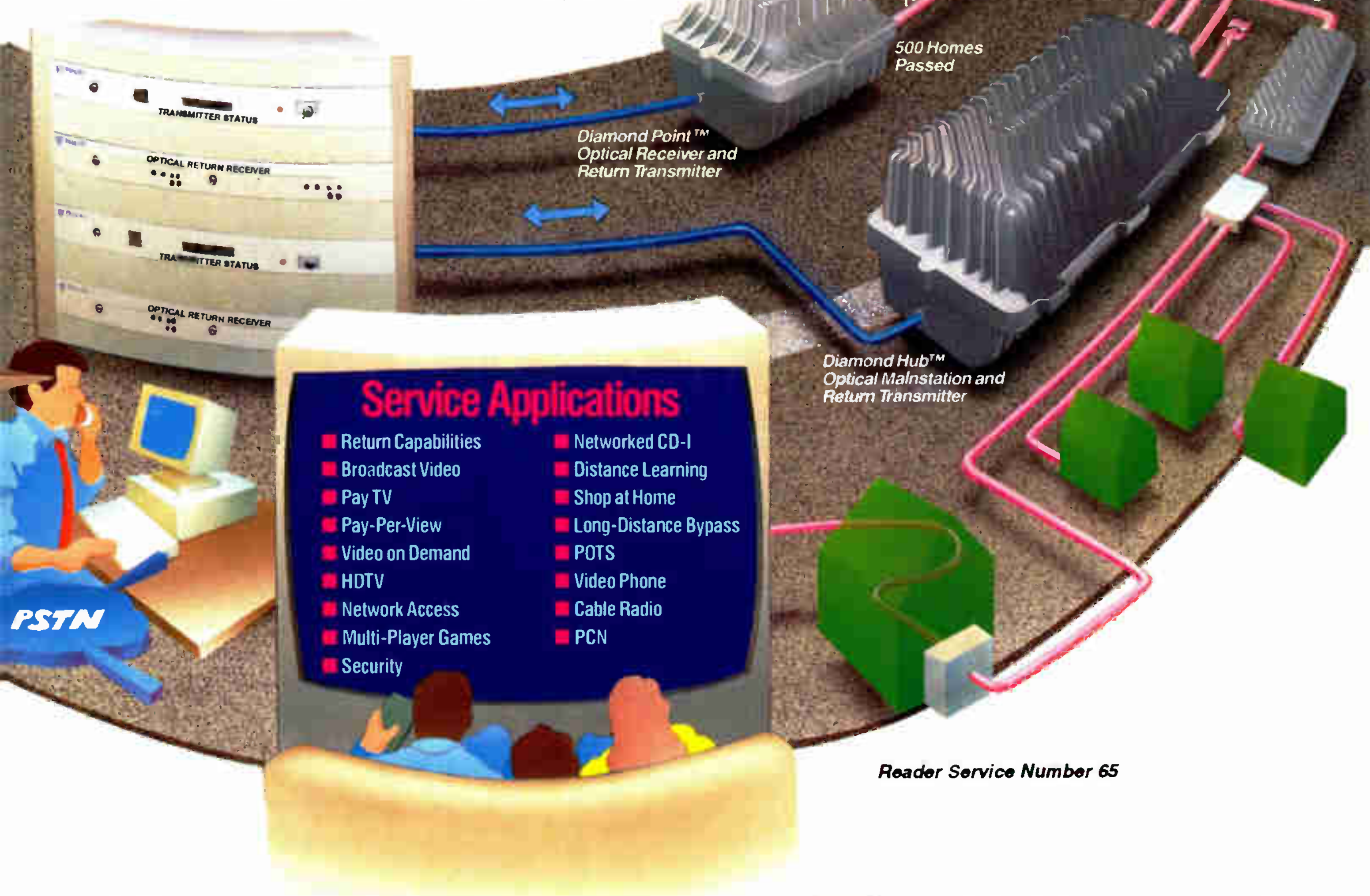

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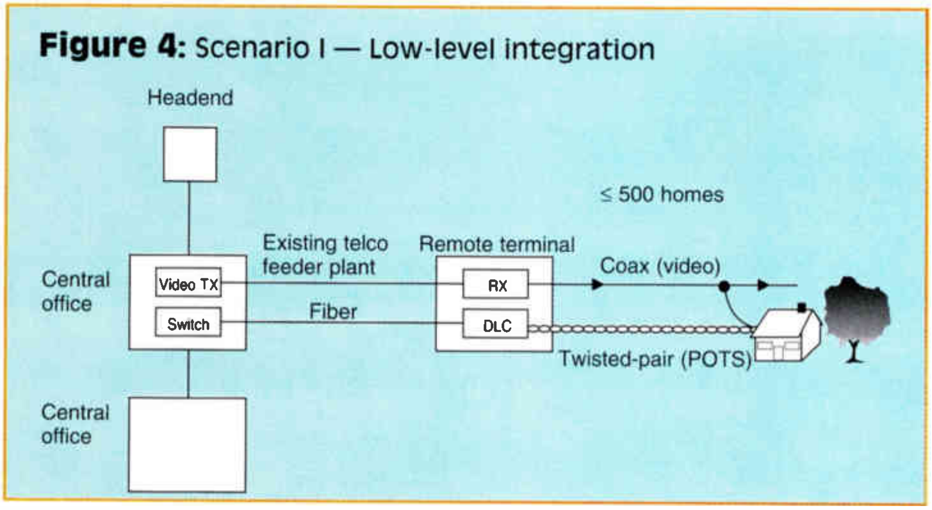


ing, and digital multiplexing of voice and video. Several FTTC topologies have been proposed and evaluated including bus, star and passive optical network (PON).

Telco FTTC

Narrowband FTTC networks have reached cost parity with copper for new construction in many situations and are being considered for widespread deployment throughout the telephone industry for rehabilitation and replacement of aging copper plant. FTTC deployment is being driven by two goals: 1) lower operating and maintenance costs vs. all-copper systems for narrowband plain-old-telephone service (POTS); and 2) the evolution to a video services platform to generate increased revenues.

To date, more than 100 FTTC field trials have taken place in North America and Europe with several large deployments currently underway. Bell Atlantic is deploying FTTC systems to more than 100,000 homes in New Jersey and Virginia for video dialtone applications, while Bell South is deploying a similar number of lines for POTS in four cities within its region. The German telephone company, Deutsche Bundespost Telecom (DBT), however, is leading the world market with a three-year deployment of 1.2 million lines begun in 1993.

Although narrowband FTTC systems are expected to reduce operating expenses for POTS compared with copper, video capability provides an opportunity to generate new revenue streams. Annual growth of the regulated residential telephone business (basic telephone service) averages a mere 3-4% and thus most LECs perceive growth limitations.

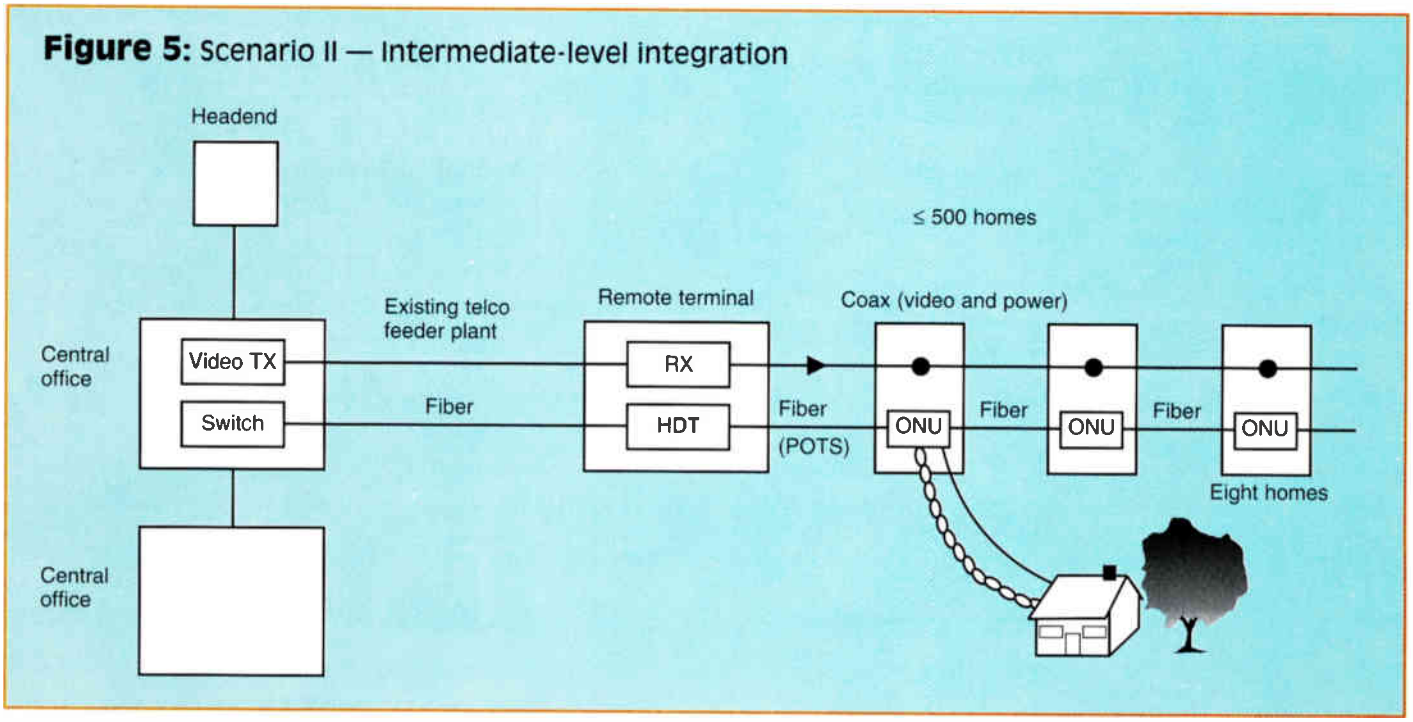
Today, cable TV and telephone companies have a number of technologies to consider that could provide the necessary means for delivering an expanded array of services to the home. Those technologies include asymmetrical digital subscriber line (ADSL), direct broadcast satellite (DBS), wireless personal communications systems (PCS), 28 GHz video distribution systems, and fiber/coax systems. However, determining the best way to provide cost-effective video capability with conventional FTTC systems has been the subject of debate for several years.

Of most interest to the cable TV industry is the evaluation by major telephone companies of fiber/coaxial hybrid architectures for the provision of interactive high-bandwidth capability to the home.

Full service fiber/coaxial hybrid

A fiber/coaxial hybrid architecture providing voice and video capability may provide a good balance between the reliability and functionality of a narrowband FTTC network and the low implementation costs of the cable TV industry's FTF. The use of coaxial cable in the "last mile" offers telephone companies a flexible starting point in providing broadband services to subscribers inside and outside their operating areas.

Fiber/coaxial hybrid architectures could be deployed in a variety of ways



Video distribution in metro areas using digital fiber systems

By Robert W. Harris
Digital Applications Engineer

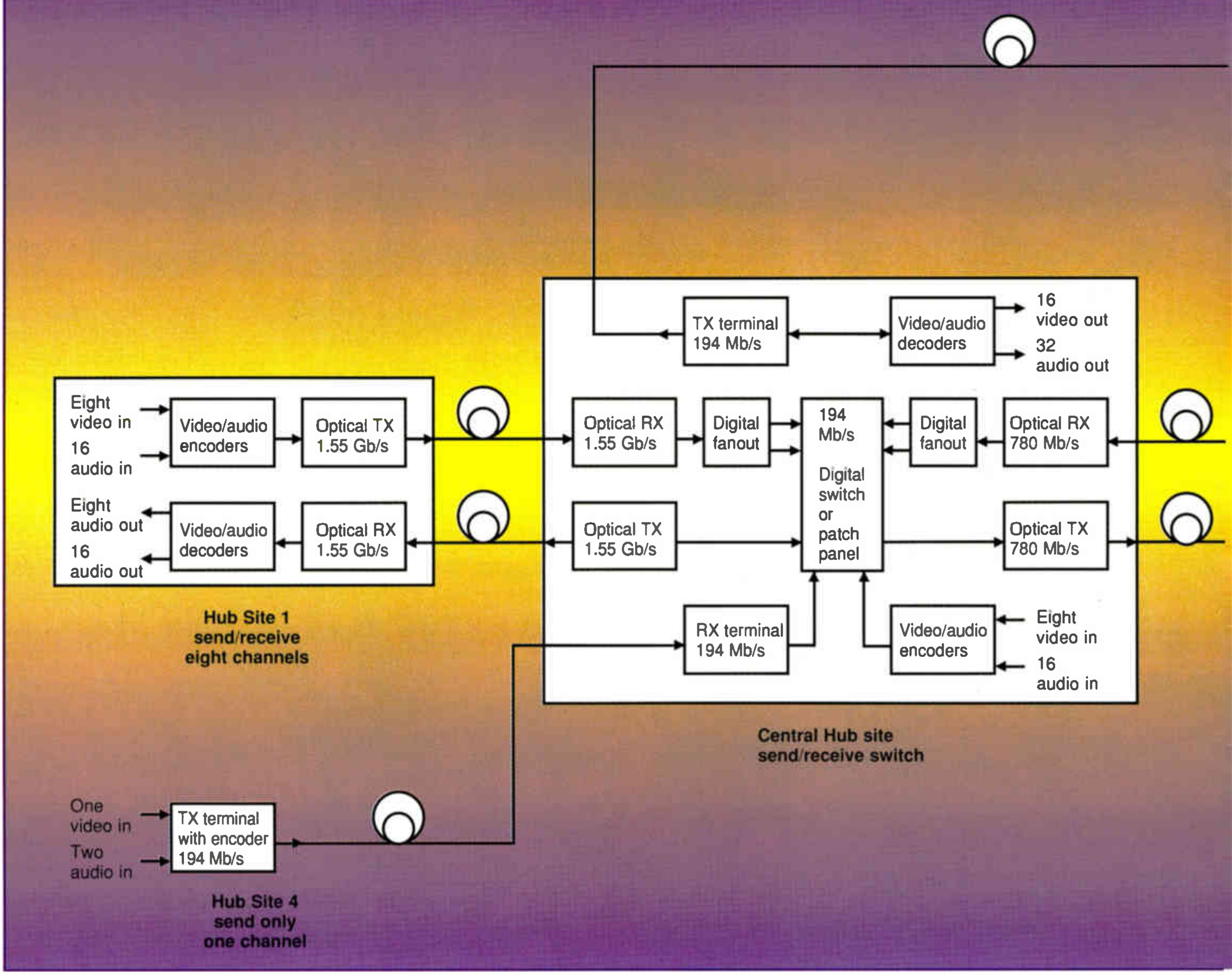
And Ken Regnier
Director of Sales, Broadcast and International Digital Video
C-COR Electronics Inc.

Transmission of video over high-speed digital fiber-optic systems has seen widespread use in CATV networks within metropolitan and regional serving areas. These digital systems replace older AML microwave systems, FM systems and stand-alone headends, and serve as backbone networks transporting video, audio and data services to hub sites within the CATV network.

Within many cities there is now a rapidly increasing need for high-quality, cost-effective interconnect capability among the following:

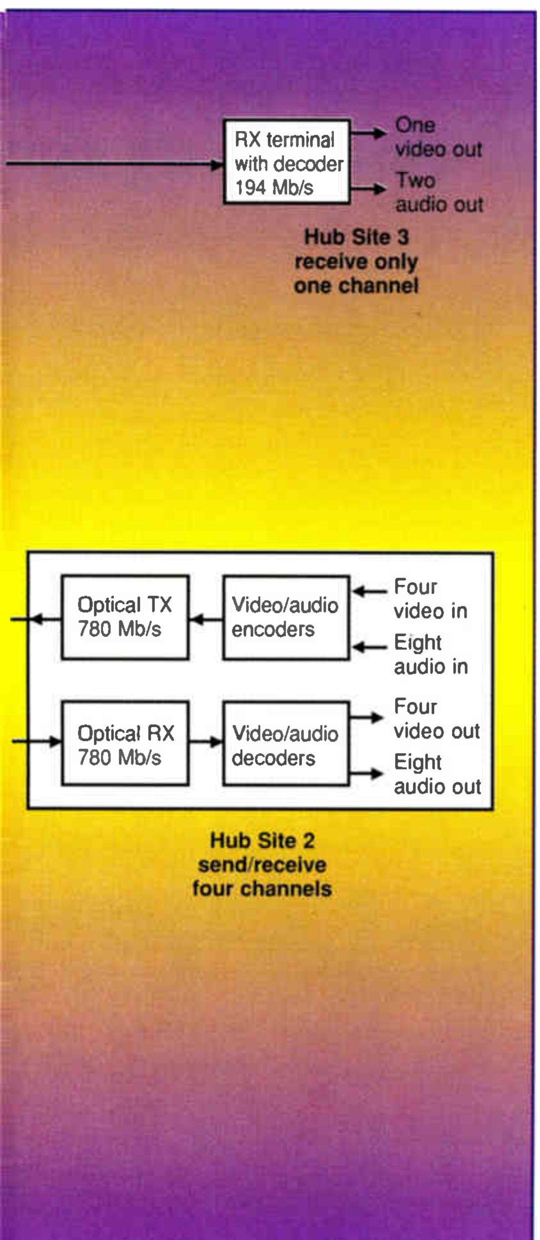
- TV broadcast studios
- TV transmitter sites
- Teleports and satellite earth stations
- Public buildings and stadiums

Figure 1: Metropolitan video fiber network central hub switched star



- Educational and commercial video facilities
- Commercial CATV systems

The need for these new networks is driven by the limitations of existing video microwave availability and/or limitations in performance and availability of coax copper line networks. Another major factor has been the increased business opportunities created by new interconnect capability. Operating economies and quick response time for TV news and special events is enhanced by interconnects to public buildings and facilities. Service reliability and signal performance is often improved by interconnecting broadcast studios and CATV headends. Interconnects between educational and commercial video facilities can enhance programming and video production activities as well as provide public service information and educational TV opportunities.



Until recently, the use of fiber optics for these networks has been severely limited by a lack of fiber availability. If a fiber was installed within a city by a local telephone utility, it was generally either unavailable for other uses or too expensive to lease. However, this situation is changing as other fiber routes become accessible from sources such as alternate access carriers, CATV networks and public utilities. As a result, video transmission over fiber networks becomes a practical and reliable alternative to microwave radio or coax copper systems. The use of digital technology in the fiber-optic terminal equipment adds the element of very high quality transmission and low maintenance to the already inherent advantages of fiber.

Digital system transmission advantages

A clear advantage of digital video transmission over its analog counterparts (FM, AM and AML) is its consistent and repeatable signal performance. Digital video systems are capable of providing both medium- and short-haul RS-250C specifications. Further, the signal performance through a digital fiber-optic system is not affected by the following:

- Optical path loss or optical splitting
- Optical repeating/regeneration
- System expansions or channel additions
- Add/drop multiplexing techniques
- Number of video or audio channels
- Video or audio format

Digital video fiber-optic network configurations range from simple point-to-point links to sophisticated "self-healing" rings using "drop and repeat" and "add/drop multiplexing" functions along with full optical path and electrical component redundancy.

Typical digital transmission systems digitize (sample, quantize and code) up to 16 baseband video channels, then synchronously time division multiplex (TDM) each on a single high-speed data stream at, for example, 1.55 Gb/s. This allows every channel to be fully independent of one another. As such, video channels can be added or removed from the optical transmission channel without affecting any other signal or part of the system. Further, single channel contribution links can be easily integrated into the multichannel system for transmission and distribution into the network.

"Digital video fiber-optic network configurations range from simple piont-to-point links to sophisticated 'self-healing' rings using 'drop and repeat' and 'add/drop multiplexing' functions along with full optical path and electrical component redundancy."

Fiber-optic interconnect networks generally follow two types of architectures: star or ring. The next part of this article will outline two system examples for transporting and distributing video services within a metropolitan area network using digital fiber-optic systems.

Star network

Figure 1 shows a star network that includes digital switching (or patching) at the central hub site. This example shows how bidirectional and unidirectional links of different channel capacities (data transmission speed) can be combined within an all-digital system. This type of architecture easily is expanded to support new users and/or increased capacity requirements.

In this example, the central hub site not only provides digital switching on and off the network but also has the capacity to decode and monitor up to 16 video channels. The central hub can originate up to eight channels. (Note that these capacities are strictly arbitrary for this example and could be any required number of channels.) With this type of system, any hub site can be connected digitally to any

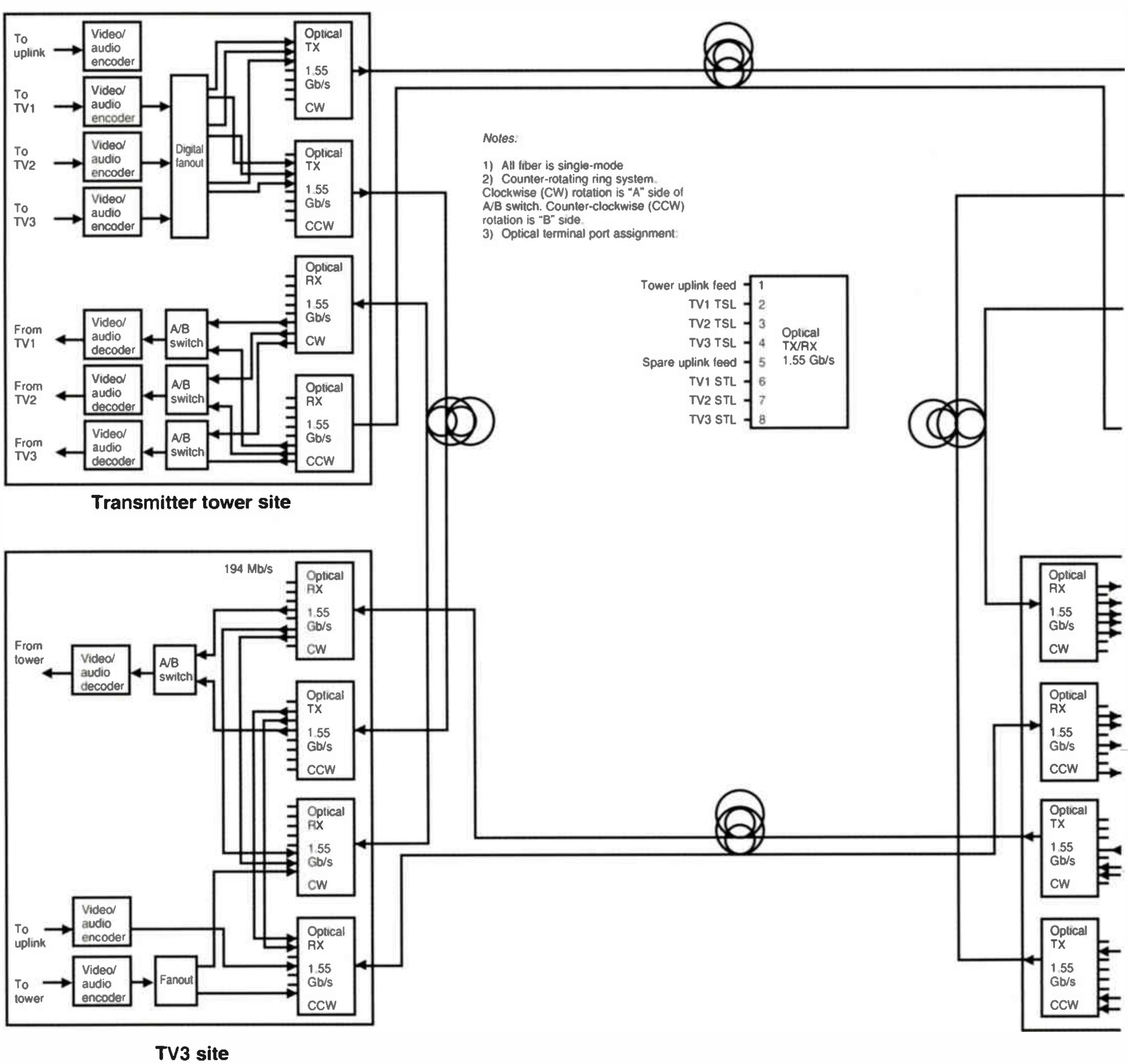
"Digital systems offer high-quality, flexible and cost-effective interconnect solutions for a variety of video service distribution applications within metropolitan environments."

other hub site in the network via the digital switch without requiring any intermediate digital encoding/decoding steps. As a result of keeping all signals in a digital format, signal transparency is preserved throughout the network

Hub Site 1 is a bidirectional eight-channel system that is interconnected to the central hub by 1.55 Gb/s optical terminals. This system uses one fiber for each direction. But through wavelength division multiplexing (WDM) at the 1,310 and 1,550 nm window, only a single fiber is required. Hub Site 1 could typically be a TV transmitter location for all of the broadcast stations within a city. It also could be a teleport/satellite earth station facility. For simplicity in this example, redundant components or redundant fiber paths have not been shown. However, redundancy is possible and practical by employing automatic hot standby switching of the optical terminals.

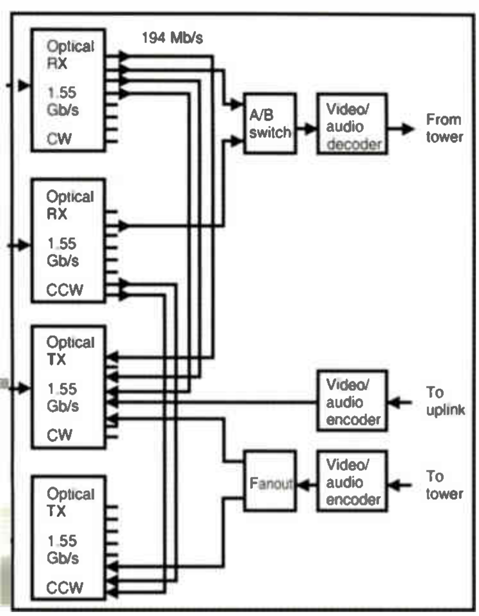
Hub Site 2 also is a bidirectional

Figure 2: Metropolitan video fiber network redundant ring

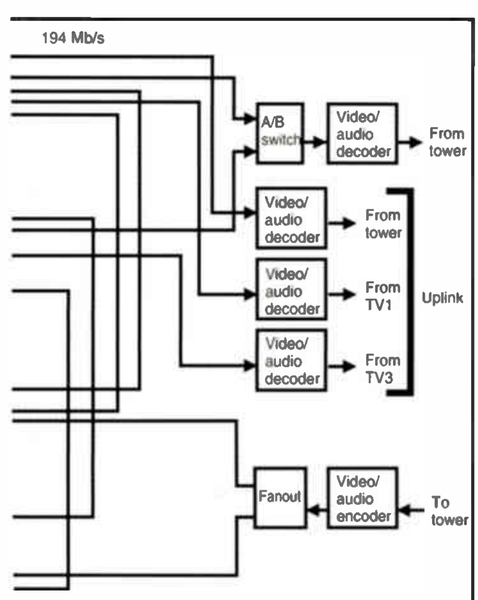


link with four-channel capacity that is interconnected to the Central Hub with 780 Mb/s optical terminals. This site might be a broadcast or production studio or possibly a CATV headend. It also might be a public building such as a sports stadium or performing arts center.

Hub Sites 3 and 4 are examples of single-channel contribution/distribution links. Hub 3 is a contribution link that could be a remote news or sports feed and Hub 4 is a single-channel distribution link. It is important to note that all of these digital signals, whether they are transported on a 16-channel, eight-channel, four-channel or one-channel system, are compatible at the digital switch in the Central Hub Site as well as with each different optical terminal.



TV1 site



TV2 and uplink site

Redundant ring network

Figure 2 is an example of a redundant ring network. This system does not use central switching but instead relies on the transparent digital multiplexing within the multichannel digital terminal equipment. Each channel on the network is assigned to specific ports on the multiplexer and each site has optical transmit and receive terminals. This example also shows redundant optical terminals with automatic hot standby switching at each site. As with the star network, there are no intermediate digital encoding/decoding steps required for any signal originating at one site to reach any other site in the network.

The ring network is easy to expand when there are spare ports available on the optical terminal multiplexers by simply adding the necessary encoders and decoders. When the capacity of the system is full, new optical terminals are added to the network for additional multiplexer capacity. In a ring network, a central switch is not required (thus simplifying the network structure). In this example, the clockwise (CW) direction of the ring is considered the main path and the counter-clockwise (CCW) is the backup path.

This ring is configured to be a studio-to-transmitter link (STL) and transmitter-to-studio link (TSL) system for three TV stations interconnected to a TV transmitter site. There also is a channel to interconnect all sites to a satellite uplink located at TV Station Site 2. Although the satellite channels do not have redundancy, as do the STL/TSL channels in this example, it could easily be added at a later date.

In both the star or ring configurations, long distances or high-loss links are possible because the optical loss budget available from the optical terminals is approximately 30 dB at either 1,310 nm or 1,550 nm optical wavelengths.

Conclusion

Within many metropolitan areas is the need for high quality and cost-effective interconnect capability among TV broadcast studios, TV transmitter sites, public buildings, stadiums and educational facilities, as well as within the CATV network itself. Digital fiber-optic systems are commonly used in today's metropolitan area networks because of their inherent advantages over other analog approaches. Digital systems deliver a uniform signal performance independent of the number of channels transported, optical path loss, and the types of video, audio or data services carried on the network.

These digital systems can be configured as simple point-to-point links or as more sophisticated multifunction star or ring networks with route redundancy and automatic self-healing capability. As new services are added and serving areas expand, system extensions are accomplished transparently without degrading the performance of existing services.

These attributes highlight the important concept that digital systems offer high-quality, flexible and cost-effective interconnect solutions for a variety of video service distribution applications within metropolitan environments. **CT**

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Reader Service Number 45.

The 43 Mbit/s digital 16-VSB modem for cable TV

By Pieter Fockens
Technical Consultant, Zenith Electronics Corp.

A 43 Mbit/second cable modem using 16-VSB (vestigial sideband) digital modulation will allow one 6 MHz channel to carry 23 movie programs (each compressed to 1.5 Mbit/s) or nine live video programs (compressed to 4 Mbit/s) or two high definition channels, or a combination of these types of digital signals. In existing cable TV systems, any 6 MHz analog NTSC channel can be replaced by the 16-VSB digital signal without any mutual interference.

The 16-VSB modem is a byproduct of digital high definition TV (HDTV) broadcast development work.[1] Recent testing of vestigial sideband modulation and quadrature amplitude modulation (QAM) broadcast and cable modems considered for transmission of HDTV data in a 6 MHz channel, showed the VSB system was superior and was selected by the digital HDTV Grand Alliance as its broadcast and cable modulation subsystem. It was subsequently accepted by the Federal Communications Commission Advisory Committee on Advanced Television Systems.

Because signals find a much more favorable environment in modern cable systems than in over-the-air broadcasts, the modulation scheme developed for over-the-air HDTV broadcasts was simplified while still doubling the bit rate from 21.5 Mbit/s to 43 Mbit/s in a 6 MHz cable channel. A 43 Mbit/s 16-VSB modem was tested at by Cable Television Laboratories and was shown to be superior to a QAM system of the same bit rate. The new modem also has been extensively field tested with excellent results.

Figure 1: Error probabilities of VSB and QAM systems

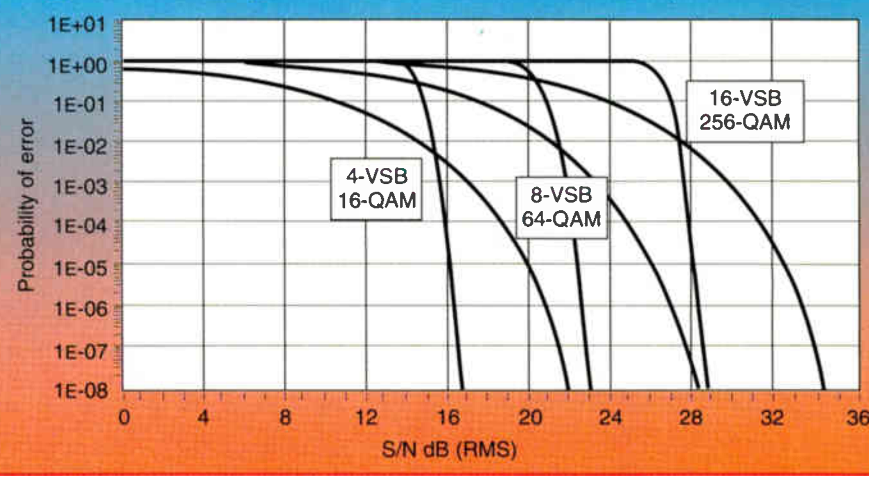


Table 1: S/N thresholds for various VSB modes

System	Levels/ symbol	Bits/ symbol	Mbits/s in a 6 MHz channel	S/N threshold (dB)
2-VSB	2	1	10.76	10
4-VSB	4	2	21.5	16
8-VSB	8	3	32.3	22
16-VSB	16	4	43	28

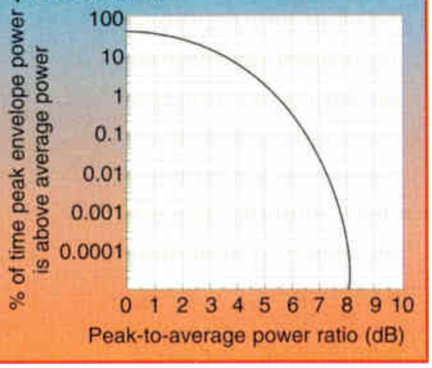
16-VSB digital modulation

For a 6 MHz channel, the theoretical maximum (Nyquist) rate is 12 Msymbol/s but is unachievable because it requires "brick-wall" filters. With current surface acoustic wave (SAW) filter technology, 10.76 Msymbol/s is economically feasible. At this symbol rate if binary (two-level) symbols are transmitted a 10.76 Mbit/s transmission results. If 4-level symbols are sent, the resultant transmission rate is 21.5 Mbit/s. For 8-level and 16-level symbols, the resultant transmission rate is 32.3 Mbit/s and 43 Mbit/s respectively. The VSB modem is actually designed to handle 2-, 4-, 8- and 16-level VSB modes. The VSB receivers will be able to automatically switch modes under headend control.

This increasing of the transmission bit rate comes at a price. For example, if the average transmitted power is kept constant, the (voltage) distance in a receiver between two adjacent levels in a 4-level system is smaller than in a 2-level system and, thus, is easier to upset by noise. It is common to improve noise performance of digital transmissions by using forward error correction (FEC). In the VSB modems for cable, a Reed-Solomon (t = 10,208,188) FEC approach is used. The resultant signal-to-noise ratio (S/N) thresholds for various VSB modes are shown in Table 1. Threshold is defined as the S/N required to reach a predetermined error performance.

Given that digital transmission requires receiving and distinguishing between the various transmitted levels, noise and other impairments at the receiver input will cause errors in reception. An important parameter in the transmission of digital signals is error rate. Depending on the system, error rate is expressed as bit-errors/bit (bit error rate or BER) or byte-errors/byte or block-errors/block. Figure 1 shows the probability of error vs. S/N for the various VSB modes. The steep curves represent systems with FEC and are measured in block-errors/block while the gentle curves represent systems without FEC and are measured in bit-errors/bit. →

Figure 2: Cumulative distribution function of 16-VSB peak-to-average power ratio



Both Table 1 and Figure 1 (page 41) show that the S/N threshold for a 16-VSB signal is 28 dB. Even at reduced power levels compared to analog NTSC signals, this S/N is achievable in modern cable plants and appears to be a good choice for cable transmission. The 16-VSB transmission system provides 43 Mbit/s of data in a 6 MHz channel.

Signal power

For analog NTSC signals, the RF power is expressed as the power of the carrier at peak of sync, which remains constant even if the video signal varies continuously. The digital VSB signal is noise-like and has no such constant reference; the peak power varies randomly, however the average power is constant. Computer simulations have resulted in the curve shown in Figure 2, which expresses the percentage of time that peak envelope power exceeds the average power. It shows that at a peak-to-average power ratio of 6 dB the peak power exceeds the average power only 0.35% of the time. Thus, when 16-VSB is transmitted in a cable system at an average power level of 6 dB below NTSC power, negligible extra loading of the system is caused.

When measuring signal power, it is customary to measure carrier power at RF and express an RF carrier-to-noise ratio (C/N). After data is detected in the receiver, a recovered signal-to-noise ratio is expressed. In the VSB system, these two terms are virtually identical and are used interchangeably throughout this paper. The differences between C/N and S/N for the VSB system arise from the use of a small amplitude pilot and differences in transmitted bandwidth and recovered bandwidth. The additional pilot power offsets the bandwidth differences making C/N and S/N negligibly different.

VSB vs. QAM

Although the curves in Figure 1 (page 41) show the same error probability for VSB and corresponding QAM systems these only illustrate theoretical C/N performance. In practice, total system performance must be gauged against a variety of impairments including noise. Besides impairments, performance also is degraded by the specific design of the VSB and QAM systems. In contrast to all the QAM systems proposed for broadcast and cable transmission of digital data, the VSB system implements unique techniques that have proven to provide better overall performance in the areas of multipath, impulse noise, phase noise, white noise (composite triple beat) and combinations of these. This was recently shown in tests at CableLabs where the 16-VSB modem was compared to a military-grade 256-QAM modem supplied by Applied System Technology Co. Theoretically, the two are identical but the 16-VSB implementation proved to be superior.

Techniques practiced in the VSB system but not in QAM systems include the use of a small amplitude pilot, the use of

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"Field tests have shown that the digital 16-VSB system replaced an analog NTSC channel with no problems for either the 16-VSB signal or for the NTSC signals."

segment syncs, and the use of a frame sync also used as a training signal. These techniques allow the VSB systems to acquire and lock at C/Ns of 0 dB. This feature is especially useful for diagnostics in systems where a failure has occurred and data reception is lost. Despite poor signal conditions, by using the training signal, the VSB system can report the condition of the received signal such as the presence of multipath or the C/N. In proposed QAM systems, once data is lost the receiver is unable to acquire the signal or get any useful information from it.

An important consideration of any cable modem is compatibility: Future HDTV receivers will have to work on cable as well as on over-the-air signals. Since VSB has been selected by the Grand Alliance as its digital HDTV broadcast transmission system, a VSB cable modem will be more compatible than a QAM modem. In fact, a broadcast HDTV receiver will require virtually no additional hardware to decode the 16-VSB signal. In contrast, decoding a QAM signal would almost double the hardware complexity of an HDTV modem.

Another advantage of 16-VSB is cost-effectiveness: the analog-to-digital (A/D) conversion requirements and the adaptive equalizer are simpler than in comparable QAM systems because QAM must independently equalize two (the in-phase and quadrature) bit streams while VSB has only one.

It should be noted that the 64-QAM cable modem, which has been claimed but not publicly demonstrated, has only 2/3 of the bit rate of 16-VSB. The 256-QAM system that was tested in the laboratory only was not specifically designed for cable systems, but rather for $50,000+ military applications.

Digital C/N in the 16-VSB system

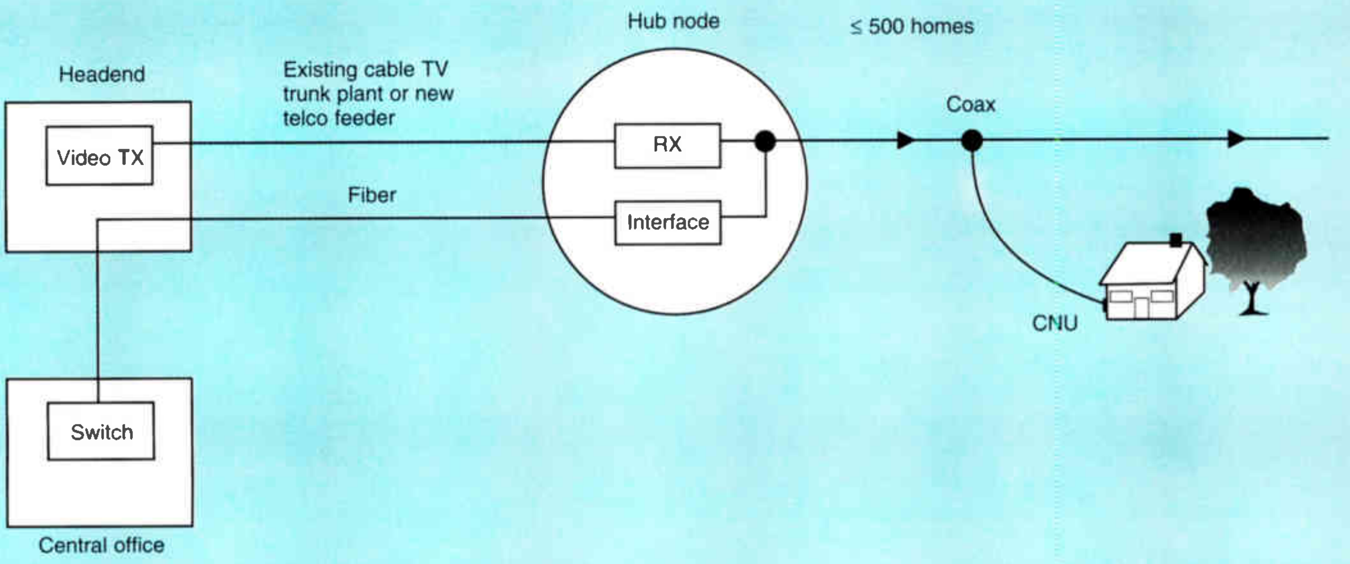
The current minimum C/N in U.S. cable systems is 40 dB, defined over a 4.2 MHz bandwidth. When defined over a 6 MHz bandwidth, 1.8 dB less is required or 38.2 dB. If a digital signal is transmitted 6 dB below an NTSC signal, the available C/N is 38.2 - 6 = 32.2 dB. Since 28 dB is required to properly detect the digital signal, a margin of 4.2 dB results. Many cable systems have channels with better than 40 dB C/N, providing additional margin. Note the extreme steepness of the probability of error curves with Reed-Solomon (R-S) protection in Figure 1 (page 41): a slight increase in C/N of even fractions of a dB significantly reduces the probability of error and thus improves the quality of reception.

Synchronization

The data in the 16-VSB system are arranged in fixed length "data segments," which are identified by binary (2-level) segment syncs of 4-symbol duration while the segments are arranged in frames identified by framing syncs of one segment duration. All the VSB modes use this same data framing.

In 16-VSB mode, each data segment includes two R-S data blocks of 208 bytes each. Each R-S block includes 20 bytes (160 bits) of parity information for error correction. The steep curves in Figure 1

Figure 6: Scenario III — High-level integration



by telephone companies, distinguished by different degrees of integration of voice and video transport. What follows is a description of three such scenarios.

Scenario I: Low-level integration

In this scenario, voice and video are delivered over separate media (twisted-pair and coax), from a fiber-fed remote terminal, utilizing the same cable trench or strand and enclosures.

Telephone companies with a large undepreciated twisted-pair copper plant with a goal of rapid in-region deployment of video capability, may configure their existing networks as shown in Figure 4. In this scenario, telephone companies would continue to use their existing fiber digital loop carrier (DLC) feeders and copper distribution plants to carry POTS. Video services would be provided over newly constructed (or acquired) coaxial distribution networks. Video and POTS would be separately transmitted from central offices over fiber feeder plant to remote terminals serving typically less than 500 homes. Dedicated copper twisted-pairs from remote terminals would deliver POTS while video would be delivered over coaxial cable. Video signals could be delivered from the CO/headends using conventional amplitude modulation (AM) or they could be digitally compressed and delivered to digital set-top converters in the homes. As in the United Kingdom today, POTS and video fiber nodes may service different numbers of subscribers, and may not be collocated.

This fiber/coax variation trades off service integration in favor of low first installed costs and rapid deployment capability. All of the network equipment is "off-the-shelf" and available today.

With sufficient fiber deployed to the remote terminals, this version offers telcos an inexpensive, proven solution for delivering video today while positioning them for a FTTC upgrade in the future to further lower network operating costs.

Scenario II: Intermediate-level integration

In this scenario, conventional narrowband FTTC architecture (eight homes per ONU) carries voice, and a fiber/coax overlay delivers video (and ONU power) from a fiber-fed remote terminal.

Telephone companies deploying FTTC systems within their regions for new construction or neighborhood rehabilitation (primarily for POTS but also requiring broadband capability) may deploy a fiber/coax architecture as shown in Figure 5 . POTS could be deployed on a narrowband FTTC network compliant with Bellcore's TR-NWT-000909, "Generic Requirements and Objectives for Fiber in The Loop Systems," while video would be delivered over a collocated but separate coaxial distribution network to the home. Voice is delivered on fiber taken directly to narrowband optical network units serving approximately eight homes, while video (AM or digitally compressed) is carried on coaxial cable from the remote terminal to the home. The coaxial cable ideally would pass through the narrowband FTTC ONU pedestals, where it would be tapped for subscriber drops to the home. At the same time, the coax provides a cost-effective powering solution for the ONUs. Future upgrades could involve video delivery over fiber to smaller subscriber serving areas (connecting one to eight FTTC ONUs) and, thus, eliminate the need for cascaded coaxial amplifiers, providing for even greater operational benefits.

Scenario III: High-level integration

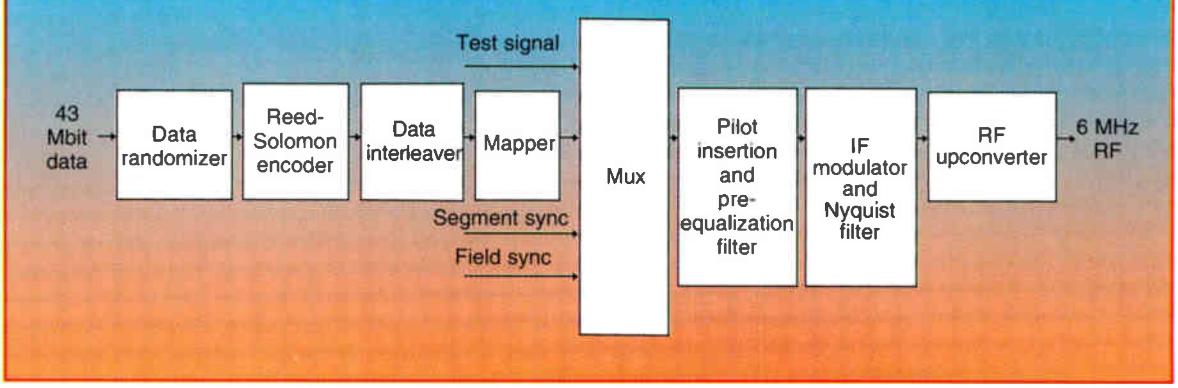
In this scenario, a fiber/coaxial platform carries both voice and video on the coax portion of the network.

Telephone companies that wish to provide video together with voice on one integrated platform, may utilize a traditional FTF architecture upgraded with new "voice-over-coax" equipment, as illustrated in Figure 6. Video programming would be delivered from the headend or CO over fiber to remote terminals or nodes serving between 100 and 300 homes. POTS also would be delivered separately over fiber from the CO to the same node and combined with the video for distribution over coax to the home. A coaxial network unit (CNU) is required (either on the outside of the residence or in a curbside pedestal) to separate the video signal from the telephony

Reader Service Number 40

are applicable. The framing sync is a pseudo-random binary sequence repeated at data frame rate. It is used, as the name indicates, for framing the data and also as a reference signal for the adaptive equalizer in the receiver. The receiver compares the received reference signal to a stored copy of the pseudo-random sequence to derive information to synchronize the frame, and to equalize the channel. The equalizer corrects for channel tilts, echoes and microreflections, effects that decrease the detection margin.

Figure 3: 16-VSB transmitter



Equipment

The block diagram of a 16-VSB transmitter is shown in Figure 3. The combined data is randomized, excluding syncs and R-S parity bytes. This ensures that random data is transmitted even when constant data is applied to the system, as may happen when a data input is disconnected. The receiver includes a complementary de-randomizer.

Next, the R-S parity bits are added for error protection. The subsequent interleaver spreads the data of a single R-S block over a large number of data segments as a protection against burst-noise. Any burst of errors during transmission is spread out by the de-interleaver in the receiver, which makes it easier for the R-S decoder to correct since they are not all concentrated in one R-S block.

The pilot is added in the form of a constant DC level shift, which translates to constant residual carrier in the subsequent modulator. The IF modulator translates the signal to a double-sideband signal centered at the IF carrier, which is 310 kHz below the upper edge of the 41-47 MHz IF channel or at 46.69 MHz. The subsequent Nyquist filter performs part of the previously mentioned spectrum shaping in addition to deleting most of the upper sideband. The filter performs only part of the spectrum shaping because the complementary part of the total needed shaping is done in the receiver.

A simplified block diagram of the receiver is shown in Figure 4 (page 50). The receiver front-end is fed by the cable. The tuner is of the dual-conversion type; the first conversion stage is an up-converter to 920 MHz while the second conversion heterodynes the signal down to the standard 46.69 MHz IF frequency. The IF signal is filtered in a SAW device. The local carrier is regenerated in a frequency/phase-locked loop (FPLL) circuit, which locks on to the small pilot carrier. The phase-locked loop part of the FPLL has a bandwidth under 2 kHz. It is the narrowness of this band that accounts for the 0 dB or less C/N condition under which carrier acquisition still occurs.

After carrier recovery, the IF signal is synchronously detected before feeding the baseband data to the A/D converter. Only one A/D converter running at 10.7 MHz is required since quadrature carriers are not modulated.

The next step after carrier recovery is data segment sync detection. This takes place by searching for the 4-symbol binary signal that constitutes the segment sync embedded within every data segment. The binary and repetitive

"The robust acquisition of the VSB transmission system also aids cable operators in system maintenance by being able to report signal conditions when data transmission has failed."

nature allow it to be reliably extracted from the random data (again using a narrowband phase-locked loop circuit) even though the data themselves cannot yet be properly detected (because automatic gain control, AGC, is not yet at its proper value).

Using recovered segment sync, the data clock can be synchronized and proper AGC is set. With proper AGC and proper clock phasing, data can be properly detected. Their interpretation is not possible, however, until the frame sync is detected.

As mentioned, the frame sync signal is a constant pseudo-random binary sequence of one segment duration. Synchronization is established by comparing the received sequence to the ideal reference sequence stored in receiver memory. Since the data clock and segment sync have already been locked, a simple data pattern comparator is used to find the framing code. Like the other synchronization circuits in the receiver, frame synchronization below 0 dB S/N is possible.

The frame sync sequence also is used to adjust a channel equalizer. The difference between the detected frame sync and the ideal stored reference frame sync is used to adjust the taps of a single real only transversal filter in the adaptive equalizer. The equalizer corrects primarily RF channel ghosts and cable microreflections as well as any distortions emanating from the headend transmitter and in the receiver front-end.

Although the receiver may properly detect data after the equalizer, an extra margin is provided by a phase-tracking circuit. This circuit counteracts the phase noise that originates in the tuner's first local oscillator or anywhere within the cable system heterodyning processes. Phase noise in the data sig-


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Table 2: 16-VSB cable field test summary

Parameter	Washington, DC	Montreal, Quebec	San Francisco
Test dates	2/93	5/93	6/93
Cable channels			
Frequency range (MHz)	50-400	50-400	50-400
Active channels	59	52	52
16-VSB channel number	Ch. A-2	Ch. 47	Ch. 46
16-VSB channel center freq. (MHz)	111	183	177
Digital audio channels	Yes	No	No
Cascaded amplifiers	11	2-35	19
16-VSB signal level below NTSC (dB)	12	6	10
Operating margins (dB)	16-18	11-16	20-21
Number of sites tested	1	17	1
AML microwaves	No	Yes	No
Fiber-optic links	No	Yes	No
Overnight runs	Yes	Yes	No

nal acts as intersymbol interference, which reduces the data detection margin. The phase-tracking circuit significantly increases this margin.

Phase disturbances in the data signal are principally attributed to the tuner's first local oscillator and include 120 Hz hum frequency modulation and microphonics in addition to phase noise. The threshold of errors due to these disturbances can be measured. The phase noise threshold of the 16-VSB system with the phase tracker is about -82 dBc/Hz at 20 kHz offset, while without the phase tracker it is about -99 dBc/Hz at 20 kHz offset. A lower threshold represents a more stringent requirement. The phase corrector provides almost a 20 dB improvement in phase noise performance, thus allowing the tuner to have less stringent local oscillator specifications. The amount of 120 Hz FM hum on the 16-VSB signal that can be corrected by the phase corrector is 4.9 kHz peak deviation.

System tests

An experimental 16-VSB modem was tested by CableLabs in Alexandria, VA, during May 1993. Before and after the laboratory tests, three field tests were carried out as summarized in Table 2.

The first field test was conducted in Washington, DC, on the District Cablevision cable system operated by Tele-Communications Inc. during February 1993. This test included a building distribution system.

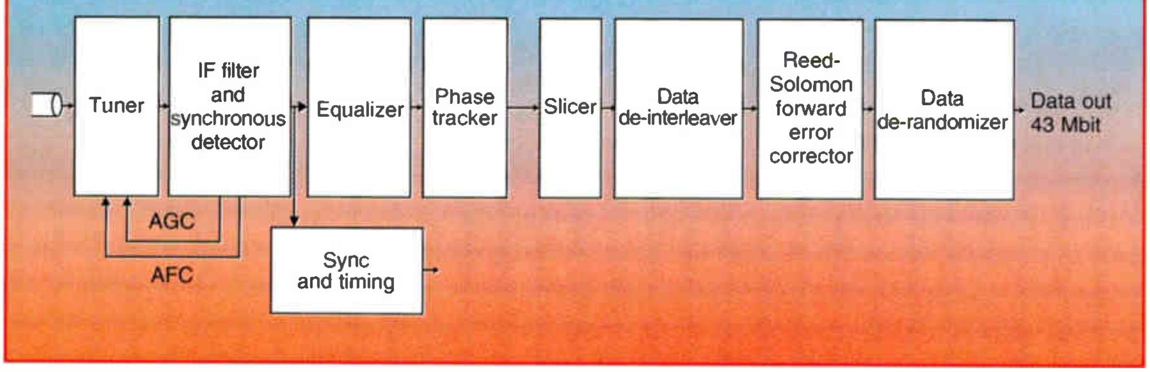
The most extensive field test was conducted on the Videotron cable system in Montreal and environs from May 10-21, 1993. This test is described in the next section.

The third field test was held in conjunction with the NCTA convention in San Francisco in June 1993.[2] The local Viacom system was used.

The Videotron field test[3]

The Videotron cable system in metropolitan Montreal serves more than 600,000 subscribers, providing 52

Figure 4: 16-VSB receiver



channels. Ch. 47 was made available for the 16-VSB signal.

Extensive use was made of microwave links (AMLs). Each single channel AML is designed for NTSC (4.2 MHz) and has considerable response roll-off at the band edges. The AMLs were used without modifications; the response of the full 6 MHz needed for the 16-VSB channel was initially pre-equalized in the 16-VSB modulator at the start of the tests and then left to the receiver's automatic equalizer for the rest of the tests.

Typical NTSC signal levels supplied to subscribers varied between 0 dBmV and +14 dBmV. Many paths contained more than 10 cascaded amplifiers; some had more than 30. The typical C/N on the system is 43 dB or more (4.2 MHz)

The field tests were conducted by transporting the 16-VSB receiver hardware and test equipment around metropolitan Montreal in a Videotron field test vehicle. Connections were made at pole taps or directly to the subscriber tap within a home. Error rate measurements were taken at 17 different sites, all except one at the cable system extreme ends. All AMLs were long and varied from 4.6 to 38 km, and at one site the path included a 6 km fiber-optic link. The number of cascaded amplifiers varied from two to 35; only two amplifiers were in the path at a close-in site where verification measurements were taken; one site had eight amplifiers in the path and all others had more than 12 amplifiers.

The 16-VSB (average) power was adjusted 6 dB below the NTSC (peak) power. At that level the 16-VSB system worked error-free with margin at each site. In fact the 16-VSB system did run error-free at 11 to 16 dB below NTSC, depending on the test site. White noise was a limiting factor at only one site but still left 11 dB margin. Composite triple beat (CTB) was not a major limiting factor at any of the test sites. System phase noise affected the margin in most sites and became the limiting factor in one site, still leaving 13 dB margin. Microreflections were limited to magnitudes of 10% or less, all ca-

pable of being equalized in the 16-VSB receiver.

Conclusion

Field tests have shown that the digital 16-VSB system replaced an analog NTSC channel with no problems for either the 16-VSB signal or for the NTSC signals. Cable plant impairments of CTB, white noise, AMLs, fiber links, phase noise and other degradations were all handled by the 16-VSB system in field tests with ample margin. The 16-VSB transmission system uses techniques that allow it to perform with no implementation loss and operate down to the theoretical S/N threshold. In comparison to QAM transmission systems, it provides 33% more data than 64-QAM proposals, has been proven in the field, and is more cost-effective.

In applications that require even more robust performance, the VSB transmission system also offers 2-, 4- and 8-VSB modes. These modes are switched from the headend with all receivers automatically following. The robust acquisition of the VSB transmission system also aids cable operators in system maintenance by being able to report signal conditions when data transmission has failed. **CT**

References

[1] "VSB Transmission System, Grand Alliance, Technical Details," monograph submitted to the FCC Advisory Committee on Advanced Television Systems, 2/18/94.

[2] "Practical Implementation of a 43 Mbit/sec (8 bit/Hz) Digital Modem for Cable Television," R. Citta and R. Lee, presented at NCTA '93 in San Francisco.

[3] "Summary of the Zenith 16-VSB Modem Field Test on Videotron's Cable System in Montreal," G. Sgrignoli, 6/21/93. (Technical report available from Zenith Electronics Corp.)

What technologies may be used in full service broadband

	Urban	Suburban	Rural
Bypass voice	PCS, fiber/coax	PCS, fiber/coax	Cellular
Lifeline POTS	FTTB, copper	FTTC, copper	Copper (mini DLC)
Broadcast video	Fiber/coax, FTTB, 28 GHz	Fiber/coax, FTTB, 28 GHz	28 GHz, DBS, MMDS
Interactive multimedia	Fiber/coax, FTTB, ADSL	Fiber/coax, FTTC, ADSL	Fiber/coax, FTTC

signal for carriage over the traditional in-house telephone and cable TV wiring.

Scenarios I and II use FTTC or copper-based equipment to provide extremely high reliability (99.998%) for the delivery, of "lifeline" POTS. Scenario III is currently used to provide "nonlifeline" voice service with a slightly lower reliability (99.8%), and without a requirement of battery backups. Providing this type of voice service over this type of network has been estimated to cost only 20-25% more than a video-only FTF system. This could be reduced further by increasing the node size from 100 to 200-300 homes. However, by reducing the coaxial serving areas to approximately 100 homes, an all-passive or nearly passive coaxial distribution plant can be used, which greatly simplifies operations and provides increased upstream bandwidth capability from every home. "Voice-over-coax" equipment currently is being used in a field trial in the United Kingdom. Meanwhile, several major equipment manufacturers are developing commercial products for use in the United States and are working to improve reliability to meet "lifeline" service requirements.

Evolving with alternate technologies

As cable TV operators and telephone companies continue to deploy fiber in order to position themselves to provide interactive multimedia services to the home, several interim or niche technologies may be used to provide other services. The use of these niche technologies may provide a flexible and evolutionary approach toward fiber/coaxial hybrid or FTTH architectures, by delivering different services depending upon neighborhood densities. The accompanying table above suggests what technologies may be used along the evolutionary path toward a full-service broadband network.

Return bandwidth considerations

Cable TV operators deploying fiber to nodes serving between 100-500 homes have positioned themselves adequately to provide upstream bandwidth capability for future interactive services. It often is mentioned in the technical literature that the 5-30 MHz return band is adequate for providing voice service with full contention to approximately 400 homes. For example, each home within the 400-home serving area might be assigned a specific radio frequency within the 5-30 MHz band to provide for a dedicated return path. However, other higher-bandwidth interactive services will probably require spectrum allocation above the conventional downstream analog broadcast video spectrum (50-550 MHz).

"With regulatory barriers falling and technological advances reaching new heights on what seems to be a weekly basis, the race has begun among wireless, telco and cable TV operators for primacy in the residential broadband services industry."

Telephone companies deploying fiber/coaxial systems also will want to drive fiber to smaller and smaller node sizes in order to facilitate larger return bandwidth capacity.

Deploying passive-coaxial versions of FTF can effectively provide a dedicated high-bandwidth coax return path from the fiber node (serving less than 100 homes) to a hub node or remote terminal (serving approximately 500 homes). The return signals travel up the coax cable from the home, are frequency multiplexed at the fiber node or ONU and transmitted up the dedicated coaxial cable to the hub node or remote terminal. All upstream signals from the 400-500 home serving area are combined at the hub node or remote terminal and returned to the headend over fiber. Deploying dedicated fiber from the headend to serving areas of approximately 100 homes will greatly facilitate high return bandwidth capability for future interactive services such as voice, data and multimedia.

Redundancy

As cable TV operators upgrade their networks with fiber and increase the number of services carried to subscribers, network redundancy becomes very important. This is particularly true as more cable operators build or lease fiber systems to provide regional interconnect networks. Interconnecting several headends located within different franchise areas allows cable TV companies to share the large investments required for headend equipment, and reduce their operating costs. However, route diversity becomes essential for maintaining a high degree of reliability when large numbers of subscribers are served over regionally interconnected networks.

Telephone companies routinely deploy fiber for route diversity at the CO to CO level, as well as to main feeder locations. This degree of route redundancy is required to compete effectively in the business voice and data services market.

Fiber types

Cable TV operators and telephone companies have used standard single-mode fiber with a zero dispersion wavelength near 1,310 nm for nearly all of their residential network construction. This trend probably will continue as 1,310 nm equipment costs (particularly with video transmitters) are driven further down the learning curve by high-volume deployment.

Single-mode dispersion-shifted fiber, optimized for operation at 1,550

Addressable converters: From security to digital and interactivity

By Daniel Sutorius
DigiCable Project Manager
General Instrument Corp., GI Communications Division

Despite its short history, the addressable set-top converter has had a remarkable (one could almost say spectacular) evolution. Starting in the early 1980s as an electromechanical unit that was essentially a security device for protecting cable operators' investment in programming, the addressable converter quickly evolved to include any number of attractive subscriber features.

Today's analog addressable converters come in several flavors. Some are focused mainly on scrambling techniques with no other feature really highlighted. Others add consumer features, including on-screen displays and in some instances dual tuners. These units are designed to make addressability as subscriber-friendly as possible. Almost all of today's addressable converters offer such features as downloadable channel mapping flexibility for operators, volume control, electronic parental control, various timers, impulse pay-per-view (IPPV) capability, and baseband audio and video outputs that can be fed directly into the TV set or VCR.

On-screen displays ease operation for subscribers and offer operators the ability to send messages and advertise upcoming programming. Today's addressable converters, in fact, offer quite a bit of memory, with current units containing on the average of a 20-character by 10-line capability over 18 pages. Next generation converters will be able to hold up to 40 pages at potentially even greater resolution.

For their part, operators today have a number of options available to make addressability as welcome in the subscribers' home as any programming being offered over those systems.

Coming soon — computer power

When we look at next-generation analog addressable converters, one of the big advances will be enhanced pro-

"Despite its short history, the addressable set-top converter has had a remarkable (one could almost say spectacular) evolution."

cessing in the terminals themselves. Higher levels of microprocessors and graphics devices will use the memory of the terminal and really allow the operator to choose how the converter will be configured (with full memory now or through upgrades adding memory later).

Certainly, one upgrade option would be two-way RF or phone modem capability. Also, as the power of computers comes to addressable converters, interactive network modules will be available to allow real-time communications from the terminal to the headend. This will allow the consumer terminal to drive the interactivity as opposed to only being polled at a time determined by the operator's addressable controller.

Another future upgrade will be to move into the digital environment where the operator could in some applications use the functionality of the analog terminal and upgrade the hardware to make it digital-ready. Base functionality of any state-of-the-art analog terminal would provide access control, messaging, renewable security and higher bandwidth tuners. By expanding to a "CompuVerter" platform with the insertion of computer processing capabilities, operators would be able to talk directly to converters, providing them with any number of capabilities and applications.

Applications providers

Applications providers will be needed to write programs that will talk to these terminals. Typical applications would probably include electronic program guides, where various program titles and program description information is continuously downloaded to the terminal. More advanced applications would include interactive home shopping. This would be much more than just waiting by the telephone, watching shopping channels and dialing appropriate numbers. The terminal would allow the subscriber to select the types of merchandise — or categories of merchandise — and make the impulse purchase directly through the terminal.

Another application that will come with these advanced analog units will be graphics. Vendors are looking to increase to 32 characters-per-line by 16 lines, choosing up to 16 colors from the color palette. Analog units should be able to upgrade to various levels of bitmapped graphics capability, on the order of 288 pixels by 216 lines.

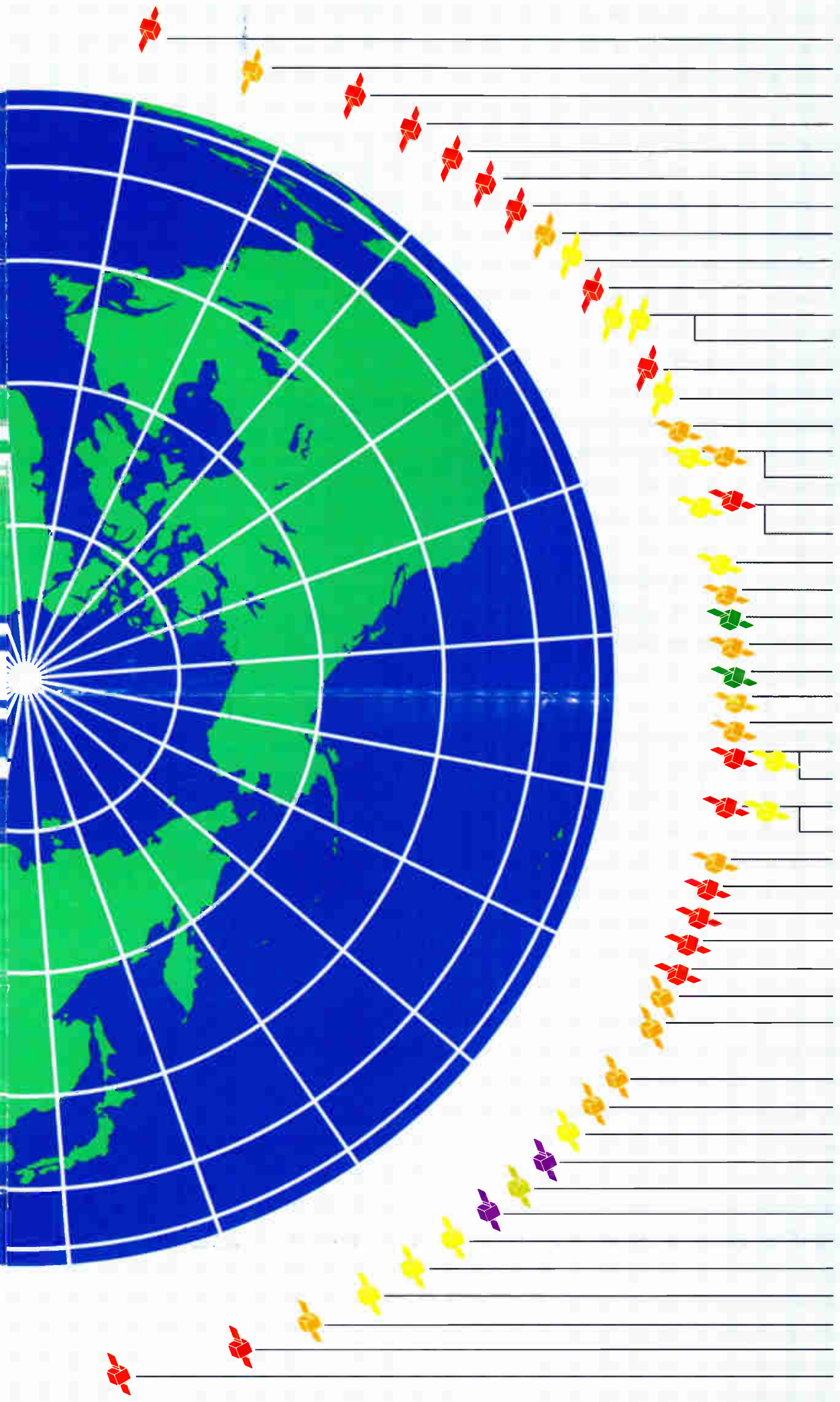
Digital changes

Once programmers and converters enter the digital world it will be easier to handle most services. In analog, the converter is still dealing with lines of video information, even though these could carry 9,600 baud channels within the video programs themselves. This 9,600 baud data could be used to support virtual channels that would include sports statistics, stock quotes, weather information and programming information.

But, as you reach higher bandwidths, whether due to real increases in amplifier technologies or virtual bandwidth created by digital compression, a key service could be near-video-on-demand (NVOD). This is really associated with multiple PPV ordering systems where the operator would download all the various movie categories, titles, descriptions and start times at higher frequency per movie than currently exists. The subscriber could tune to a virtual NVOD channel and go into the menuing system.

The key to NVOD is to compete with the video rental market by mimicking the process of renting tapes. Then, once rented, the system would have to provide such VCR-connected function-

Systems D



Orbit	Number of Transponders	Satellite
65 W	24	Brazilsat
69 W	24	Spacenet
70 W	24	Brazilsat
72 W	24	Satcom 2
74 W	24	Galaxy I
76 W	20/24	Comstar
85 W	24	Telstar 3
87 W	24	Spacenet
93 W	16	Gstar II
93.5 W	24	Galax
95 W	19	SBS
95 W	10	SBS
96 W	24	Tels
97 W	10	SBS
99 W	24 C, 24 Ku	Gal
101 W	16 each	Dire
101 W	24	Spac
103 W	16	Gstar
103 W	24	Galax
105 W	16	Gstar I
107.3 W	24 C, 16 Ku	Anik E
109.2 W	18 C, 15 Ku, 1 L	Solidar
111.1 W	24 C, 16 Ku	Anik E
113 W	18 C, 15 Ku, 1 L	Solida
113.5 W	24	Mor
116.8 W	24	Mo
123 W	24	Te
123 W	14	S
125 W	24	Gala
125 W	16	Gstar II
128 W	24	ASC 1
131 W	24	Satcom C
133 W	24	Galaxy I
135 W	24	Satcom C
137 W	24	Satcom C
174 W	26 C, 6 Ku	Intelsat 5
177 W	26 C, 6 Ku	Intelsat 5
180 E	26 C, 6 Ku	Intelsat 5
177 E	26 C, 6 Ku	Intelsat 5
164 E	15	Optus A
162 E	29	Superbir
160 E	15	Optus B
158 E	29	Superbir
156 E	15	Optus A
154 E	32 (1&2)	JCSat 2
150 E	32 (1&2)	JCSat 1
140 E	6 C, 1 Ku, 1 L	Stat. 7/G
125 E	2	STW-1
113 E	24	Palapa B

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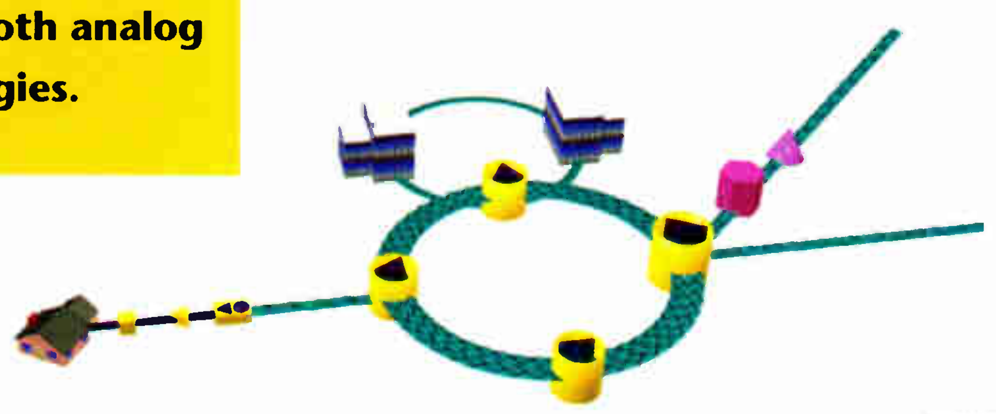

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Name	Operator/Nation	Launch Date	Life Expectancy	Band(s)	Polarity
A1	Brazil	1985	8	C	Linear
II	GTE Spacenet/U.S.	1984	10	C/Ku	Linear
A2	Brazil	1986	8	C	Linear
R	GE Americom/U.S.	1983	12	C	Linear
	Hughes/U.S.	1983	10	C	Linear
D2/D4	Comsat/U.S.	1976/81	7	C	Linear
)2	AT&T/U.S.	1984	10	C	Linear
III	GTE Spacenet/U.S.	1988	10	C/Ku	Linear
	GTE Spacenet/U.S.	1988	10	Ku	Linear
	Hughes/U.S.	1984	10	C	Linear
	Hughes/U.S.	1990	10-12	Ku	Linear
	Comsat/U.S.	1982	7	Ku	Horizontal
	AT&T/U.S.	1993	12	C	Linear
	Comsat/U.S.	1981	7	Ku	Horizontal
	Hughes/U.S.	1993/92	12	C/Ku	Linear
ellites)	Hughes/DirecTv/U.S.	1993	12-15	Ku	Circular
	GTE Spacenet/U.S.	1991	10	C/Ku	Linear
	GTE Spacenet/U.S.	1985	10	Ku	Linear
	Hughes/U.S.	1990	10	C	Linear
	GTE Spacenet/U.S.	1990	10	Ku	Linear
	Telesat Canada	1991	10	C/Ku	Linear, cross-polarized
d I	Mexico	1993	14	C/Ku/L	Orthogonal
	Telesat Canada	1991	10	C/Ku	Linear, cross-polarized
II	Mexico	1994	14	C/Ku/L	Orthogonal
	Mexico	1985	9	C/Ku	Orthogonal
	Mexico	1985	9	C/Ku	Orthogonal
	AT&T/U.S.	1985	10	C	Linear
	Hughes/U.S.	1988	10-12	Ku	Linear
	Hughes/U.S.	1992	10	C	Linear
	GTE Spacenet/U.S.	1988	10	Ku	Linear
	GTE Spacenet/U.S.	1985	9	C/Ku	Linear
-3	GE Americom/U.S.	1992	12	C	Linear
	Hughes/U.S.	1983	10	C	Linear
-4	GE Americom/U.S.	1992	12	C	Linear
-1	GE Americom/U.S.	1990	10	C	Linear
10	Intelsat	1985	7	C/Ku	Circular (C), Linear (Ku)
03	Intelsat	1981	7	C/Ku	Circular (C), Linear (Ku)
-08	Intelsat	1984	7	C/Ku	Circular (C), Linear (Ku)
11	Intelsat	1985	7	C/Ku	Circular (C), Linear (Ku)
2	Optus/Australia	1985	7	Ku	Dual linear
1 B	SCC/Japan	1992	10	Ku/Ka	Linear (Ku), Circular (Ka)
	Optus Australia	1992	13	Ku/L	RHCP (L), Dual linear (Ku)
1 A	SCC/Japan	1992	10	Ku/Ka	Linear (Ku), Circular (Ka)
	Optus/Australia	1987	10	Ku	Dual linear
	Japan Sat. Systems	1990	10	Ku	Linear
	Japan Sat. Systems	1989	10	Ku	Linear
orizont 18	Russia/CIS	1989	5	C/Ku	RHCP
	China	1984	4	C	Circular
2P	P.T. Telekom/Indonesia	1987	8	C	Linear

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STW — Color TV, telex, facsimile, telephone and telemetry. Antennas beam coverage: global. Contact Ministry of Posts and Telecommunications, 1-6011250, China.

Superbird — SNG, CATV program distribution, TV program and PCM music program broadcasting, transponder resale. Antennas beam coverage: Japan. Tokyo spot beam. Contact Space Communications Corp., 3-3503-3170, Japan.

TDF — DBS including TV and radio. Antennas beam coverage: France and adjacent countries. Contact Telefusion de France, 1-49-65-10-00, France.

Telecom — Communications services, digital business, radio and TV broadcasts. Antennas beam coverage: French mainland and adjacent areas, overseas territories and Caribbean spot beam. Contact France Telecom, (212) 977-8630, U.S.A.

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Thor — DBS. Antenna beam coverage: Scandinavia. Contact Norwegian Telecom, 22-778990, Norway.

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y Band(s)	Polarity
C/Ku	Circular (C), Linear (Ku)
C/Ku	Circular (C), Linear (Ku)
C/Ku	Linear
C/Ku	Circular (C), Linear (Ku)
C/Ku	Circular (C), Linear (Ku)
Ku/X	Linear (FSS), LHCP (DBS)
C/Ku	Circular (C), Linear (Ku)
C/Ku	Circular (C), Linear (Ku)
K	RHCP
Ku	LHCP (downlink)
C/Ku	Circular (C), Linear (Ku)
C/Ku/L	LHCP (uplink), RHCP (downlink)
C/Ku/L	RHCP
C/Ku	Circular (C), Vertical (Ku)
C/Ku	Circular (C), Vertical (Ku)
C/Ku	Circular (C), Linear (Ku)
Ku	RHCP

C/Ku/X	Circular, (C), Vertical (Ku)
Ku	Dual linear
Ku	Dual linear
Ku	Dual linear
Ku	Dual linear
Ku	Linear
Ku/Ka	Dual linear (Ku), Linear (Ka)
C/Ku	Circular (C), Linear (Ku)
Ku/Ka	Dual Linear (Ku), Linear (Ka)
C/S	LHCP/RHCP (C), Linear (S)
Ku/Ka	Dual linear (Ku), Linear (Ka)
C/Ku	RHCP
C/Ku	RHCP
C/Ku	Circular (C), Linear (Ku)
C/Ku	Circular (C), Linerar (Ku)
C/Ku	Circular (C), Linerar (Ku)
C/Ku	Circular (C), Linear (Ku)
C/S	LHCP
C/Ku	LHCP, RHCP
C/S	Linear
C	Linear
C/Ku/L	RHCP
C/Ku	Circular (C), Linear (Ku)
C/Ku/L	RHCP
C	Linear
C/Ku	Linear
C/Ku/L	RHCP
C	Linear
C	Dual linear
C	Linear
Ku	RHCP
C	Linear

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y — Cable TV programming, network broadcast, VTS, ITS, business TV, distance learning, direct-to-home and private busi- ata. Antennas beam coverage: U.S.A. 50 states. Contact Hughes Communications Inc., (310) 607-4511, U.S.A.
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Gstar — Analog and digital compressed data, video and voice. Antennas beam coverage: U.S.A. 50 states. Contact GTE Spacenet Corp., (703) 848-1000, U.S.A.
Hispasat — Government payload, TV and radio broadcast, public and private telecommunications networks, DBS and interchange networks. Antennas beam coverage: Spain, Canary Islands and The Americas. Contact Hispasat S.A., 1-207-6040, Spain.
Insat — Meteorological observation, data collection, DBS, TV and radio programming distribution, dat STFS. Antennas beam coverage: Inc Department of Space, 9180-334474,
Intelsat — Occasional-use and full- switched telephony and private netw band digital communications. Anten Contact Intelsat, (202) 944-6800, U.
JCSat — Data transmission and bro to CATV and network TV stations, t remote printing, high-speed facsimil Antennas beam coverage: Japan, Co 33-5400-3700.
Morelos — Analog and digital telep Antennas beam coverage: Mexico ai

MUNICATIONS
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Orbit	Number of Transponders	Satellite Name	Operator/Nation	Launch Date	Life Expectanc
53 W	26 C, 6 Ku	Intelsat 513	Intelsat	1988	7
50 W	21 C, 6 Ku	Intelsat 506	Intelsat	1983	7
45 W	18 C, 6 Ku	PAS-1	PanAmSat	1988	13.25
34.5 W	40 C 10 Ku	Intelsat 603	Intelsat	1992	10
31.4 W	21 C 6 Ku	Intelsat 504	Intelsat	1982	7
31 W	13 Ku, 5 DBS, 3 X	Hispasat 1A & 1B	Spain	1992	10
27.5 W	40 C, 6 Ku	Intelsat 601	Intelsat	1992	7
21.3 W	21 C, 6 Ku	Intelsat 502	Intelsat	1980	7
19 W	6	TDF 1 & TDF 2	Telefusion de France	1988/90	8
19.2 W	6	TV Sat 2	Deutsche Bundespost	1989	10
18 W	26 C, 6 Ku	Intelsat 515	Intelsat	1989	7
14 W	6 C, 1 Ku, 1 L	Stat. 4/Gorizont 15	Russia/CIS/Intersputnik	1990	5
11 W	6 C, 1 Ku, 1 L	Stat. 11/Gorizont 26	Russia/CIS	1992	5
8 W	10 C, 9 Ku	Telecom II-A	France Telecom	1992	10
5 W	10 C, 9 Ku	Telecom II-B	France Telecom	1992	10
1 W	26 C, 6 Ku	Intelsat 512	Intelsat	1985	7
.8 W	5	Thor	Norwegian Telecom	1990	10
3 E	4 C, 6 Ku, 2 X	Telecom 1C	France Telecom	1988	7
7 E	16	Eutelsat II F4	Eutelsat	1992	8.5-9
10 E	16	Eutelsat II F2	Eutelsat	1991	8.5-9
13 E	16	Eutelsat II F1/F6	Eutelsat	1990	8.5-9/10
16 E	16	Eutelsat II F3	Eutelsat	1991	8.5-9
19.2 E	16/18/1 C	Astra 1A, 1B & 1C	SES/Luxembourg	1988/91/93	12-14
23.8 E	10 Ku, 1 Ka	DFS-1	Deutsche Bundespost	1989	12
24.5 E	40 C, 10 Ku	Intelsat 605	Intelsat	1991	10
28.5 E	10 Ku, 1 Ka	DFS-2	Deutsche Bundespost	1990	12
31 E	25 C, 1 C/S	Arabsat 1-C	Arab Sat. Comm.	1992	10
33.5 E	10 Ku, 1 Ka	DFS-3	Deutsche Bundespost	1992	12
40 E	6 C, 1 Ku, 1 L	Stat. 12/Gorizont 12, 22	Russia/CIS	1990	5
53 E	6 C, 1 Ku, 1 L	Stat. 5/Gorizont 17	Russia/CIS	1989	5
57 E	21 C, 6 Ku	Intelsat 507	Intelsat	1983	7
60 E	40 C, 10 Ku	Intelsat 604	Intelsat	1991	7
63 E	40 C, 10 Ku	Intelsat 602	Intelsat	1991	7
66 E	21 C, 6 Ku	Intelsat 505	Intelsat	1982	7
74 E	18	Insat II-A	ISRO/India	1992	9
80 E	6 C, 1 Ku, 1 L	Stat. 13/Gorizont 24	Russia/CIS/Intersputnik	1991	5
83 E	14	Insat 1-D	India	1990	7
87.5 E	4	Chinasat 1	China	1988	7
90 E	6 C, 1 Ku, 1 L	Stat. 6/Gorizont 13, 21	Russia/CIS	1986/90	5
91.5 E	21 C, 6 Ku	Intelsat 501	Intelsat	1981	7
96.5 E	6 C, 1 Ku, 1 L	Stat. 14/Gorizont 19	Russia/CIS	1989	5
98 E	4	Chinasat 3	China	1990	7
101 E	10 C, 2 Ku	Thaicom-1	Shinawatra Sat./Thailand	1993	13-15
103 E	6 C, 1 Ku, 1 L	Stat. 21/Gorizont 14, 23, 25	Russia/CIS	1991/92	5
103 E	2	STW-2	China	1986	4
105.5 E	24	Asiasat 1	Asiasat/Hong Kong	1990	9-10
108 E	24	Palapa B2R	P.T. Satelit Palapa/Indonesia	1990	8
110 E	3	BS-3A & BS-3B	TAO/Japan	1990/91	7
110.5 E	4	Chinasat 2	China	1988	7

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ASC — Analog and digital compressed data, video and voice. Antennas beam coverage: U.S.A. 50 states, Puerto Rico. Contact GTE Spacenet Corp., (703) 848-1000, U.S.A.
AsiaSat — National and regional TV, domestic voice, data telecommunications, radio, telecommunications, point-to-multipoint services. Antennas beam coverage: China, Japan, Hong Kong, Taiwan, Korea, Indonesia, India, Middle East and Eastern Europe. Contact AsiaSat, 805-6666, Hong Kong.
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BS — DBS. Antenna beam coverage: Japanese archipelago, including outlying islands. Contact Telecommunications Advancement Organization of Japan (TAO), 3-3769-6811.
Chinasat — Color TV, telex, facsimile, telephone and telemetry. Antennas beam coverage: China. Contact Ministry of Posts and Telecommunications, 1-6011250, China.
Comstar — Voice, data, facsimile and video services. Antennas beam coverage: Continental U.S.A. and Puerto Rico. Contact

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nm, has seen increased use by most of the long-distance telephone companies as well as a few LEC and cable TV companies. Since dispersion-shifted fiber facilitates use of faster digital transmission speeds over longer distances, it may prove to be the fiber of choice for LEC interoffice trunks or cable TV regional interconnects.

Couplers and WDMs

Optical couplers have been widely used throughout both the cable TV and LEC networks to reduce costs by sharing expensive transmission equipment among several receivers. Cable TV companies typically have used 1x2 directional taps or optical splitters within the headend to preserve the dedicated "home run" fiber topology they are deploying. However, larger-port-count optical splitters may soon find acceptance in the field as both cable TV operators and LECs try to cost-effectively deploy fiber to smaller node sizes for increased operational benefits.

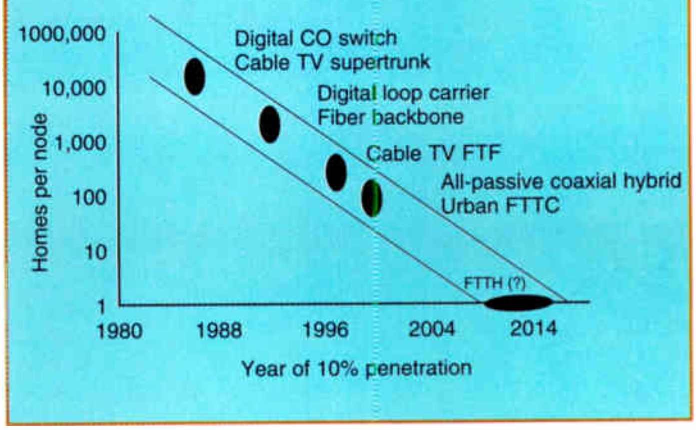
Optical splitters can be used effectively in the outside plant by locating them at or beyond nodes typically serving between 300-500 homes. The deployment of optical splitters in the field may help deliver cost-effective downstream services over fiber to receiver nodes or ONUs. The deployment of splitters at or beyond nodes serving between 300-500 homes also reduces testing and maintenance issues, since splitters are serving fewer homes. The use of splitters to reduce downstream transmission costs enables dedicated fibers to be deployed more cost-effectively for providing return bandwidth capability. These dedicated fibers to small node sizes allow for a flexible migration path as service requirements arise.

Wavelength division multiplexers (WDMs) combine two or more wavelengths of light onto a single fiber for simultaneous transmission. Although WDMs are commercially available, they have not yet seen wide scale use within the cable TV or telephone industries. WDMs may be used to increase the number of channels per fiber or enable the use of a return path on an existing operating fiber.

Summary

Today, cable TV operators and telephone companies share the common objective of positioning themselves for future service requirements while reducing operating costs. A properly designed and provisioned fiber-based network can facilitate the delivery of those new and existing services while maximizing the operational benefits of a shared network.

Figure 7: Deployment of fiber



As cable TV operators continue deploying fiber to smaller and smaller serving areas and telephone companies migrate from FTTH to FTTC architectures, residential network designs are converging from opposite directions toward a fiber/coax hybrid solution with subscriber serving areas of 50-100 homes per node. Although a coaxial distribution plant provides for a cost-effective delivery medium for the "last mile" in the interim, both cable TV operators and telephone companies believe that coax eventually will give way to the deployment of fiber all the way to the home. Figure 7 plots the deployment of fiber within the cable TV and telephone industries as a function of homes served by node.

To maximize their position as the primary provider of residential broadband services, cable TV operators must continue to deploy fiber to smaller and smaller serving areas. This will establish a fiber-based infrastructure that will be synergistic with today's telco deployment strategy. Transmission technologies and protocols like SONET, ATM, FDDI, etc., will become readily available to facilitate the integration of voice, video and data. The deployment of these technologies and protocols will require fiber-based networks that provide higher information carrying capacity.

Their use should be relatively easy provide that cable TV and telephone companies have developed their fiber infrastructures properly. With similar deployment strategies, cable TV operators and telcos will perhaps find it more desirable to cooperate than compete for the promise of those new emerging broadband services. **CT**

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11) R.R. Green, Speech to the ATM Forum Meeting in San Francisco, Aug. 25, 1993.

"With digital technology will come digital audio and the quality of digital video — all in a unit that continues to offer the latest in subscriber conveniences and friendliness."

ality as pause, fast forward and rewind. This could be achieved by jumping back and forth to the next start-time of the movie.

A question facing operators will be how to structure the ordering system in such a way as to provide multiple categories with multiple movies per category. The operator will have to determine how closely to mimic a tape rental, whether it will be just a one-time showing of the movie or actually allow the subscriber to rent a particular block of time to enable pause, fast forward and rewind capabilities. That block of time could be as long as 24 hours, similar to the rental time for a typical video.

Real-time interactive networks

An exciting new development on the horizon for both analog and digital converters is the real-time interactive network. This is not just the typical polling environment, where each converter waits for the controller computer at the headend to request information, but the ability to communicate with the terminal on the return path at any given time. The key here is real-time, two-way RF communications with the headend and any associated applications/servers.

To accomplish this, the operator would broadcast the information downstream telling the terminal what frequencies are available. This will be enabled by expansion of the downstream out-of-band speed from today's 14 kb/s to a rate of 1.544 Mb/s. This would typically go into the unused video bandwidth — 78 to 130 MHz. In an interactive network, the operator might even want the frequencies in which the downstream, out-of-band information is carried to be frequency agile, requiring a frequency agile receiver.

In the upstream, more information will be sent than is typical today and with more frequency. This will call for

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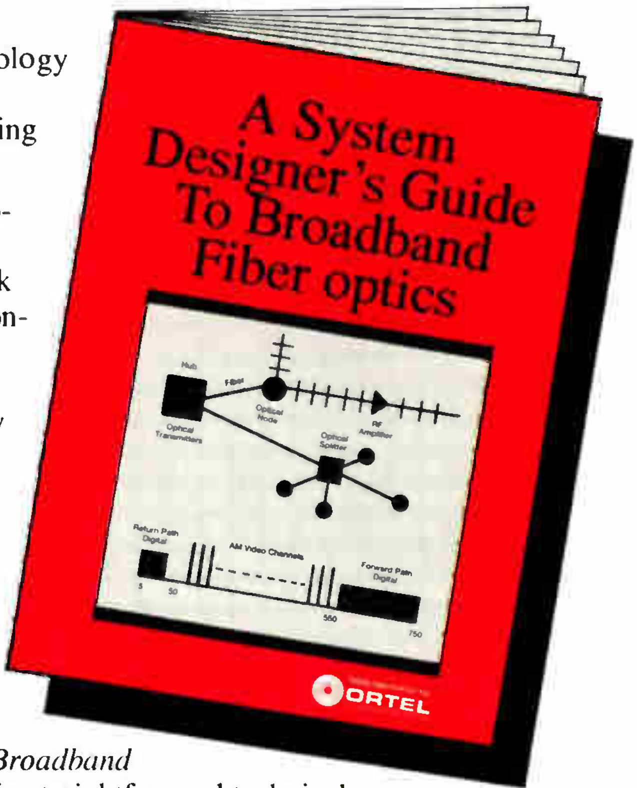

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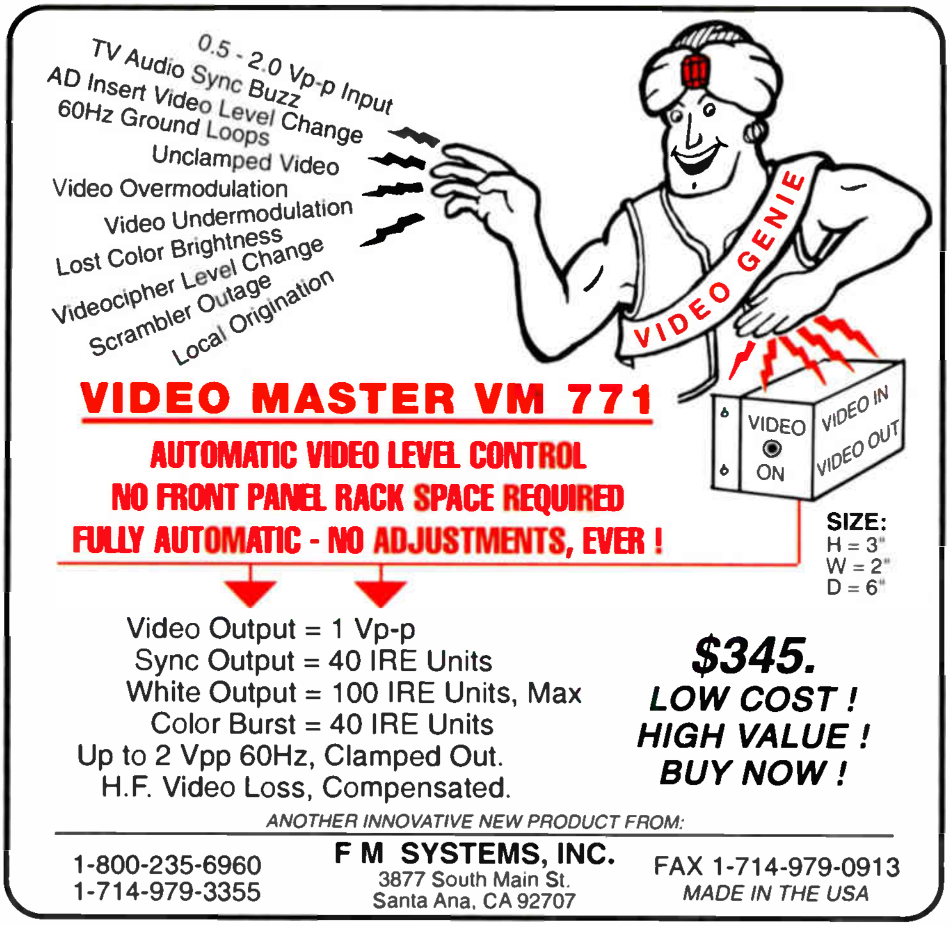

an increased return path speed to something like 64 kb/s. The types of messages that will be sent upstream could still use the poll type of service for some applications or the terminal could operate in a single-message, terminal-initiated environment. It might be a connection-oriented service where there is a need for an extended data dump or continuous mode for a fixed period of time. There are all different types of applications that are required in interactive networks.

The types of applications envisioned for these advanced data streams could include such activities as interactive video games, with subscribers playing against themselves or other subscribers; the virtual mall, where shopping is interactive rather than categorical; interactive yellow pages; electronic encyclopedias; and other programs now being developed by applications providers.

Digital audio and security

Today's digital audio service typically requires a separate tuner in the subscriber's home to handle all the audio functions. That ability will be integrated into the advanced next-generation converter to offer subscribers the capability of watching or listening. There also exists the possibility of a dual tuner terminal that will allow a customer to watch a program while another samples the digital audio services.

Certainly, all these provisions will require higher bandwidths – with or without digital compression. And, as with all valuable programming, security will be a necessity. In the case of the next-generation interactive converters, there will be a renewable security options that, using smart cards, will alter the encryption algorithms that should deter piracy.

The possibilities are limitless

Whether analog or digital, tomorrow's addressable converter will be greatly different from those electromechanical devices of only a decade ago. Computer-enhanced capabilities will permit full interactive services via cable TV. Digital compression will allow the placement of up to 10 channels of programming in a single 6 MHz of bandwidth, thus allowing NVOD applications. And, with digital technology will come digital audio and the quality of digital video — all in a unit that continues to offer the latest in subscriber conveniences and friendliness. **CT**

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Much has been said and written about the information superhighway and the variety of new services it will deliver: interactive video games, movies-on-demand, telephony, educational networks, training programs and medical information, to name a few.

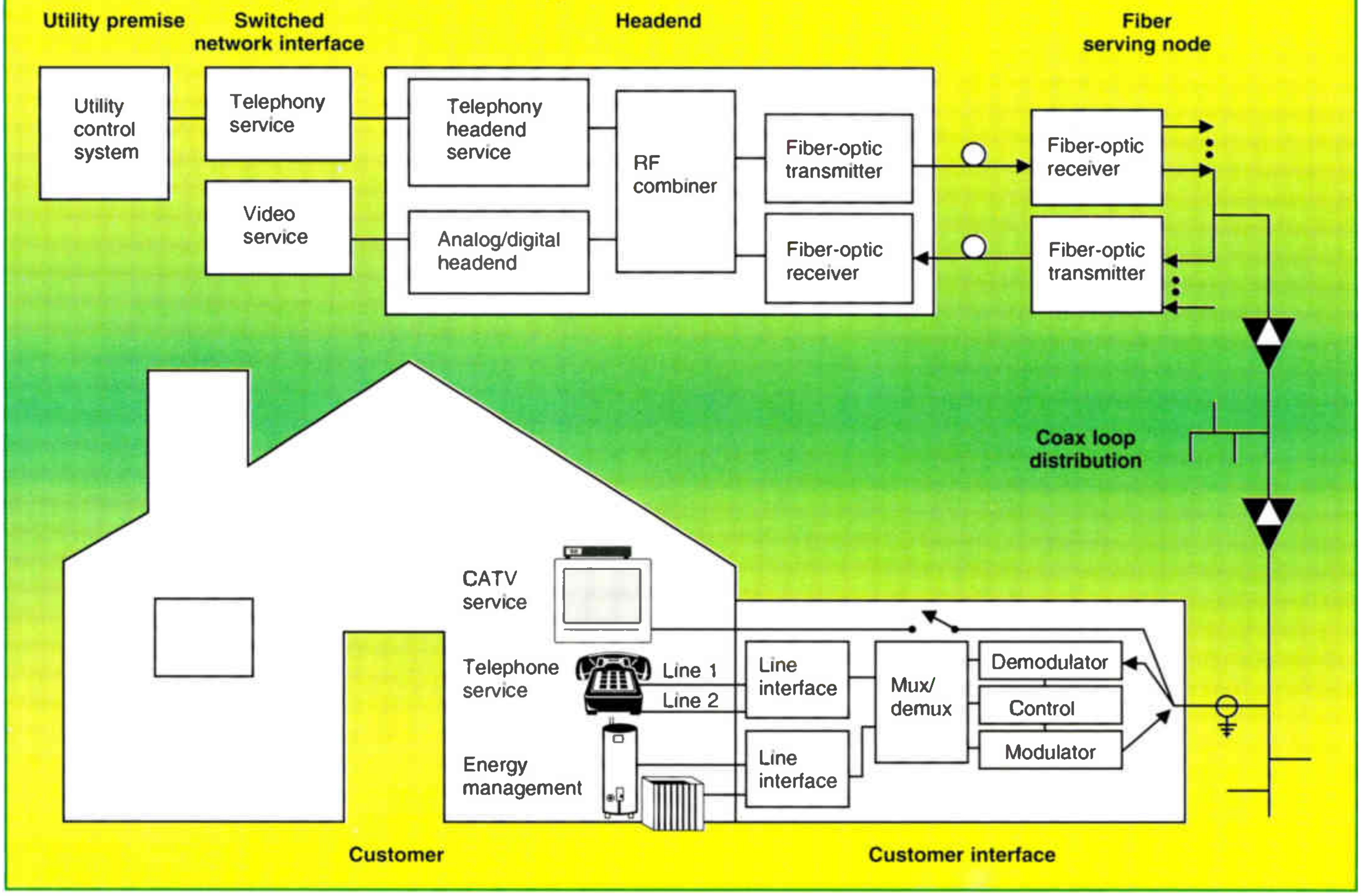
The electric utility industry, an industry not often associated with the technology of the information superhighway, has expressed an interest in this broadband network. Utilities see the superhighway as a potential means to reduce the cost of gathering information from their own power networks. The accompanying figure shows potential utility network management.

Utilities typically divide their automated information gathering into two broad categories: generation/transmission and distribution. Power generation-type activities have been highly automated for many years. Distribution-level automation systems, on the other hand, are newer and less widespread. Supervisory control and data acquisition (SCADA) systems have long been used to automate substations, typically utilizing either leased lines or private radio networks to communicate from these substations to the utility's control center.

Beyond the substation, however, very little has been deployed. Utilities have experimented with various technologies over the years to improve access to information about their customers and conditions on the power network, but the costs associated with direct one-to-one communications have been prohibitive.

A communications network that employs cost-effective reliable two-way communications — one where customers could play a more active role in the way they purchase and consume energy — is very attractive to utilities. If this network reaches a large part of their service area and data can be obtained efficiently, a case could be made to de-

Potential utility network management



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Utility network automation applications

There are systems installed today that are used for distribution automation. For example, consumer air conditioners and water heaters are cycled during peak periods to slow demand for electric power by a technique called direct load control. Nearly every utility that has a load control program today uses one-way communications because of the cost-effectiveness and reliability.

Additionally, there are functions that a two-way network could provide:

- Read meters remotely.
- Provide power consumption information in a simple and direct manner.
- Connect and disconnect power remotely.
- Pinpoint power outages quickly.
- Provide pricing signals to facilitate time-of-use rates.
- Offer new services such as in-home energy management and home security.

While most of these applications are seen as strategic initiatives to improve the level of service the utilities can provide — both electrical and customer service — they also have very attractive cost control implications.

Several utilities already see the potential for establishing nonregulated revenue-generating opportunities within these applications as well. They feel that customers would be willing to pay for certain types of premium services, such as interactive billing or power-off notification. Others want to include services for gas and water utilities, such as meter reading or system monitoring. The applications possibilities are numerous and will continue to grow once the network is in place.

Network control and reliability

Because of utility interest in the superhighway, we may see competition developing for network control and maintenance. This was clearly evident at the recent Distribution Automation and Demand-Side Management (DA/DSM) Symposium, a key electric utility conference addressing the various aspects of utility distribution system automation. Utilities, manufacturers and broadband system operators were in attendance. A key topic of discussion revolved around the utility role in the information superhighway.

Several utilities expressed the belief that they should play a major part in the control of the communications networks that link users and utilities if the network is used for the supply and management of electrical power. Many already maintain very sophisticated fiber-optic networks that are used primarily for internal communications, such as SCADA and in-house information systems.

These resources could be used in additional ways. This viewpoint is best

demonstrated by an investor-owned utility that recently announced its intentions to build a pilot-scale fiber-optic and coaxial cable network in a metropolitan area. It intends to test several energy management programs and has not dismissed the possibility of delivering entertainment or other revenue-generating services to recover the cost for full implementation.

Another utility holding company shares a similar perspective. It too wishes to leverage its existing fiber network. While implementing effective energy management applications via the network is key to its efforts, it also has shown an interest in leasing excess bandwidth to entertainment or other service providers without directly getting into these businesses.

Many other investor-owned utilities or their subsidiaries currently lease these "dark fibers" in their internal networks to various telecommunications carriers. Their interest in expanding the networks to customer homes varies, but each has indicated that it will follow developments closely.

A different point of view is held by a number of other utilities. They may lease bandwidth from broadband providers in order to implement their programs. Pacific Gas & Electric (PG&E) recently announced that it is working with TCI to conduct an energy management trial over TCI's network in San Francisco. PG&E does not view itself as a communications company and believes that energy management applications, while important, require only a small part of the broadband capacity. Its desire is to be able to access bandwidth without having to build and maintain an entire network.

Utilities also have other service options including leasing time on wireless networks (primarily for commercial load management) as well as traditional telephony networks.

Not surprisingly, most broadband operators would rather follow the PG&E/TCI approach. They point to the fact that major portions of the superhighway are already constructed and in operation. They see utility overbuilding as posing an imprudent expense on electricity rate payers.

To make their services even more attractive, several major cable operators have organized to present a single front to their local utilities. In most instances, an electric utility's service area will encompass numerous cable systems, so it is important that the cable companies show that they can technically and operationally provide a seamless system.

Technological approach

Because cable/utility relationships are still evolving, both parties have centered their discussions around technical approaches that have a great deal of inherent flexibility. All agree that implementation of the ubiquitous broadband network will likely be a lengthy process.

Typically, utilities want to make sure that a migration path is available. They often want to implement many of the energy management applications prior to having the complete network in place. Therefore, it is essential that an approach is developed to enable them to employ combinations of communications and applications to help them facilitate growth.

One approach that has been met with positive response by the utilities and MSOs involves a system that provides a foundation where video, telephony and telemetry services can be integrated into an advanced fiber/coax network. Existing utility automation programs such as direct load control and power outage detection can then be easily overlaid into

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Nuts and bolts of video compression

The following is updated from the 1993 Society of Cable Television Engineers' Emerging Technologies seminar technical papers. The author was with Scientific-Atlanta at the time of this writing.

By Robert A. Luff
Vice President of Strategy
Bell Atlantic

Video compression technology promises to be the most significant technological development of the decade for the cable industry. Most operators have plans to upgrade their systems to more advanced 750 MHz or even 1 GHz capable fiber-rich double-star buss architectures in order to prepare for future telephony and other two-way services, but the ability to provide double, quadruple or even more digital compressed channels over existing coax and fiber distribution systems radically changes the economics of the entire cable TV industry.

Standards are all but finalized. Manufacturers already have real-time compression demonstrations producing excellent quality pictures. Some satellite programmers and at least one major MSO have announced plans to roll out compression technology. Accordingly, many cable TV chief engineers may be soon asked to plan for compression technology in their systems.

The purpose of this article is to provide a general overview of digital video compression and familiarize the system chief engineer with the primary system level compression technology issues. These issues include: system bandwidth planning; satellite reception; headend compression equipment requirements; distribution and drop requirements; and finally, test and measurement of digital signals.

The MPEG standard

There are many ways to compress video images. However, to retain compatibility between future digital consumer electronic devices and electronic transmission industries (including cable TV) there is growing acceptance for a single worldwide video compression standard developed by the Motion Picture Experts Group

Figure 1: Comparison of analog and digital TV delivery systems

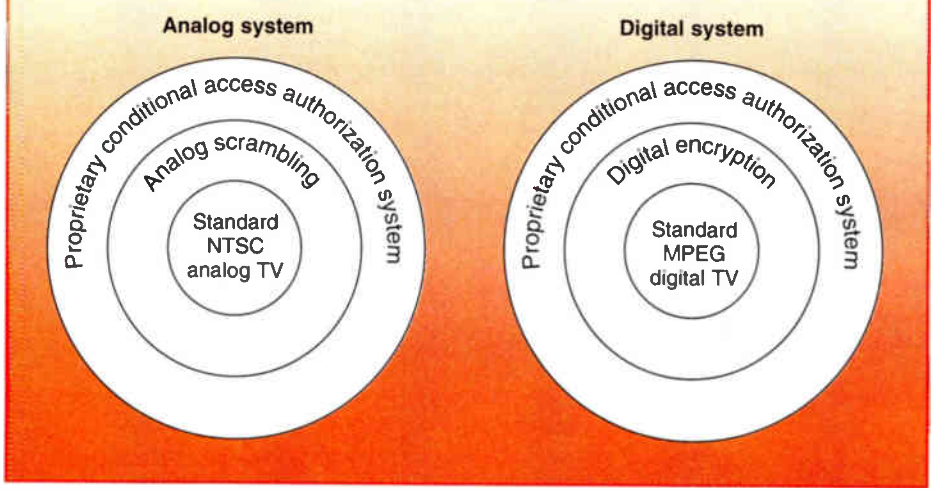
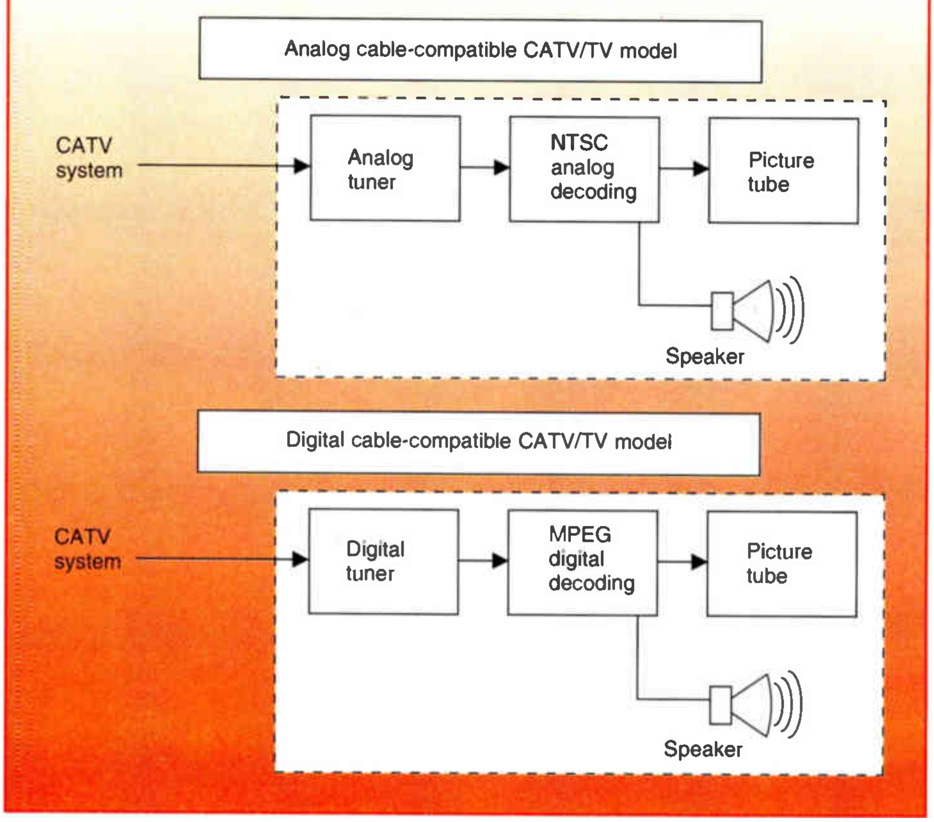


Figure 2: Why CATV should adopt MPEG



this system. More importantly, new two-way applications such as monitoring per-home power usage on a real-time basis, rate setting and evaluation of network performance at the home become possibilities. Broadband providers can continue to deliver video services without interrupting utility activities. Both parties benefit by utilizing bandwidth more effectively.

The future

The information superhighway concept is an exciting and challenging proposition that will require diverse industries to work together to turn a great idea into reality. It may change the way utility services are managed, delivered and consumed to the mutual benefit of the industries involved and their common customers. However, state regulatory influences and federal communications policies will certainly affect the speed with which these alliances take shape. With the technology available today, broadband providers and utilities can help propel that deployment forward by working together cooperatively. **CT**

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2) Michael R. Niggli, "Advantage Power Companies: Creating Competitive Opportunities with the Information Superhighway," Entergy Corp., Fourth Annual Symposium on Distribution Management and Demand-Side Management, Jan. 17-20, 1994, Orlando, FL.

A practical test point

By Jack Webb
Product Manager, Sencore

Automated testing can be a very complex project in a cable TV system. A simplified alternative can be implemented using readily available signal level meters, a few common pieces of system hardware and the personal computer in your office. Naturally, this approach has a shortcoming in that you have to place and retrieve the signal level meter, but it can be implemented by any system for very a modest investment.

While this approach has an obvious application for Federal Communications Commission proof-of-performance (POP) testing, it also will be useful in preventive maintenance and troubleshooting. Most system operating difficulties arise from the fact that the system operates in a hostile environment and must function 24 hours a day 365 days a year. You cannot take the system to a tech bench for thorough testing and troubleshooting. You have to make house calls with a limited amount of time and diagnostic equipment. Recent automated signal level meter offerings provide the ability to make unattended measurements and to store the measurement data in memory for printout.

This sounds wonderful and it is, but implementation is not as simple as it may appear. Problems arise in the implementation when you want to fully utilize the meter's capability to make 24-hour tests or use the same test procedure to help troubleshoot a nagging problem on a long cascade. Just where do you leave your expensive meter for 24 hours and how do you make sure that it does not run out of battery power halfway though the tests?

The following description discusses an approach used by several operators to simplify this test procedure.

Figure 1: Portable test point lock box

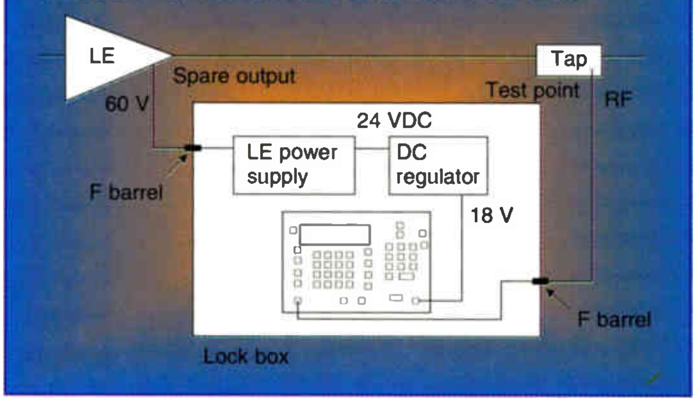


Figure 2: DC regulator

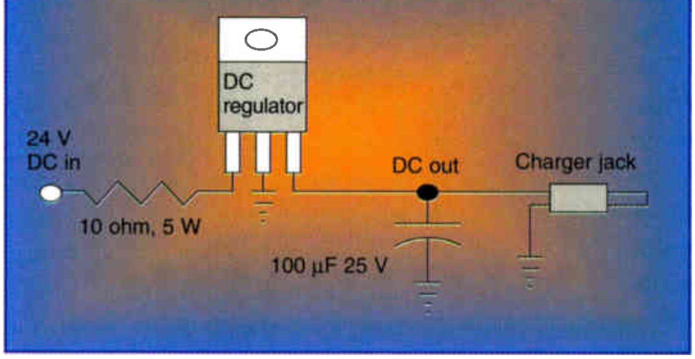
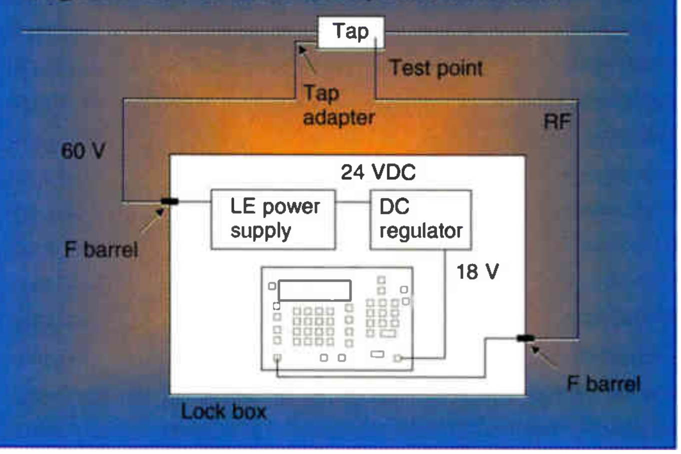


Figure 3: Portable test point lock box



Portable test point lock box #1

A plastic lock box (available from several box and pedestal suppliers) fitted with pole clamps makes an excellent temporary safe home for your meter. This safe haven easily can be wired with temporary power right from the system using a line extender (LE) power supply. In most cases, the system design will permit addition of an LE supply without overloading the system. Several power and test signal configurations are possible depending on the test point to be monitored and the availability of the 60 VAC power. See Figure 1.

In Figure 1, power is taken from the LE via an unused output port using a housing-to-F adapter and RG-59 cable to the lock box. F-61 connectors are mounted in the lock box for convenience. Label each with a marker for future reference. Mount a spare LE power supply in the top of the

Figure 4: Inductor

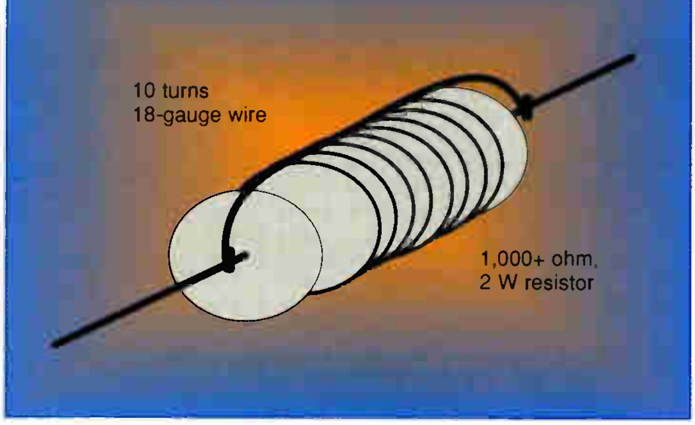
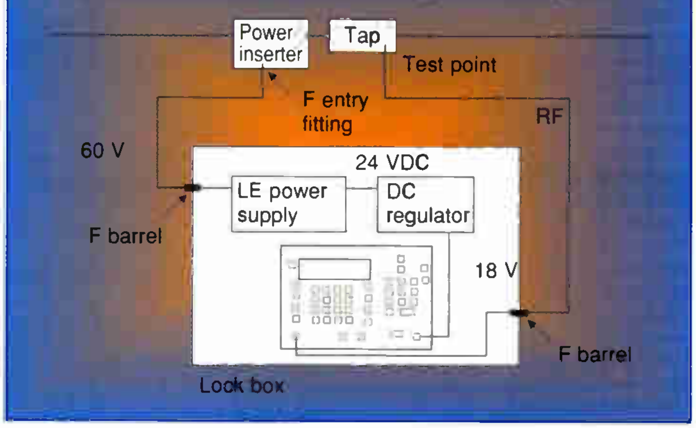


Figure 5: Permanent test point lock box



lock box using a power jack from an old chassis so that the power supply can be changed by unplugging it. Check your signal level meter's manual for proper charger voltage. In some cases, 24 V is acceptable. If less than 24 V is required, a simple power supply circuit can be built to drop the voltage to the desired level. This can be done on almost any type of breadboard or prototype PCB material or simply skywired on a terminal strip. The schematic is shown in Figure 2 (page 70).

DC regulator

Be sure that the regulator chosen is rated for the current and power required for your meter. These are readily available from a number of manufacturers. In the regulator circuit most of the excess voltage is dropped across the resistor. The value of the resistor also will vary depending on the desired output voltage.

Be sure to calculate the power requirement for the resistor based on the rated current of your meter and the voltage that will be dropped across the resistor. It is a good practice to use a resistor with a power rating of twice the calculated value. Also check the rating on the regulator to be sure that you heat sink it as recommended by the manufacturer. Most charger jacks are commonly found at your local electronic supplier. If not, obtain one from the meter manufacturer. You may want to take the meter with you since many jacks look very similar but may not fit properly. Take care in wiring the charger jack to ensure

"Automated testing ... can be implemented using readily available signal level meters, a few common pieces of system hardware and the personal computer in your office."

the proper polarity is maintained.

In many cases an LE or other amplifier is not available for power. A second common configuration is illustrated in Figure 3 (page 70).

Portable test point lock box #2

In Figure 3, the lock box and contents are identical to Figure 1. The method of getting power from the system is the only difference. A tap adapter (to take power off of the system) can be constructed using a housing entry fitting and an F adapter. The stinger on the entry fitting should be trimmed so that when screwed into a port, it firmly contacts the seizure screw. An inductor must be placed in series with the line to prevent affecting the RF characteristics of the distribution system. This can be done by winding a coil of wire around a 2 W resistor. The value of the resistor is not important as long as it is 1,000 ohms or larger. Construction is illustrated in the Figure 4 (page 72).

The coil should be eight turns of 16- to 18-gauge insulated magnet wire wound snugly around the resistor with each end soldered to the lead of the resistor close to its body. Remove the shield compression ring from the connector body and screw the F and entry fitting ends into the body, placing the resistor and coil in the female pins where the cable center conductor would normally be placed. This adapter can then be used to "tap" power from the RF line at any seizure screw port.

Permanent test point lock box

A lock box so constructed can be clamped to a pole or chained to a pedestal and connected to the system in a matter of minutes. Many operators using this technique have elected to install test lock boxes in permanent locations near the end of long distribution legs for end-of-line tests, including their FCC POP tests. For a permanent installation, a power inserter can be cut in rather than using the tap adapter method. The connection for the power adapter is shown in Figure 5 (page 72).

Utilizing this technique to provide a convenient test point for your FCC POP 24-hour tests and preventive maintenance testing will help simplify testing, save you time and help prevent lost test data. Most important, you can count on not only having the data you expect but also having your meter when you go back for it. **CT**

Now turn to page 76 where the author considers why the cable industry needs automated testing to meet the demands of the information superhighway age.

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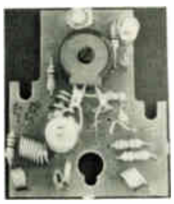

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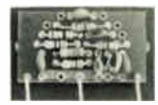

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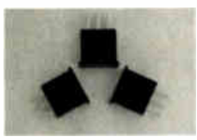

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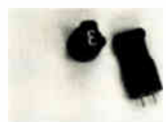

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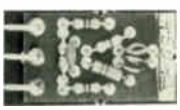

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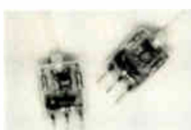

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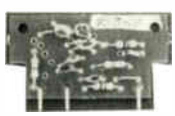

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Who needs automated testing? We do!

By Jack Webb
Product Manager, Sencore

Automated testing in cable TV systems has been around for many years, starting in the mid-1970s with the SAM IID. The SAM IID was designed with an RS-232 interface for external control by a personal computer. While a PC is an integral part of most of our lives today, in the mid-1970s "hackers" were pioneering many applications for the PC using equipment with less computing power than a Nintendo game. Initial offerings in the market provided hardware leaving the user to "hack" his way through developing his own software to make a few simple signal level measurements. While these meager beginnings are similar to many such PC applications, automated testing in cable systems has not developed, kept pace and advanced as many other applications have. Automated testing has not been a priority for system operators causing automated test equipment development to be slow and at times stagnant.

Status monitoring starts

Through the '70s status monitoring systems, monitoring power supplies and AGC/ASC voltages, became available. These were adopted by a few "state-of-the-art" systems, generally finding that the system equipment was more reliable than the status monitoring equipment. Through the '80s, status monitoring was expanded to more thorough testing providing signal level information. Adoption has been very slow as initial system reliability and accuracy were less than desirable. Developments over the last few years have brought great improvements in reliability and capability, although complete Federal Communications Commission proof-of-performance (POP) is beyond current capabilities by most systems.

Automated test systems are widely used in other communications industries. Most telecommunications systems utilize automated monitoring and correction systems. Telecommunication lines and switching terminals used for both data and voice communications use automated test systems that both evaluate the lines and electronics on a continuous basis. In addition, redundant equipment is automatically switched into service when problems are detected. These systems are similar in operation to redundant systems developed and used in a few cable systems, where backup trunk amplifiers are switched in when the primary amplifier fails.

There may be several reasons that automated and redundant systems have not been adopted by cable operators. System component reliability is very high with MTBF (mean time between failure) running up to 20 years on passives and over 10 years on actives. These low failure rates make the investment in automated test equipment and monitoring systems less attractive. New architectures utilizing shorter cascades make the investment even less attractive, all else being equal.

Systems also already have an excellent monitoring system in place. Customers report problems in the system almost instantly. An effective testing system would have to be testing and on-line continuously to improve the timeliness of reports. Benefits would still remain from redundant backup systems to prevent outages. One major problem is simply that it is difficult to test the system more thoroughly than a viewer. A TV set is simply the most effective piece of test equipment to evaluate picture quality on a cable system. Developing and implementing test equipment that can be equally effective would be an expensive undertaking. Such thorough testing would require a minimum of $50,000 per test point using classical instruments. Specialized test equipment,


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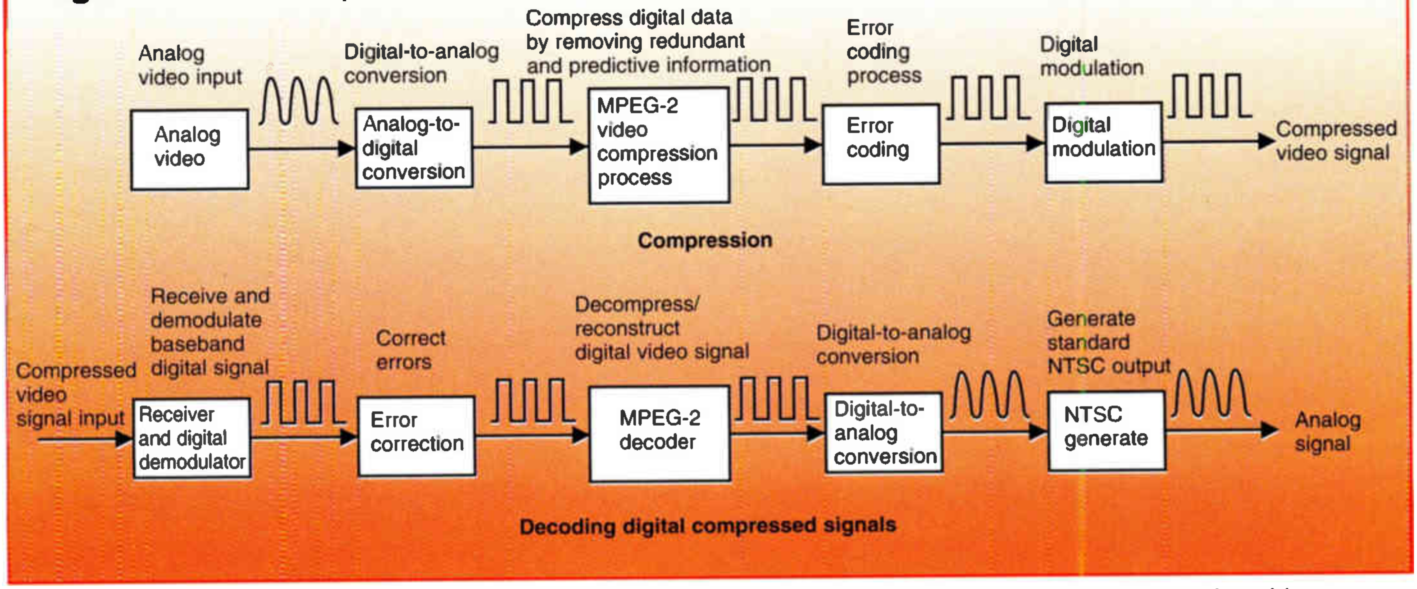
Figure 3: Video compression process



(MPEG). MPEG-1 is an existing compression standard finalized several years ago and optimized for noninterlace images, such as film-based motion pictures and computer game images. Already available in video consumer electronic stores are MPEG-1 compression products that can play back up to 74 minutes of compressed video from an audio CD size laser disk. These MPEG-1 products offer a variety of interactive video game and music video applications.

While MPEG-1 compression technology performs well on film-based or computer images, normal NTSC full interlace TV signals require much higher data rates and storage to produce similar quality pictures. An MPEG-2 committee was convened to develop a compression standard specifically optimized for full interlace TV video and backward compatibility with the earlier MPEG-1 compressed material. (Existing MPEG-1 material will continue to play on the newer MPEG-2 hardware but not the other way around.)

The list of supporters of the MPEG-2 video compression standard process reads like a "Who's Who" of the major worldwide consumer electronic, computer, telephone and cable TV industries. Many companies are already developing MPEG-2 compression chips based on the belief that the majority of the MPEG-2 video standard issues have been resolved. Some chip and hardware manufacturers also are including various design techniques that would allow final software changes to better ensure that their early products are compatible with the important final MPEG-2 standard functions.

Figure 1 compares today's NTSC analog system with the MPEG-2 digital system in the cable TV environment. The only differences are that the "core" analog NTSC decoding is replaced by the digital compression MPEG-2 decoding, and analog scrambling is replaced with much more secure digital encryption. Figure 2 shows the difference between today's NTSC analog TV sets and future MPEG-2 compression-ready TV sets. Again, the primary difference is that the "core" NTSC analog decoding circuitry is replaced with MPEG-2 decoding digital circuitry as well as an upgraded digital tuner.

How is video compression achieved?

Figure 3 provides a generalized flow diagram of the video compression process. Original analog video component waveforms are converted into digital ones and zeros and arranged as digital words that very accurately represent the original analog video. This produces approximately 90 megabits per second (Mbps), which is actually too much data to be able to be carried in a 6 MHz channel. But because there is much redundancy and predictive motion in TV images, various compression techniques have recently been made possible as a result of low-cost high-speed microprocessor technology. As a result, most of the bits representing the redundant and predictive video information can be determined and thrown away or represented in a much more efficient manner digitally before transmission. This reduces the actual necessary bits per second to between 1.2 Mbps to 7.5 Mbps depending on desired picture quality.

"The rapid developments in video compression over the past two years and rapid succession of competitive compression claims by various manufacturers have caused some confusion over compression ratio."

The receiving low-cost high-speed microprocessor-based compression digital circuitry is able to reconstruct a complete digital "picture" using one or more digital frame stores that are used to build and store complete digital images from the received digital signals. These digital frames are converted to their analog equivalent and a reconstituted NTSC analog signal is forwarded to the TV set. The reconstituted picture can be extremely high-quality yet occupy only a fraction of the total 6 MHz bandwidth normally used for analog transmission.

Digital multiplexing

To take full advantage of digital

which is capable of measuring key system parameters and is economically viable, represent a significant design challenge.

Perhaps the desired level of service to the subscriber or the willingness of the subscriber to pay for better service has been a contributor to slow development in these areas. This is likely to be attributable to the public's lack of appreciation for the technology required to provide cable services. After all, broadcast TV is "free" and all you need is a coat hanger for an antenna.

While the reasons may not be so important, it is a fact that automated system monitoring, testing and redundancy has not been widely adopted by cable system operators. Perhaps this has contributed to the current reregulation and FCC enforcement of technical standards.

The FCC role

Enactment of the recent FCC technical standards has brought a flourish of new signal level meters capable of automated testing, data storage and computer interface. While not the answer to automatic system testing, these meters have greatly simplified the testing process required to meet the FCC POP requirements. Operators have struggled through the mounds of paperwork, sifted through the results of hundreds of measurements, and made system repairs. System performance has improved and so has the level of customer satisfaction.

> ***"While we lived without automated testing and backup systems for basic TV services, we may have to have these tools to meet the demands of the information super-highway age."***

Still, little attention has been given to picture quality or outage issues in the scramble for quantity. Are these issues resolved? Were they ever a real issue? Or were they simply an easy way to help push price regulation through Congress?

Not only would automated testing simplify the POP tests, but automated testing may have prevented FCC intervention. (That's if you believe that technical quality issues were a legitimate reason for reregulation.) The reality that we must live with is that the rules are in place and, real or not, the industry cannot afford "bad press" on these issues as we promise to implement new technologies and advance the state-of-the-art in telecommunications.

Channel capacity is once again a paramount issue as operators scramble to compete with promises of VOD (video-on-demand). As we collectively move to the next generation of system architecture (moving toward the information superhighway), quality as well as quantity will be a key issue.

As users increase their dependence on our systems and we become more dependent on incremental revenues, system reliability will be a more critical issue. While we lived without automated testing and backup systems for basic TV services, we may have to have these tools to meet the demands of the information superhighway age. **CT**

What does power supply status monitoring really tell you?

By Jud Williams
Owner, Performance Products

There are several reasons for adding status monitoring to your cable TV system. For example, if your system provides a critical communications link between a corporate subscriber and its long distance service, monitoring the activity of power supplies is certainly necessary. In such a situation, several parameters may require attention. On the other hand, where a cable system supplies only TV signals to subscribers, far less information concerning power supplies is needed (unless it's Super Bowl weekend).

Status monitoring enables you to take a look at the various locations throughout a cable system and be on the look out for any malfunctions that may be occurring. In the case of a power supply, knowing whether it will go into standby when the demand arises is of course the basic requirement. Knowing the condition of several of the levels within a power supply configuration may aid in predicting an impending malfunction or failure. Of particular importance is knowing when the supply is in standby operation.

How it's done

The most basic means of monitoring a power supply is simply by the illumination of indicator lamps installed into the enclosure so that a service tech can determine whether the power supply is in standby or not. This requires that the tech go to the location where the problem is, but can be useful in pinpointing the specific problem power supply for corrective action.

A second very basic status indicator simply tells if a standby power supply failed to operate during any past outage by illuminating a lamp and having it continue to glow until reset. In noncritical situations this approach may suffice.

Another simple but very useful indicator is made up of an elapsed time indicator or "hour meter" and an impulse counter. This combination is useful where the utility is a continuing source of problems. The meters may be read only at the site and cannot be considered in the same category as a true status monitor but serves a useful purpose and are relatively inexpensive.

Status monitors are designed to delve more deeply into the workings of the device they are attached to. Very briefly, a status monitor is usually a computer-based system that is able to "read" various parameters of cable TV power supplies. The element that links the power supply to the status monitor system is an interface card. It connects to the various outputs and functions of the power supply and adjusts them to work within the input ranges of the status monitor's transponder.

As an example, the transponder may require 3.6 volts from the power supply's 36 volt batteries. The interface card may merely use a resistive voltage divider to achieve this. In another example, in order to monitor the 60 VAC output of the power supply and furnish the transponder with the proper DC level to interpret, a simple voltage divider combined with a rectifier and capacitive filter would transform the AC voltage to the required 4 VDC.

The transponder located within the power supply enclosure along with the interface card derives its power from the power supply. The transponder responds to the DC levels given it by the interface card and changes these analog DC levels to digital information. Then it modulates (converts) them to RF to be sent down the cable to the master control unit that interfaces with a computer.

The tests that may be performed on power supplies by modern day status monitors might include the following:

1) The occurrence of a power outage.
2) Output voltage of the power supply.
3) Output current of the power supply.
4) Battery charger float current/voltage.
5) Standby battery voltage.
6) Battery charging current.
7) Occurrence of recent outages.
8) Duration of outages.
9) Tamper alarm on enclosure door.

Let's examine several of these tests to see what we may interpret from them.

Since utilities are often set up in grids, it is useful to be alerted of any grid that may have an outage. Dispatching a generator may be required should the outage exceed the standby time of the power supply.

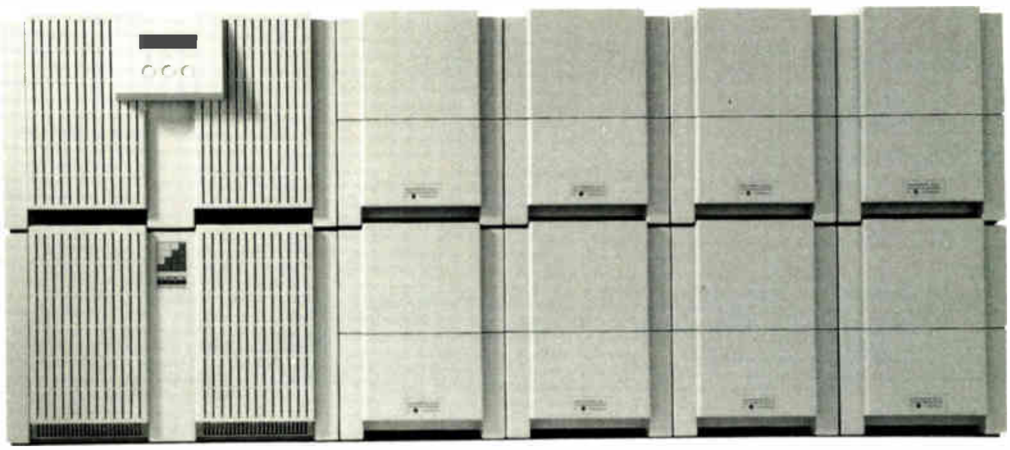
"It is important to know that the batteries in use in cable systems today should not be equalize charged — particularly gelled electrolyte batteries."

Monitoring the output voltage of the power supply is of concern mostly when the power supply is in standby since the AC section is rather stable and comparatively reliable. The output current would be of more concern since it would indicate some malfunction out in the system if a significant deviation from normal were indicated.

Some examples of the kinds of problems that may be detected would be a failing power pack at an amplifier location because of the deterioration of one of its electrolytic capacitors. The capacitor would draw a significant amount of current above normal. Hybrid modules used in trunk amplifiers, bridgers and line extenders also will draw excessive current as they deteriorate. A finely tuned status monitor system should reveal this. Either of these problems would help locate the source of distortion that would be building up in the system.

The float voltage battery test is useful in determining if the charging circuit is functioning properly. If the voltage level is very low it would indicate that the charger no longer has an output due to a blown fuse or tripped circuit breaker. A very high output would indicate that the regulating action of the charger has failed or the equalize voltage function has yet to be disabled. It is important to know that the batteries in use in cable

Power corrupts but lack of power corrupts absolutely...



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> *LAN Times*

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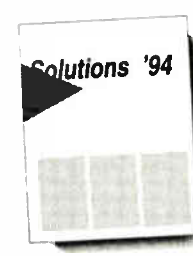

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systems today should not be equalize charged — particularly gelled electrolyte batteries. The application of this excessive charge during float or trickle charge is one reason you may be unnecessarily replacing batteries every 18 months rather than every four or more years.

Observing the charge current going to the batteries immediately after the power supply has been in standby is one way to discover faulty batteries. If the recharging current rate is low and the batteries reach their full charge level rapidly, it may indicate that one or more batteries in the string has very high internal impedance (resistance) possibly due to excessive sulfation or grid corrosion. Such a battery will have very short standby time and would prevent the other batteries from receiving full charge.

Maintaining a log book relating the readings the status monitor has given to the specific problem discovered in the field should increase the effective usefulness of the system. Briefing technicians during periodic training sessions may be needed to emphasize the need for feedback in order to update the log book on a continuous basis and to alert them as to what they should be looking for in the field. **CT**

May 1994

BACK TO BASICS

The training and educational supplement to Communications Technology magazine.

Focus on cable audio

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Troubleshooting digital audio

By Jennifer Hays
Technology Integration Engineer, Digital Cable Radio

Digital modulation offers the cable industry extraordinary opportunities for expanded service offerings and much improved quality. With the advent of this new technology, cable TV installers and technicians face new challenges in maintaining quality service to subscribers. Whether or not your cable system has moved into the digital age, it is important to learn as much about the technology as possible.

Many cable systems are now offering a digital audio service to their subscribers. These services are indicative of the quality available using digital transmission techniques, and are often the first broadband digital service a cable system offers. They provide system personnel an opportunity to become familiar with the problems and causes associated with digitally modulated signals. Among the identified proactive measures for digital signal carriage, as discussed at the SCTE 1994 Emerging Technologies Conference, was the resolution of digital music problems.[1]

Digital signals are relatively impervious to noise and degradation. However, problems that seem minor to an analog video signal may eliminate digital information. If enough of the data is eliminated, re-creation of the signal for viewing or listening is disrupted. This causes a popping sound on an audio signal or picture freeze on a video signal. These symptoms will be more apparent to the subscriber than lines or noise in their analog video service, and therefore, more critical to correct.

The same troubleshooting premise you currently use will carry through for the digital services. Start simple. Do not let the technology drive you to think the cause of a problem is a complicated technical issue.

Identify the problem as precisely as possible by asking these questions:

1) What frequencies (or channels) are being interrupted?

2) Is the problem occurring constantly or intermittently?

3) What is the scope of the problem, one or two locations in the home, the entire neighborhood, the office location?

Listen to the problem and watch the audio tuner indicators for visual verification of the problem:

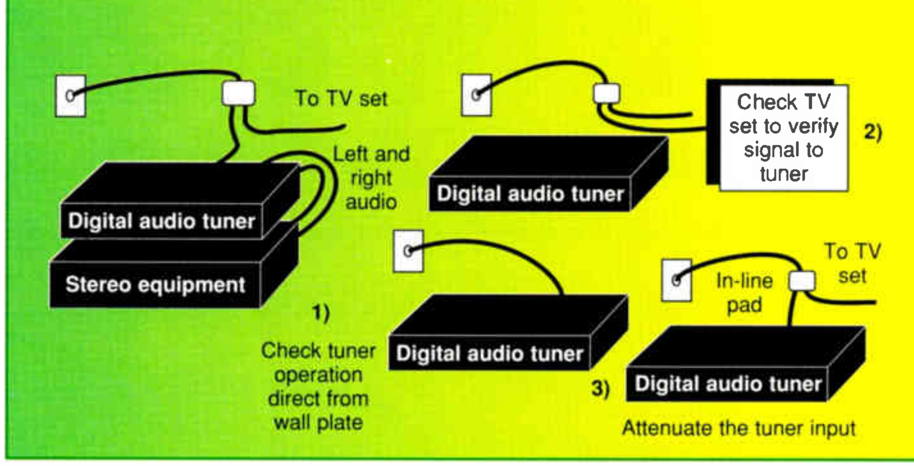


Figure 1: Typical installation and simple verification methods

1) Verify the proper operation of the subscriber's stereo equipment using another device (CD player, radio, etc.). Check the cabling from the digital tuner to the stereo. Are the correct outputs and inputs in use (audio must be into a line-in jack, not a phono-in jack)?

2) Also, check the subscriber's TV reception for degradation. This will give you an idea of the extent of the problem and possibly some clues as to the cause. Now that the problem has been outlined, one of the following areas of action should be identified.

Subscriber stereo problem: Demonstrate the problem to the subscriber, using the same device used to identify it. Offer to connect alternate stereo equipment for the subscriber. A digital tuner's audio outputs can be run into powered speakers, a stereo VCR or TV set with input jacks, or a portable radio with input jacks.

Digital tuner: After verifying the operation of the stereo, make sure the tuner does not require any addressable action (i.e., authorize services). Use the tuner indicators to verify the presence of the digital signal and, if applicable, the addressable data stream. The advent of integrated circuits and digital tuning circuits make the new generation converters (including digital tuners) extremely reliable. The old school of automatically changing out the "box" is now just a waste of time and subscriber irritant.

Drop problem: The integrity of the drop is critical. As with analog troubleshooting, this is the area with the highest potential for problems. "In existing drop systems, poor installations, substandard indoor cabling, corrosion, tampering and vibrations all contribute to signal degradation."[2] Digital signals have specific drop level requirements and need consistency in their path:

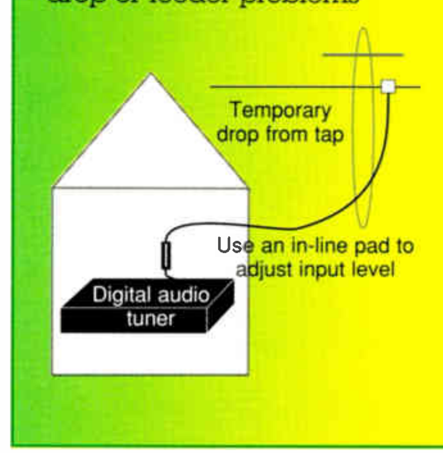


Figure 2: Determining drop or feeder problems

1) Check the input signal level to the digital tuner to make sure it meets the manufacturer's specifications. Make sure you are checking the channels with the problem.

If a signal level meter is not available (Figure 1):

- Hook the tuner drop to the TV set and check picture quality.
- Run the cable from the TV set into the tuner to check for low signal.
- Use an in-line pad at the tuner input to check for high signal level.

Also, check for any indication of interfering signals. Ingress from over-the-air signals like FM radio stations or paging devices can wreck havoc on a digital signal. Notice if one or two digital signals drop off or are elevated, and use these as a reference to find the source of the problem.

2) Sometimes a signal level meter will not identify a problem with a digital signal. The tuner itself can be used as a test device. Using the diagnostic indicators as a guide, run a temporary line directly from the tap to the tuner (use an in-line pad to reach the appropriate signal levels). If the audio indicators and sound are good, hook the drop to the ground block to check for the problem. You can continue to move this temporary line until you have identified the location of the problem (Figure 2).

3) A visual inspection will clear many of the problems (and potential problems) on the drop.

• Drop connectors should be tight and free of corrosion.

• Cables should be intact and shielded.

• All cable ends should be terminated into a device.

• The drop should be well-grounded.

Plant problem: If you have the same symptoms directly from the tap, you have eliminated the drop as the source of the problem. Troubleshooting a line problem follows the same premise as a drop problem. The integrity of the cable and devices is critical. Ingress, reflections and mismatches, and distortions are the prime causes of a digital line problem.

1) Identify the scope of the problem. Using whatever method best identifies the problem (signal level meter, spectrum analyzer, even the tuner itself), find a point on the cable where the problem does not exist and backtrack to localize the cause.

2) Signal levels are the first indicator of a problem. Make sure that all of the signal levels are flat across their individual band and across the digital music spectrum. Are the levels at the proper strength relative to the other carriers on the system? (See Figure 3.)

3) A visual inspection may provide answers. Since all of the signal levels are higher on the cable plant than the drop, reflections can be a greater source of problems. Verify that connectors are tight, but not twisting or compressing the cable. Check for imperfections in the cable or lack of termination at the end of the line or in a device. A reflection can be deceptive. Keep in mind that the source of the problem may be beyond the first point it appears. Temporarily use a terminating tap to ensure you are not looking at a reflection backfeed.

4) The smaller bandwidth and the lower signal level (compared to video levels) of the digital audio signals makes them more susceptible to interfering signals. This includes not only intruding over-the-air signals but beats. Troubleshoot over-the-air ingress using the same methods currently in practice on your system for ingress problems on video services. Beats that may occasionally cause lines in analog pictures may be the source of your digital audio problems. Using a spectrum analyzer, most of these can be identified and the problem levels or the active device corrected (Figure 4). It may be necessary to remove the digital carrier to identify another carrier on its frequency. This will not work if the beat is a product of that digital carrier.

5) Signal levels may appear to be appropriate without providing digital information. Check the activity of your trunk AGC amplifiers. If a digital signal drops off enough, the AGC will increase the modulation level, but the digital signals are not recovered enough to be reconstructed by the tuner. This may show up as a compounded problem with the levels just barely making it, until another problem occurs. A good preventive maintenance program including regular "sweepless" sweeping of the digital audio bands will help identify this problem.

Common sense and basic troubleshooting still prevail in the digital world. Most digital audio problems are simple and easy to identify. (See Figure 5.) Fixing these drop and plant problems will facilitate your system's move to digital video services.

New technologies are being handed to the cable industry at an extremely fast pace. It is imperative that you, as an installer or technician, keep abreast of the changes. **BTB**

Figure 3: Roll-off on the digital signal levels indicates a problem

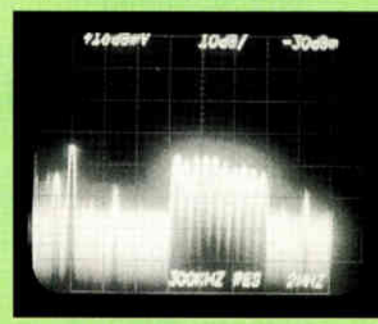


Figure 4: Over-the-air FM intrusion onto digital audio signals caused by a loose drop connector vs. good signals

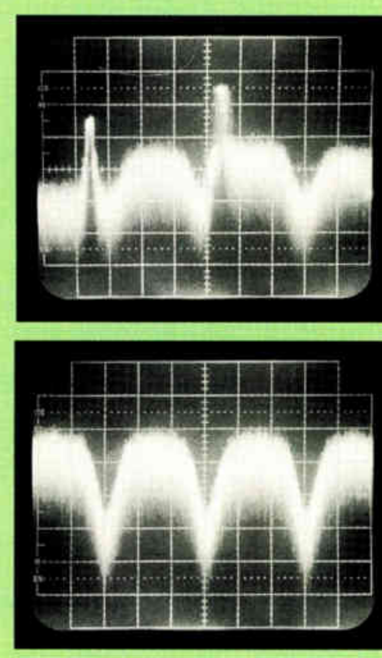
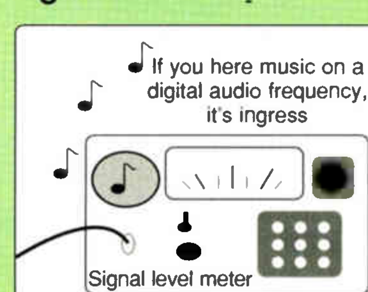


Figure 5: Tech tip



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[1] Nash, B., "Digital Compression and Transmission Field Testing Update" presentation at the SCTE 1994 Conference on Emerging Technologies, Phoenix, Jan. 5, 1994.

[2] Bauer, B., "Advancements in the Development of the Drop System: Major Digital Issues and New Approaches," SCTE 1994 Conference on Emerging Technologies Proceedings Manual (1994), pgs. 63-76.

Interchannel audio level variations: A progress report

The following is reprinted from the "1993 National Cable Television Association Technical Papers."

By Ned L. Mountain
Vice President, Marketing
Wegener Communications Inc.

If you ask subscribers and operators, one of the most frequently mentioned technical irritants is the variation in audio levels as channels are surfed with the remote control. The problem comes up at city council meetings and other places at the most inappropriate times. When I first began to discuss it at NCTA Engineering Committee meetings, many of my colleagues displayed a look of hopelessness. I have felt for many years that the problem is a series of problems compounded by complex interactions of variables over which you may or not have control.

The NCTA Engineering Subcommittee on Quality Sound has been logically analyzing the problem and we are making progress. The purpose of this article is to discuss progress toward our goal of reasonable uniformity among channels that can be achieved by headend technicians using test equipment.

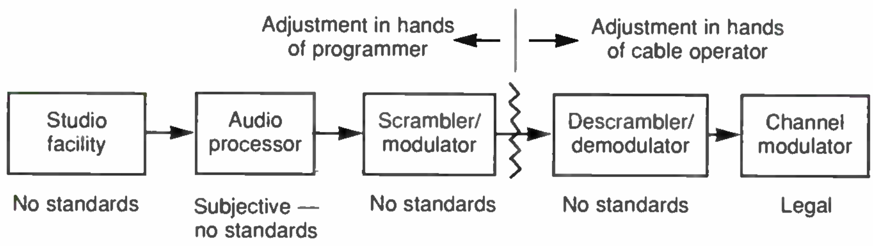


Figure 1: Cable TV sound block diagram

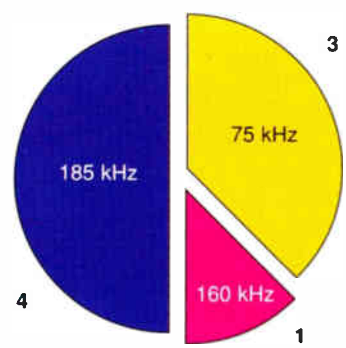


Figure 2: Reported FM subcarrier TV sound peak deviation

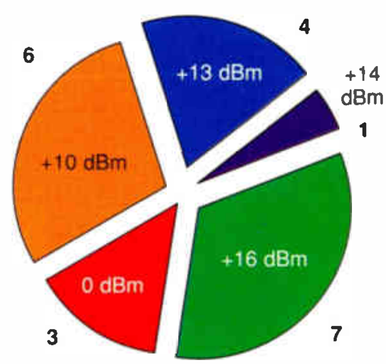


Figure 3: Reported VideoCipher peak program levels

Looking at the system end-to-end

The first step is to look at the entire transmission chain from studio output to the subscriber's speaker. Figure 1 illustrates the various elements of the system and where the critical adjustments occur. It is important to note (and this is one of the root causes of the problem) that the only part of the link governed by "standards" is the final loop from headend to subscriber. For this portion, the Federal Communications Commission has mandated in Rule 73.1570 that TV audio shall modulate the FM subcarrier no more that 25 kHz peak for monaural operation. Note that the FCC has defined a peak value, not a "0 VU" value, not an "average" value, not "peak-to-average ratio," but peak modulation. Although technically legal, no cable operator in his right mind would intentionally use any other standard for TV sound. So, as a starting point, it is important to realize that most cable modulators have a device to indicate when peaks of 25 kHz are occurring. Wouldn't it be nice if one could set the level necessary for 25 kHz modulation with test equipment using a standard reference signal? This is our goal.

The significance of achieving this goal can be put in perspective by considering the fact that the cable program sources represented by this work involve 184,273 individual audio level controls in cable headends (excluding any stereo). I lovingly refer to this as the "AMP" or audio misadjustment potential factor.

Focus on satellite delivery

Data taken by the subcommittee verified that wide audio level variations exist as received at the headend. The subcommittee did some investigation of both the FM subcarrier delivery system as well as VideoCipher. After a series of tests the group unanimously arrived at a recommended practice of 185 kHz peak for FM subcarrier transmissions to represent 100% modulation. The old reference of 237 kHz is simply too wide for many of today's receivers to handle, while a value of 75 kHz does not produce adequate audio signal-to-noise ratios in many cases.

In the case of VideoCipher, the "reference" system defines maximum audio level as approximately +16 dBm just prior to clipping. Note that a "reference" system as defined by the manufacturer includes a 6 dB pad on the input to the scrambler. Since there are no standards, the next best thing (we thought) was to ask the programmers to tell us what they considered to represent 100% peak modulation, as defined by FCC Rule 73.1570. For FM subcarrier transmissions, programmers were asked to provide a deviation value. For VideoCipher transmissions, programmers were asked to provide a value in dBm relative to the General Instrument reference system that represents 100% peak modulation.

Responses from programmers representing 29 satellite-delivered sources were received. As we suspected, the answers confirmed an amazing variation. There are FM subcarrier transmissions with peak deviations ranging from 75 kHz to 237 kHz — a 10 dB spread! In the VideoCipher world, the range is from 0 dBm to +16 dBm — a 16 dB variation! A considerable amount of time was spent reviewing each response to make sure that the answer was indeed correct. This was time well spent. As you can see from Figures 2 and 3, there is indeed a wide variation in admitted peak levels among programmers.

As an editorial comment, we as an industry should have insisted on defining recommended practices in this area 15 years ago instead of letting it go. The subcommittee encourages developers of the next satellite delivery systems to help set the practices up front.

The big headend experiment

Armed with peak program level knowledge as provided by the programmers, the next logical step was to set up a headend using these values and good test equipment and procedures. The headend at CableLabs was volunteered for this experiment. In May 1992, a technical team from the ranks of programmers, MSOs and vendors spent two full days calibrating the headend. Each IRD was calibrated using a GI-furnished scrambler to produce unity gain throughout the system. Each FM subcarrier demodulator was set for unity gain with respect to the recommended deviation of 185 kHz. Seals were then placed on all audio adjustments on all IRDs. So, at this point, we had a rack of precisely calibrated receivers and descramblers.

The modulators for each cable channel were then adjusted to produce precisely 25 kHz deviation when driven with a signal exactly equal to the level each programmer said should equal 100% modulation. This was done using Bessel Null techniques to ensure high accuracy. (At the end of the experiment, we dubbed ourselves the "Bessel Null Boys.") Calibration was verified using a precision modulation monitor. It was interesting to note that the little red "peak" indicators on the modulators were consistently within 1 dB of being totally correct.

The calibration process of our reference headend also emphasized the need for a regular calibration source available by satellite so that technicians can duplicate our efforts without the need for exotic test equipment. To that end, our subcommittee is working to establish a weekly precision audio reference test signal that will be available via satellite at a civilized hour of the day.

"If you ask subscribers and operators, one of the most frequently mentioned technical irritants is the variation in audio levels as channels are surfed with the remote control."

Monitoring the results

One channel on the system was used as a continuous reference with a precisely calibrated 400 Hz tone at 25 kHz deviation. This would serve as a benchmark to ensure credibility of results. The entire CableLabs headend was then carefully monitored using a portion of an AudioRider system. This system looks at all channels sequentially and records the audio level data in memory. Both peak level as well as "opinionated loudness" information are recorded. One full month of data was taken on the entire system.

It should be pointed out that there is a sincere desire on the part of many in the programming community to understand the issues and contribute to the solutions where it can be done in a manner consistent with their corporate goals.

The data collected on all 29 channels fills three huge binders. As of the date of this writing (mid-April 1993) we are in the process of sharing the data with each programmer along with initial interpretations of the data. The easy issues to solve will involve those programmers who are consistent, but obviously not "peaking" at the level they initially thought. Harder issues to deal with involve the subjective arena of audio processing.

Spot checking of the monitoring system reveals that all remains precisely calibrated over one year after the initial data was collected. One interesting observation was the apparent significant (4 dB) increase in level of a major well-respected programmer. When brought to their attention, the level increase was verified, but there was no obvious reason. This points out the obvious need as a part of the long-term process of a central cable quality monitoring service to alert programmers when their technical parameters are beyond established limits.

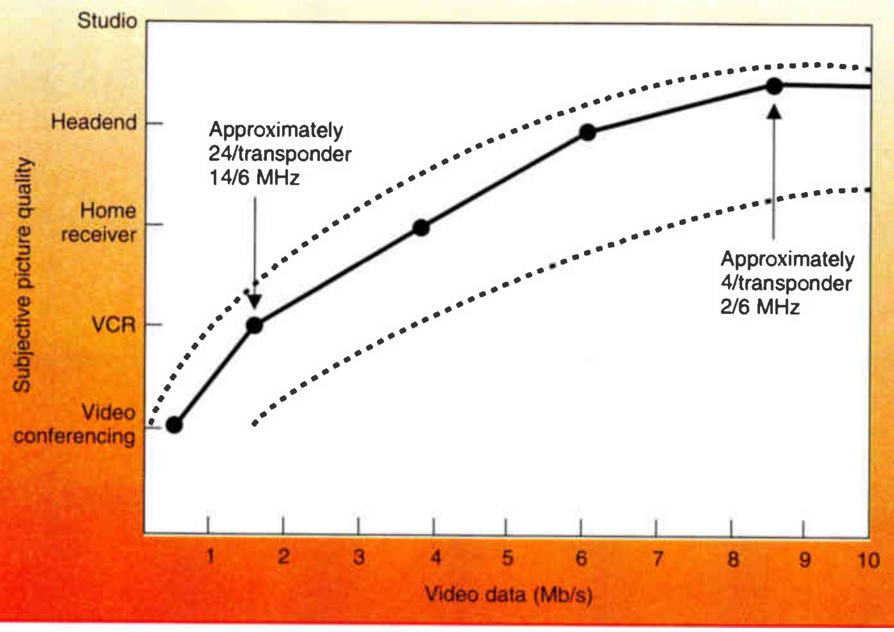
This subcommittee work is rewarding in that the subject seems so simple, yet there are so many subtle variables to make the task nearly impossible. Precise knowledge of peak levels is just the beginning. Issues such as processing, local commercial insertion, etc., also are very complex and will require continuous effort to understand and quantify. Our work will continue until such time as we can provide technicians with a written accurate guide to enable them to perform headend audio adjustments using test equipment and industry-accepted calibration methods. **BTB**

Acknowledgments

The author would like to thank those individuals and their companies that have contributed significantly to the subcommittee effort, in particular the working group known as "The Bessel Null Boys" (Mike Aloisi, Ken Cannon, David Eng, Max Morales, Paul Resch, John Vartanian and Frank Wirnler).

The staff at General Instrument VideoCipher Division also deserves a special thanks for its contribution to the effort.

Figure 4: Digital video compression estimated picture quality vs. data rate



rates of 20 Mbps then:

Compression ratio = 20 Mbps/5 Mbps

= 4 or 4-to-1

Figure 4 shows the relationship of video data rate and subjective video quality. At approximately 1.2 Mbps as many as 12 to 14 channels of VCR-quality pictures can be transmitted in 6 MHz. At 8.5 Mbps, data rate picture qualities between headend and studio are achieved. At this data rate, two digital channels can be transmitted in 6 MHz.

System considerations

Developments in digital video compression have occurred faster than perhaps any other cable TV technology. What are the primary considerations in preparing an existing, well-running but analog-based cable system for the on-rush of digital video compression technology?

transmission, several digital video compressed signals and their associated digital audios and other digital command and control and ancillary service digital signals are alternated or multiplexed together to create a dense high data rate signal containing many unrelated signals. By reversing the process on the receiving end, the distinct signals can be easily separated. Most engineers are familiar with computer modems connected to phone lines with maximum data rates of 1,200 or 2,400 bits per second. Cable TV's greater available bandwidth will allow our maximum multiplex data rates to be much higher. Current video compression data rates on cable systems are planned to be in the 20 to 30 Mbps range.

Compression ratio

The rapid developments in video compression over the past two years and rapid succession of competitive compression claims by various manufacturers have caused some confusion over compression ratio. Simply put, compression ratio is the number of digitally compressed video "channels" and associated audios that can be carried in a standard 6 MHz analog channel bandwidth. If four digital compressed channels are successfully carried in a 6 MHz bandwidth channel then the compression ratio is 4-to-1.

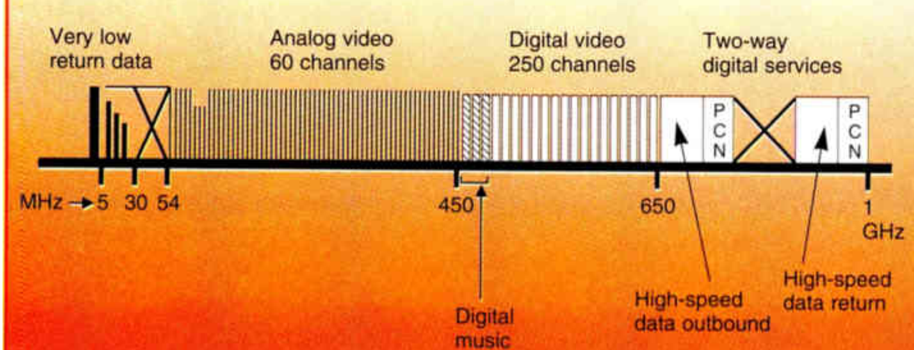
Compression ratio can be computed if the total digital data rate for the channel including any overhead bits and the cable transmission data rate are known. If the total digital compression data rate is 5 Mbps and the system plant and drop condition would support transmission data

System bandwidth planning

New revenue requirements are causing the cable TV industry to look beyond its already successful traditional TV entertainment services and toward telephony and interactive-based services. Although very much driven by the specific system architecture, these potential future services are driving the planning process for more bandwidth in the reasonable near term.

Figure 5 indicates the current planning of future CATV bandwidth as expressed by several MSOs. In general, today's 5-25 MHz subsplit return would remain in place for low data rate applications, such as IPPV ordering or similar ordering/request needs or low-speed interactive or two-way applications. The 25 MHz to 54 MHz guardband remains unchanged, although better filters in the future could reduce the guardband requirements. Even with digital video compression it is envisioned that the industry will continue to provide the bulk of off-air and expanded basic satellite-delivered signals in standard NTSC analog form well into the next decade. This is because it will take at least that long for any reasonable percentage of the existing 200 million analog TV sets and VCRs to be replaced by digital-ready devices. Accordingly, even very far-sighted system planners are intending to maintain or expand their current

Figure 5: System future bandwidth planning



Locating cable TV leaks using quasi-Doppler systems

By David Cunningham
Chief Engineer, Doppler Systems Inc.

Direction finding of CATV signal leaks is distinguished by the large number of possible signals to use and the relatively low magnitude of the radiating signal. The purpose of this article is to provide guidelines for selecting the signal frequency and to make operational suggestions that will enhance the performance of the direction finding system.

Reflections are always a problem in VHF radio direction finding. Because quasi-Doppler direction finding systems provide continuous information on the instantaneous bearing, spatial averaging can be used to advantage. (See the accompanying sidebar on "Theory of operation.") Important clues as to the true direction are found by observing the average bearing and its stability while moving the direction finding vehicle, and noting the surroundings that might be causing reflections (other vehicles, power poles, etc.).

CATV frequency selection for direction finding

CATV channel	ICC video carrier (MHz)	Over-the-air signal	Dipole Signal @ 10 ft (dBm)	Min. ground plane (in)
2	55.250	TV Ch. 2	-83.9	93.5
3	61.250	TV Ch. 3	-84.8	84.4
4	67.250	TV Ch. 4	-85.6	76.8
5	73.250	TV Ch. 5	-86.3	70.5
6	79.250	TV Ch. 6	-87.0	65.2
FM	88-108 WBFM	FM broadcast	-88.5	60.6
0	109.250 (or marker 109.275 typ.)	AM	-89.8	47.3
1	115.250 (or marker 115.275 typ.)	AM	-90.3	44.8
14	121.250	AM	-90.7	42.6
15	127.250	AM	-91.1	40.6
16	133.250	AM	-91.5	38.8
17	139.250	NBFM	-91.9	37.1
18	145.250	NBFM	-92.3	35.6
19	151.250	NBFM	-92.6	34.2
20	157.250	NBFM	-93.0	32.9
21	163.250	NBFM	-93.3	31.7
22	169.250	NBFM	-93.6	30.5
7	175.250	TV Ch. 7	-93.9	29.5
8	181.250	TV Ch. 8	-94.2	28.5
9	187.250	TV Ch. 9	-94.5	27.6
10	193.250	TV Ch. 10	-94.8	26.7
11	199.250	TV Ch. 11	-95.0	25.9
12	205.250	TV Ch. 12	-95.3	25.2
13	211.250	TV Ch. 13	-95.5	24.5

Frequency selection

Several considerations play a factor in selecting the CATV signal to use with the direction finder. The type of CATV signal modulation is important as well as its relative strength. Interfering over-the-air signals must be avoided. Range is affected by the effective area of the receiving antenna, which depends on frequency. Finally, the size of the receiving antenna and especially its ground plane size are frequency-related.

• *Available signals* — The table lists those CATV frequencies in common use below 216 MHz. The direction finder also may be used at frequencies above 216 MHz, but the allowable leakage level is much higher. Below 216 MHz the allowable field strength at 10 feet is 20 microvolts per meter while above 216 MHz the allowable field strength is 15 μV/m at 100 feet. This corresponds to 150 μV/m at 10 feet, so the allowable leakage is 7.5 times higher.

• *Modulation* — The direction finder is intended to be used with a narrowband FM (NBFM) receiver having a bandpass of 15 to 25 kHz. Ideally, the received signal would be an unmodulated carrier. But, either AM or NBFM modulated signals also can be used with the direction finder provided that: 1) the modulation remains within the bandpass of the receiver, 2) the modulation does not contain very much 300 Hz content, and 3) the signal is present for at least 150 milliseconds.

All three conditions are met by two types of CATV signals. The video carrier signals are amplitude modulated far in excess of the NBFM bandpass. This would appear to violate the first condition listed previously; however, the bandwidth of the modulated signal is so much larger than the NBFM bandwidth that the carrier appears very nearly like an unmodulated CW signal when received by a NBFM receiver. The other usable signals are the marker beacons used to detect leakage in the Ch. 0 or Ch. 1 frequency bands. These are narrowband amplitude modulated signals that are tone modulated in the 1 to 2 kHz range.

Signals that are not suitable for use

with the direction finder are the wideband FM (WBFM) signals used to carry the TV audio or commercial FM broadcast signals. For this reason, the FM band is shaded on the table and the TV audio carriers are not listed.

- *Over-the-air signals* — TV Chs. 2-6 and 7-13 line up with the same CATV channels. Since the over-the-air signals are much stronger than the CATV leakage, these frequencies should not be used. They also are shaded on the table.
- *Signal strength* — The video carriers and the marker beacons are the strongest signals present on the cable. In general, a marker beacon has a signal strength equal to or larger than the video carrier, and the distinctive tone modulation used makes it easy to identify. Assuming a spec level leak of 20 μV/m at 10 feet, the signal that would be received by a dipole antenna driving a 50 ohm receiver can be calculated as follows:

$W = E^2/(120 \times \pi)$

$A = (G \times \lambda^2)/(4 \times \pi)$

$P_R = W \times A$

$dBm_R = 10\log(P_R/0.001)$

Where:
W is the power density in watts per square meter.
E is the field strength in volts (RMS) per meter.
A is the effective area of the receiving antenna in square meters.
G is the antenna gain over an isotropic antenna (and is equal to 1.64 for a thin dipole).
λ is the wavelength in meters.
P_R is the received power in watts.
dBm_R is the received power in decibels over 1 milliwatt.

"Since it is hard to distinguish the tone modulation of the marker in the NBFM mode, it was found most convenient to use the receiver in the AM mode to first pick up a leak, then switch to NBFM to locate it."

As frequency increases, the dipole signal strength for a spec level leak decreases about 0.3 to 0.4 dB per CATV channel as indicated on the table. The actual range will depend on the receiver sensitivity as discussed later; however, the signal strengths above Ch. 22 have been shaded to indicate that higher frequencies will provide reduced range.

- *Antenna size* — The direction finder antenna consists of four quarter wave monopole elements spaced in a square pattern on a ground plane (the vehicle's roof). Usually magnetic mounts are used to allow varying the placement to match the received frequency. The actual spacing of the antennas is not critical, but it should be in the range of 1/8 to 1/4 wavelength. Generally, 3/16 wavelength is best. The ground plane itself works best if it extends at least 1/4 wavelength beyond each antenna. Thus, the optimum size ground plane would be 1/4 + 3/16 + 1/4 = 11/16 wavelength square. At 169.25 MHz, this works out to a reasonable 48 inches, but at 109.25 MHz, the ground plane (roof) would have to be 74.3 inches. If we require the ground plane to extend only 1/8 wavelength past the elements, and space them 3/16 wavelength apart, the minimum size roof drops to 7/16 wavelength. This is the size indicated in the last column of the table on page 88. Sizes at frequencies below 109.25 MHz are shaded to indicate an excessive size. However, it should be remembered that the sizes listed are the minimum recommended, and that a larger ground plane is preferable.

The direction finder works best when the antenna is mounted on a flat ground plane with no other radiating objects in its vicinity (such as other antennas, ladders, etc.).

If a marker beacon in the CATV Ch. 0 or 1 range is available, this would be the first choice. A good alternative is to

Theory of operation

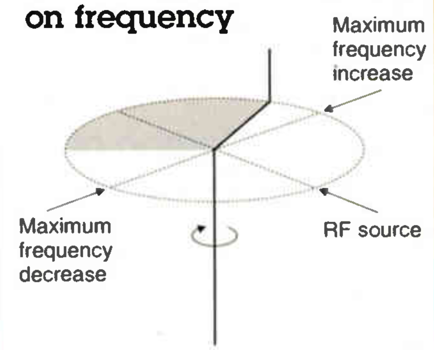
The RF summer combines the four antennas' outputs in a manner that simulates the motion of a single antenna moving in a circular path bounded by the four antennas. As the rotating antenna moves toward the RF source, the apparent frequency increases, and as the antenna recedes from the source, the apparent frequency decreases. (See the accompanying figure.)

This up-down (Doppler) phase-shift occurs at the same frequency that the antenna spins, and the phase-shift contains the bearing information. A patented method is used to combine the antennas smoothly to prevent receiver desensitization.

The up-down frequency shift is recovered by a narrowband FM receiver and can be heard as a weak 300 Hz tone at the audio output. The direction finder processes this tone further to display the bearing. Various equipment models provide a circular display of the bearing, a digital readout, an RS-232 interface or a synthesized voice output.

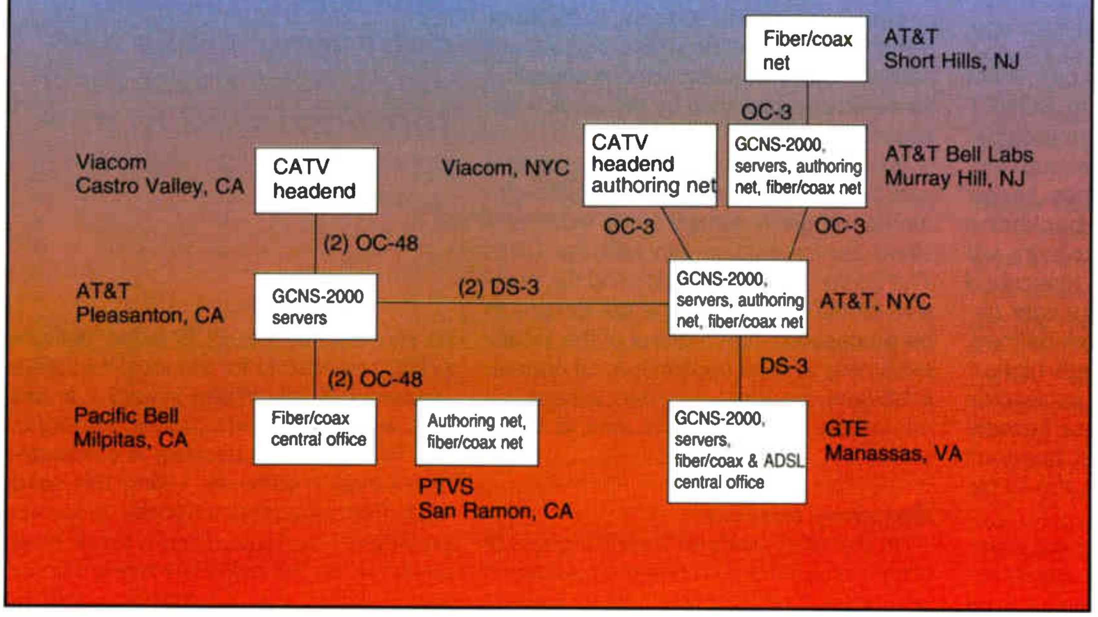
In operation, the automatic direction finder's (ADF) four magnetic-mount antennas are placed in a square pattern on the homing vehicle's roof, about 3/16 wavelength between adjacent antennas. Various antennas are used for operation between 50 MHz and 1,000 MHz. Changing frequency bands involves changing the antenna whips and moving the magnetic-mount bases to the proper spacing.

Antenna rotations effect on frequency



The RF summer output connects to the receiver antenna jack, and the external speaker output connects to the ADF (which uses a 12 VDC power source). — *DC*

Figure 3: Backbone network for the ICVS platform trials



both the media elements and application control flows.

The first challenge faced in offering ITV services is building the tools required for creating the applications to be offered. The process of creating interactive multimedia titles or applications is often known as "authoring." Authoring is a special form of computer programming that often uses high-level programming languages known as scripting languages.

To date, scripting languages have typically been designed to support computer-based delivery platforms, such as PCs, which have minimal capabilities for high-quality real-time audio and video. As discussed earlier, consumers have high expectations for the production qualities of programming delivered via television. Consequently, to achieve broad acceptance, both the platform for delivering ITV programming, and the tools used to create that programming, must be capable of meeting or exceeding the quality of conventional linear television.

To address the challenge of offering an authoring system, which enables the creation of visually exciting ITV applications, AT&T has created a new scripting language, called M, and a suite of associated support tools. M has been designed to simplify the creation of programming based on multiple full-motion audio and video streams that are manipulated and composed in real-time to form an ITV program. Precise control of media elements and production effects is easily expressed using a model immediately familiar to creative people conversant with standard TV production and editing techniques.

M is a textual scripting language that is very powerful but could be overwhelming to someone trying to create a simple but compelling application. To support people who are not comfortable with text-based programming, AT&T has created a visual programming tool that can be used by ITV authors to automate the creation of M scripts. Using icons, arrows and other symbols, authors can visually specify the control flow of an interactive application and then instruct the tool to create the corresponding detailed M script automatically.

Over the past few years, AT&T has been producing ITV programming to support various marketing and technical trials, and to learn about the content creation process itself. AT&T currently operates a digital production studio in lower Manhattan that is used to support the creation of test materials and to train customers and partners in the use of interactive multimedia creation tools. The staff of this facility has had extensive experience in traditional TV and audio production in the New York media community.

One of the initial lessons learned from the digital production studio was that the production people have a wide range of preferences for tools for creating the media elements for ITV applications. For example, to create still graphics, some artists use Macintosh-based paint or drawing packages, while others still prefer to use traditional chalk or ink on paper (which is then captured using a standard video copy camera stand).

With this knowledge, AT&T has concentrated its authoring tools effort on supporting the creation of control flows and media element manipulation specifications, rather than on creating the media elements themselves. These authoring tools accept media element files created by all of the popular Mac and PC-based graphics, video and audio production programs.

To support the creation of interactive applications, a stand-alone workstation was developed that allows an author to develop and preview an application before it is put on-line for subscribers. This workstation has the capability of executing an ITV application locally and presenting it on an attached TV set just the way residential customers will see it.

One of the significant problems in delivering constantly evolving interactive applications is how to efficiently test these applications and their updates before they are made available to subscribers. The state of the art in software testing is to exercise a program with sequences of various inputs (manually or automatically) to discover any problems. This method cannot be guaranteed to discover all the bugs in a program, and to achieve a high level of confidence in the quality of a new or updated application can take far too long to be practical in an ITV service environment.

Recognizing this problem, new technology was developed for automatically verifying the correctness of ITV application control flows. These verification techniques are based on AT&T's substantial experience with automatic verification of communication protocols. Communication protocols are often specified as groups of communicating finite state machines; mathematical techniques have been developed to verify that these state machines do not have deadlocks, livelocks or unreachable states under all possible input sequences.

ITV applications programmed with the M script language are compiled into finite state machine specifications that are interpreted at application run-time. After compilation, but prior to loading into the server for subscriber use, the compiled M application state machines are submitted to the verification system for a final quality assurance. The only problems detected by this testing are those that could cause a failure or hang-up of the system. The verification tools are not intended to screen for poor presentations or bad edits, for example.

The trials

AT&T will be collaborating with Viacom International, GTE Telephone Operations and Pacific Telesis Video Services (PTVS) on trials of interactive consumer video services using the ICVS platform. The goals of each of these trials is to study consumer demand and acceptance of interactive services and to test the platform technology.

Each of these trials is scheduled to operate for a minimum of 12 to 18 months with significant focus on subscriber application usage and the effectiveness of various merchandising and promotion strategies. The trials will use a mix of basic set-top boxes (supported by media composition in the network) and advanced high-end set-tops.

In late summer 1994, Viacom and AT&T will begin a trial with 1,000 to 4,000 households on Viacom's state-of-the-art CATV system in Castro Valley, CA. This trial is designed to test a wide variety of services including movies-on-demand, home shopping and interactive versions of some of Viacom's existing CATV programming. The server complexes for this trial will be located on AT&T premises in Pleasanton, CA, which is approximately 6 miles from Castro Valley.

In late 1994 or early 1995, AT&T and GTE will begin a trial with approximately 1,000 households on a newly constructed GTE fiber/coax plant in Manassas, VA. This trial may eventually test delivery of interactive video services over ADSL as well.

In early 1995, AT&T and PTVS will begin a trial with approximately 1,000 households on a newly constructed Pacific Bell fiber/coax plant in Milpitas, CA. This trial will share the Pleasanton server complexes used for the Castro Valley trial with Viacom.

Viacom, PTVS and GTE will each develop programming for the trials and some may be shared among the trials. Programming developed by third parties (e.g., Paramount) also could be offered.

The trials with GTE and Pacific Telesis may incorporate the FCC-mandated Level 1 gateway for open service provider access.

As indicated in Figure 3, the three trial locations, the AT&T digital production studio and control center, and Viacom's production center in New York City are interconnected by a nationwide ATM network — the ICVS backbone. Bell Labs in Murray Hill, NJ, also is connected to the backbone to facilitate on-going development of the platform technology.

The ICVS backbone allows all servers to be monitored, controlled and updated from Manhattan. In addition, the backbone could be used to let a subscriber on the trial in Virginia, for example, play a game with a subscriber on one of the trials in California. **CT**

Acknowledgments

Many people in AT&T have contributed to the ICVS project. Although they are far too numerous to name here explicitly, their efforts are recognized and appreciated.

Interactive TV at AT&T

AT&T is using its communications expertise to make possible a variety of interactive TV (ITV) experiences that integrate previously separate or not yet available activities, including voice and video communication, information services, entertainment such as movies-on-demand and multiplayer multilocation games, and transactions such as home shopping through video catalogs and virtual malls.

"Clickity Corners"

Depicted here is a scene from *Clickity Corners* with Claymo the Magnificent. A child "clicks" on Claymo to have the character begin a spelling game. The menu bar at the bottom of the screen allows the child to return to the previous menu ("Last Guide"), go to the "Interactive TV Guide" or return to the "Main Guide." Clickity Corners was developed by AT&T for use during upcoming ITV trials.

Home shopping

Shown here is a screen from the home shopping service, with which users can purchase any of thousands of products via on-line catalogs. This picture shows a juice extractor; menu bars allow viewers to compare prices and features of competing products immediately.

Video phone calls

This is a representation of what a full-motion broadcast-quality video telephone call might look like on a TV screen. In this shot, the entire screen is devoted to the video call; however, a viewer also could choose to receive such a call in a smaller portion of the screen, while simultaneously continuing to watch a program, play a game or conduct some other ITV activity on the rest of the screen.

The three options shown on this video call screen ("hang up," "selfview" and "privacy") allow the caller to end the call, see how she or he looks to the other party or stop transmitting his or her own video image.

How to do a pole-top rescue

By Kip Hayes
Technical Operations Manager
TCI of Oregon

Hey look. What kind of deal is that? Oh, that's a... What is that? Is there a person on that pole? No. Well, maybe. But why would he be in a position like that?

When do you need pole-top rescue techniques? How about when you are the one in trouble? Would someone be able to help? What if everyone understood a few simple techniques that could make it possible for you to get home one more time?

The first thing you must remember is that everyone is a potential life saver. You never know when or where or who it may be.

When you find yourself in a situation that requires helping someone out of a dangerous or potentially dangerous predicament on a pole:

- Let your office or emergency rescue team know.
- Don't waste time. Get your climbing gear on. Even if help arrives before you get up the pole you may be able to assist from the pole.
- Assess the situation. Make sure that whatever created the problem for the per-

Figure 1

Figure 2

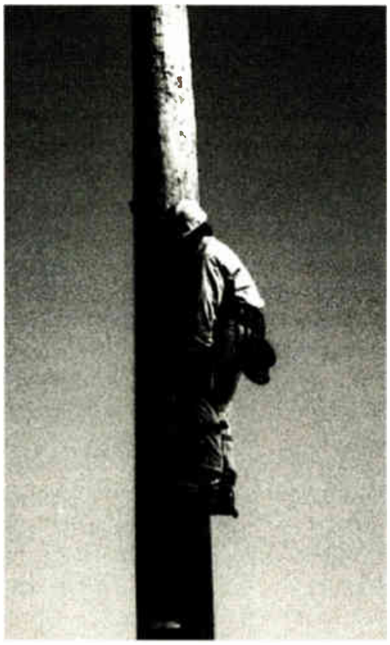
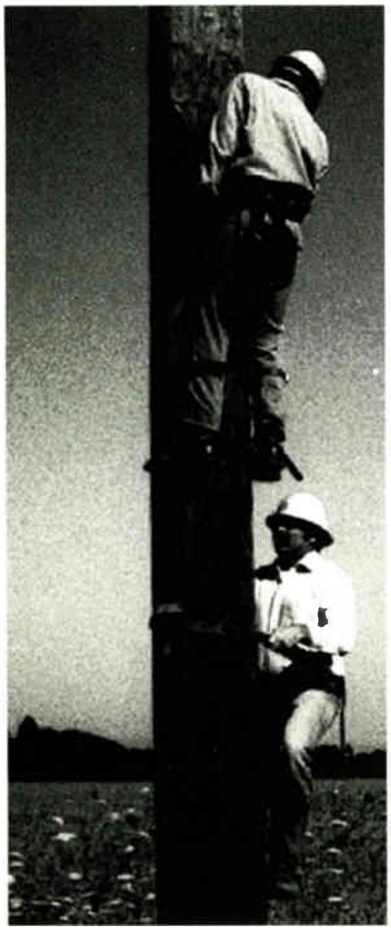


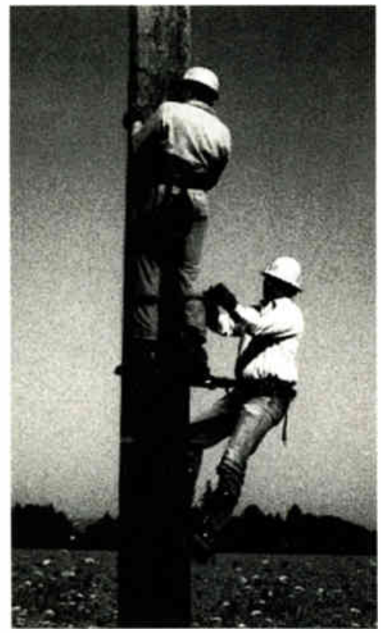
Figure 3



son you found will not create a problem for you.

• If you can verify that the person up the pole is clear of electrical lines, obstructions and loose objects, then you can proceed.

Figure 4



Let's get started

Knowledge is the bridge between a quick save and disaster.

To practice the rescue technique, have someone climb up a pole about 10 feet off the ground and hook his safety strap around the pole and a screwdriver or "J" lag driven in at an angle. (See Figure 1.) Have the person play dead or just go limp. (See Figure 2.) It's best to pair everyone up with someone of about the same weight.

Now it's time for the rescue

Put your hard hat on. Let your safety strap out by at least two or three holes

Figure 5

more than would be required for normal belt-assisted climbing of the pole. Walk over to the pole and strap yourself in. Watch for movement from the person in trouble (PIT). Even if you're unable to get the person's attention, this is a good time to start speaking. Keep it calm and always let him know where you are and what you are doing.

Start climbing up slowly but steadily. Stay on the side or back of the pole in relation to the PIT's position. (See Figure 3.)

When you are even with the PIT's gaffs, remove them. (See Figure 4.) You really don't want to deal with them if the person revives during the rescue. Be careful. The PIT may slide down at any time, especially after the gaffs are removed.

Move your safety strap even with or

"Make sure that whatever created the problem for the person you found will not create a problem for you."

above the persons' belly button. The higher you are the easier it is to free his safety strap.

Reach out and grab the person's leg closest to you. Lift it over your head and

Figure 6

Figure 7

Figure 8

rest it in front of you on your safety strap. (See Figure 5 on page 95.) Next, reach over and pull him completely onto your safety strap. (See Figure 6.) Use his belt or belt loop for a gripping point.

Once you have him balanced on your safety strap (in your lap), control his upper body by putting your left or right hand under his arm and across his chest to the opposite shoulder. Use the other hand to unsnap and remove his safety strap. You must free the safety strap. Remove the entire body belt or cut the safety strap if necessary.

Don't let go of his upper body or you may lose him. Keep talking to him all the time. Let him know where you are and what you're doing.

Now it's time to come down

You want be able to see your own gaffs very well so you must know where the center of the pole is. You will have to feel the pole with your gaffs and aim them toward the pole's center. Take short steps. This is the wrong time to get in a hurry. If you have trouble getting your gaffs out of the wood, use your toe to push sideways. This will act like a pry bar and help clear your gaffs. Don't stomp the pole. Let your combined weights push the gaffs into the pole. As you will find out, sinking into the wood is not a problem. (See Figure 7.)

When you get on the ground (Figure 8), find a flat spot where you can administer first aid. Make sure medical help is on the way, then start with the first aid.

After you are the rescuer, you can play the victim to see how it feels. **CT**

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4	30	56	82	108	134	160	186	212	238	264	290
5	31	57	83	109	135	161	187	213	239	265	291
6	32	58	84	110	136	162	188	214	240	266	292
7	33	59	85	111	137	163	189	125	241	267	293
8	34	60	86	112	138	164	190	216	242	268	294
9	35	61	87	113	139	165	191	217	243	269	295
10	36	62	88	114	140	166	192	218	244	270	296
11	37	63	89	115	141	167	193	219	245	271	927
12	38	64	90	116	142	168	194	220	246	272	298
13	39	65	91	117	143	169	195	221	247	273	299
14	40	66	92	118	144	170	196	222	248	274	300
15	41	67	93	119	145	171	197	223	249	275	301
16	42	68	94	120	146	172	198	224	250	276	302
17	43	69	95	121	147	173	199	225	251	277	303
18	44	70	96	122	148	174	200	226	252	278	304
19	45	71	97	123	149	175	201	227	253	279	305
20	46	72	98	124	150	176	202	228	254	280	306
21	47	73	99	125	151	177	203	229	255	281	307
22	48	74	100	126	152	178	204	230	256	282	308
23	49	75	101	127	153	179	205	231	257	283	309
24	50	76	102	128	154	160	206	232	258	284	310
25	51	77	103	129	155	181	207	233	259	285	311
26	52	78	104	130	156	182	208	234	260	286	312

A. Are you a member of the SCTE (Society of Cable Television Engineers)?

01. ___ yes
02. ___ no

B. Please check the category that best describes your firm's primary business (check only 1):

Cable TV Systems Operations

03. ___ Independent Cable TV Syst.
04. ___ MSO (two or more Cable TV Systems)
05. ___ Cable TV Contractor
06. ___ Cable TV Program Network
07. ___ SMATV or DBS Operator
08. ___ MDS, STV or LPTV Operator
09. ___ Microwave or Telephone Comp.
10. ___ Commercial TV Broadcaster
11. ___ Cable TV Component Manufacturer
12. ___ Cable TV Investor
13. ___ Financial Institution, Broker, Consultant
14. ___ Law Firm or Govt. Agency
15. ___ Program Producer or Distributor
16. ___ Advertising Agency
17. ___ Educational TV Station, School, or Library
18. ___ Other (please specify)_____

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

19. ___ Corporate Management
20. ___ Management
21. ___ Programming

Technical/Engineering

22. ___ Vice President
23. ___ Director
24. ___ Manager
25. ___ Engineer
26. ___ Technician
27. ___ Installer
28. ___ Sales/Marketing
29. ___ Other (please specify)_____

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

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

E. What is your annual cable equipment expenditure?

53. ___ up to $50,000
54. ___ $50,001 to $100,000
55. ___ $100,001 to $250,000
56. ___ over $250,000

F. In the next 12 months, what fiber-optic equipment do you plan to buy?

57. ___ Fiber-Optic Amplifiers
58. ___ Fiber-Optic Connectors
59. ___ Fiber-Optic Couplers/Splitters
60. ___ Fiber-Optic Splicers
61. ___ Fiber-Optic Transmitter/Receiver
62. ___ Fiber-Optic Patchcords/ Pigtails
63. ___ Fiber-Optic Components
64. ___ Fiber-Optic Cable
65. ___ Fiber-Optic Closures & Cabinets

G. What is your annual fiber-optic equipment expenditure?

66. ___ up to $50,000
67. ___ $50,001 to $100,000
68. ___ $100,001 to $250,000
69. ___ over $250,000

H. In the next 12 months, what cable test & measurement equipment do you plan to buy?

70. ___ Audio Test Equipment
71. ___ Cable Fault Locators
72. ___ Fiber Optics Test Equipment
73. ___ Leakage Detection
74. ___ OTDRs
75. ___ Power Meters
76. ___ Signal Level Meters
77. ___ Spectrum Analyzers
78. ___ Status Monitoring
79. ___ System Bench Sweep
80. ___ TDRs
81. ___ Video Test Equipment

I. What is your annual cable test & measurement equipment expenditure?

82. ___ up to $50,000
83. ___ $50,001 to $100,000
84. ___ $100,001 to $250,000
85. ___ over $250,000

J. In the next 12 months, what cable services do you plan to buy?

86. ___ Consulting/Brokerage Services
87. ___ Contracting Services (Construction/Installation)
88. ___ Repair Services
89. ___ Technical Services/ Eng. Design
90. ___ Training Services

K. What is your annual cable services expenditure?

91. ___ up to $50,000
92. ___ $50,001 to $100,000
93. ___ $100,001 to $250,000
94. ___ over $250,000

L. Do you plan to rebuild/ upgrade your system in:

95. ___ 1 year
96. ___ more than 2 years

M. How many miles of plant are you upgrading/ rebuilding?

97. ___ up to10 miles
98. ___ 11-30 miles
99. ___ 31 miles or more

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4	30	56	82	108	134	160	186	212	238	264	290
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14	40	66	92	118	144	170	196	222	248	274	300
15	41	67	93	119	145	171	197	223	249	275	301
16	42	68	94	120	146	172	198	224	250	276	302
17	43	69	95	121	147	173	199	225	251	277	303
18	44	70	96	122	148	174	200	226	252	278	304
19	45	71	97	123	149	175	201	227	253	279	305
20	46	72	98	124	150	176	202	228	254	280	306
21	47	73	99	125	151	177	203	229	255	281	307
22	48	74	100	126	152	178	204	230	256	282	308
23	49	75	101	127	153	179	205	231	257	283	309
24	50	76	102	128	154	180	206	232	258	284	310
25	51	77	103	129	155	181	207	233	259	285	311
26	52	78	104	130	156	182	208	234	260	286	312

A. Are you a member of the SCTE (Society of Cable Television Engineers)?

01. ___ yes
02. ___ no

B. Please check the category that best describes your firm's primary business (check only 1):

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03. ___ Independent Cable TV Syst.
04. ___ MSO (two or more Cable TV Systems)
05. ___ Cable TV Contractor
06. ___ Cable TV Program Network
07. ___ SMATV or DBS Operator
08. ___ MDS, STV or LPTV Operator
09. ___ Microwave or Telephone Comp.
10. ___ Commercial TV Broadcaster
11. ___ Cable TV Component Manufacturer
12. ___ Cable TV Investor
13. ___ Financial Institution, Broker, Consultant
14. ___ Law Firm or Govt. Agency
15. ___ Program Producer or Distributor
16. ___ Advertising Agency
17. ___ Educational TV Station, School, or Library
18. ___ Other (please specify)_____

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

19. ___ Corporate Management
20. ___ Management
21. ___ Programming

Technical/Engineering

22. ___ Vice President
23. ___ Director
24. ___ Manager
25. ___ Engineer
26. ___ Technician
27. ___ Installer
28. ___ Sales/Marketing
29. ___ Other (please specify)_____

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

30. ___ Amplifiers
31. ___ Antennas
32. ___ CATV Passive Equipment including Coaxial Cable
33. ___ Cable Tools
34. ___ CAD Software, Mapping
35. ___ Commercial Insertion/ Character Generator
36. ___ Compression/Digital Equip.
37. ___ Computer Equipment
38. ___ Connectors/Splitters
39. ___ Fleet Management
40. ___ Headend Equipment
41. ___ Interactive Software
42. ___ Lightning Protection
43. ___ Vaults/Pedestals
44. ___ MMDS Transmission Equipment
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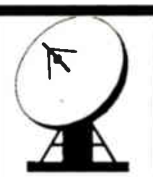

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May 16-27	Nov. 28 - Dec. 9

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PRODUCT NEWS

Composite video monitor

Ultech Corp. introduced the TV Trigger Mate, a tool for analyzing composite video. It allows operators to maintain video equipment with only a general purpose oscilloscope. The scope doesn't need delayed sweep or a TV trigger.

The unit provides a stable trigger for any oscilloscope and offers individual line selection in combinations of four color fields. It can trigger on all fields, odd fields (1 and 3), even fields (2 and 4) or individual fields 1-4. It can trigger anywhere within a TV scan line in increments of 125 ns with a maximum jitter of ±8 ns. The unit works with NTSC, PAL and SECAM video.

The unit's prominent feature is its blinking marker signal available at the video output connector. The marker flashes a pixel on a TV monitor that corresponds to the trigger point. The marker can provide coordinates of objects on the screen such as text boxes.

The unit provides horizontal, vertical, field and composite sync from an incoming video signal. These outputs are available on rear panel BNC connectors or front panel probe terminals.

Reader service #208

Multimode video decoder chip

C-Cube Microsystems announced the CL9100 multimode video decoder chip. According to the company, it is the first RISC-based chip specifically designed to decode four video compression algorithms: MPEG-2 main level, main profile; MPEG-2 main level, simple profile; DigiCipher II; and MPEG-1. With multimode video capabilities, interoperability issues are eliminated for hardware developers seeking the widest range of video compression support for broadcast and convergence products. As a single-chip solution, the company says the chip provides lower total system costs and a more reliable design for products incorporating the decoder.

The chip also supports all main video standards, including NTSC, PAL and film, as well as supporting multiple video resolutions. In addition, it also provides on-screen display capabilities, efficient memory usage, advanced error concealment functionality and a high-level command-based host interface.

Reader service #207

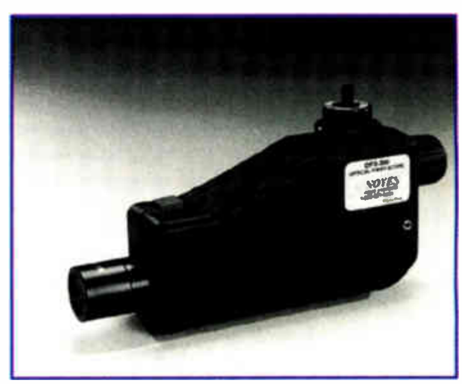
RF signal strength meter

Berkeley Varitronics introduced the Champ handheld, real-time signal strength meter for RF analysis, with options such as internal GPS and PCMCIA (memory card). The unit weighs three pounds and works for both analog and digital modulation systems. Designed to mimic a spectrum analyzer in FDM quasi-peak mode, the unit is suited for walk around or drive-thru propagation studies, scanning the full bandwidth in one second.

Studies to determine optimum frequency from 900-932 MHz can be made rapidly with its internal auto-calibrating RSSI detector circuits and outputs via an RS-232 port for printing or post processing.

Four other models will be available shortly with overlapping coverage for the PCS band from 1.8-2.4 GHz. Custom modifications and frequencies are available on request.

Reader service #206

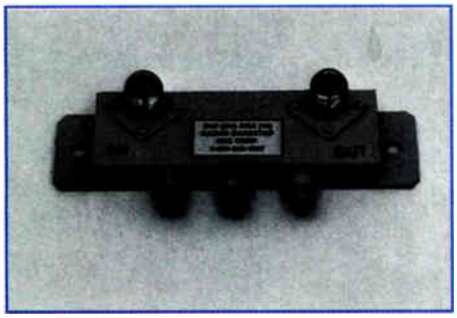


Inspection microscope

The new OFS 300 inspection microscope from Noyes Fiber Systems offers laboratory-quality optics in a rugged handheld case. Primarily used for inspecting fiber-optic connector ends during termination and polishing, the unit also is a valuable maintenance tool for periodic system inspections.

The unit offers 400x magnification for viewing of single-mode fiber ends. Manual X-Y controls ensure the fiber end is centered within the viewing area. A variety of snap-in connector adapters are available, enabling use with many systems. A momentary power switch extends battery and bulb life and is located on the top handle portion of the case, freeing the other hand for focusing. A built-in Schott KG3 filter provides 99% infrared filtering to protect against accidental viewing of live fibers.

Reader service #205



Anti-radar filter

The new BSF(N)2765(10) filter from Communications & Energy Corp. mounts at the MMDS receiver antenna to prevent overload by strong 2,765 MHz radar signals. The filter attenuates radar signals 2,760-2,770 MHz at least 40 dB while passing the entire MMDS band 2,500-2,686 MHz with less than 1 dB loss. It is inserted between downconverter and receive antenna terminals. The weatherized filter has mounting brackets with bolt holes and features type N connectors.

Reader service #204

Optic modulators

United Technologies Photonics Inc. introduced a family of modulators consisting of phase modulators, single and dual output intensity modulators and dual output phase/intensity modulators. All are available for 820, 1,320 and 1,550 nm wavelength operation and feature operation to 20 GHz. Jacketed pigtails are standard. Devices also may be configured with an optional photodetector as well as integrated bias stabilization circuitry.

All units employ the company's $LiNbO_3$ waveguide technology, which is based on the company's patented annealed proton exchange process. This process results in single polarization operation, low insertion loss (3 dB), low back reflections (<-60 dB), high on/off extinction ratio (30 dB) and reliable operation at an input power level up to 200 mW.

Reader service #203

Fiber-optic testing

Fotec unveiled a series of fiber-optic test instruments called SmartSources that use state-of-the-art microprocessor and communications technology to simplify the testing of fiber-optic cables and other components.

When used with the company's FM300 fiber-optic power meter, the units will synchronize all meter and source functions for loss testing and output the results to a printer or PC. When used with the company's FOtest software, the units perform industry standard tests automatically, graphically showing the user how to perform the tests correctly.

All these devices will run on desktop PCs in the laboratory and on laptops for the field. This can simplify field testing, manufacturing testing, or one can add a modem and test remotely.

Reader service #202

Digital encoder/decoder

Dolby Laboratories introduced the DP521 and DP522 digital encoders and decoders for the broadcast, cable and telecommunications markets. The units are designed for distribution systems requiring two channels of high audio quality at low data rates, such as cable TV and digital radio, satellite-based band-edge and SCPC schemes, and terrestrial microwave, T1 and ISDN links.

Reader service #201

Stripping/coring tool

Cablematic Division of Ripley Co. now offers the CST tool that strips the outer sheath with a tapered chamfer cut and cores CATV and telecommunication cables simultaneously in one easy operation. Several models are available for different cable types and sizes. The tools are available with either a standard T-handle or a ratchet T-handle and are easily adapted to drill operation. Color coded cable guide sleeves permit quick, easy identification.

Strip stops can be ordered for exact stripping lengths. The tool is designed for long-term use. Blades are heat-treated for extra long life and performance. Both the sheath stripping blade and the coring bit are replaceable.

Reader service #200

Media server

Oracle Corp. announced the Media Server, which according to the company is the first software platform capable of delivering information highway services to thousands of homes at affordable prices. The system is a digital multimedia library that stores, retrieves and manages all forms of information: video, audio, images, text and tables. It extends the company's database, messaging and transaction processing software to consumer applications including personalized newspapers, movies-on-demand and home shopping.

The system acts as a giant video jukebox, recording everything that is on television, or that has been recorded on film or print. Consumers use services built around it to obtain such information stored in the media library. It is portable and can run on multiple hardware platforms. In a typical configuration, it can deliver 25,000 individual video channels or "streams." Increasing the number of streams on a network is as simple as adding server hardware and software.

The package includes software for the management and delivery of real-time data (video, audio, etc.), text and relational database information. The real-time database is used to send audio and video information to consumers with full VCR-like control (fast-forward, pause, etc.). It stores, retrieves and sends requested information such as movies, news clips, audio recordings and shopping catalogs to users' TV sets.

Included is a text database capable of searching, storing, indexing and retrieving the vast amount of written material that will be stored on-line. It will include technology to provide synopses and summaries of textual information, reducing the amount of useless information to be sorted through.

The Oracle7 relational database management system also is part of the Media Server. It provides the backbone for many of the administrative requirements of interactive services and manages such back-end services as user billing systems, credit card verification, marketing tracking research and user profiles.

Reader service #199

BOOKSHELF

The following is a listing of videotapes currently available by mail order through the Society of Cable Television Engineers. The prices listed are for SCTE members only. Nonmembers must add 20% when ordering.

The following videotapes were produced at Cable-Tec Expo 1993.

☛ *Fiber–Optic Architectures and Construction Practices* — This presentation, featuring Ted Huff, Joseph Selvage and Les Smith covers fiber-optic design and construction. Topics include: trunk and feeder, backbone fiber, fiber-to-feeder, fiber-to-service area, neutral network, passive network, procedures to initiate fiber construction, fiber-optic placement, aerial/underground, direct bury duct and installation of fiber-optic cable in ducts. (70 min.) Order #T-1144, $45.

☛ *Tech Re-Act* — This presentation by Michael Lance and John Wong of the Federal Communications Commission deals with how the Cable Act of 1992 will affect you and your system. It reviews the tests required and their frequency, as well as new technical requirements mandated by the law. Topics include: emergency broadcast system (EBS), home wiring, anti-buy through provision, program access regs, must-carry rules, retransmission, defining a principal headend and area of dominant influence.(ADI). (75 min.) Order #T-1145, $45.

☛ *Test Procedures Under Technical Reregulation* — This program, featuring Terry Bush and Syd Fluck, provides an overview of the new testing required by the FCC, as well as recommendations on how to perform these tests. Topics include: carrier frequency, signal levels, signal level variations over time, in-channel response, carrier-to-noise, distortions, hum, baseband video and leakage. (70 min.) Order #T-1146, $45.

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

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

To order: All orders must be prepaid. Shipping and handling costs are included in the continental U.S. All prices are in U.S. dollars. SCTE accepts MasterCard and Visa. To qualify for SCTE member prices, a valid SCTE identification number is required, or a complete membership application with dues payment must accompany your order. Orders without full and proper payment will be returned. Send orders to: SCTE, 669 Exton Commons, Exton, PA 19341 or fax with credit card information to (610) 363-5898.

Listings of other publications and videotapes available from the SCTE are included in the April 1994 issue of the Society newsletter, "Interval."

CALENDAR

May

10: Society of Cable Television Engineers OSHA/Safety training seminar for system managers and safety coordinators on maintaining records and developing safety training programs, Holiday Inn, Philadelphia. Contact SCTE national headquarters, (610) 363-6888.

10: SCTE Cascade Range Chapter seminar. Contact Cynthia Stokes, (503) 230-2099.

10: SCTE Chattahoochee Chapter seminar, technical basics, Atlanta. Contact Mark Williams, (912) 784-5104.

10: SCTE Desert Chapter seminar, transportation systems, San Goronio Inn, Banning CA. Contact Greg Williams, (619) 340-1312, ext. 277.

10: SCTE Ohio Valley Chapter testing session, BCT/E exams to be administered, Cincinnati. Contact Frank Adams, (216) 826-2941.

10-12: SCTE Wheat State Chapter testing session, BCT/E certification exams to be administered, Multimedia office, Wichita, KS. Contact Jim Fronk, (316) 792-2574.

10-13: Alaska Cable Television Association annual convention, Anchorage, AK. Contact Mike Roberge, (206) 822-0252.

11: SCTE Big Sky Chapter seminar, installer training, Locomotive Casino/Restaurant, Laurel, MT. Contact Marla DeShaw, (406) 632-4300.

11: SCTE Central New York Meeting Group seminar, BCT/E Category V, Ramada Inn, Syracuse, NY. Contact Vince Cupples, (315) 452-0709.

11: SCTE Heart of America meeting, Kansas City, MO. Contact Dave Clark, (913) 599-5900.

11: SCTE South Jersey Chapter seminar, video compression, Ramada Inn, Vineland, NJ. Contact Mike Pieson, (609) 967-3011.

11: SCTE Ohio Valley Chapter seminar, BCT/E exams to be administered, Rodeway Inn, Cincinnati. Contact Frank Adams, (216) 826-2941.

11-13: Society of Cable Television Engineers Technology for Technicians II Seminar, hands-on technical training program for broadband industry technicians and system engineers, Columbus North Hilton Inn, Worthington, OH. Contact SCTE national headquarters, (610) 363-6888.

12: Society of Cable Television Engineers Satellite Tele-Seminar Program *System Sweep, Part 2* to be shown on Galaxy I, Transponder 14, 2:30-3:30 ET. Contact SCTE national headquarters, (610) 363-6888.

12: SCTE Big Sky Chapter seminar, installer training, BCT/E and Installer exams to be administered, Elks Lodge, Helena, MT. Contact Marla DeShaw, (406) 632-4300.

12: SCTE Greater Chicago Chapter seminar, hands-on FCC video testing, Quality Inn Hotel, Chicago. Contact Bill Whicher, (708) 362-6110.

12: SCTE Magnolia Chapter seminar. Contact Robert Marsh, (610) 932-3172.

12: SCTE Ohio Valley Chapter seminar, Holiday Inn, Cleveland. Contact Frank Adams, (216) 826-2941.

12: SCTE Penn-Ohio Chapter seminar, digital communications, annual officer elections to be held, Pittsburgh. Contact Marianne McClain, (412) 531-5710.

12: Scientific-Atlanta training session, DMX digital audio systems, Miami. Contact Bill Brobst, (404) 903-6306.

16: SCTE Oklahoma Chapter seminar, Oklahoma City. Contact Rick Martin, (405) 525-2771.

16-19: Siecor fiber-optic training course, fiber-optic installation, splicing, maintenance and resoration for cable TV applications, Hickory, NC. Contact 1-800-SIECOR1, ext. 5539.

17: SCTE Floribama Meeting Group seminar, Crestview, FL. Contact Rylan Bishop, (205) 476-2190.

17: SCTE Palmetto Chapter seminar, Columbia, SC. Contact John Frierson, (803) 777-5846.

17-18: Scientific-Atlanta training session, distribution networks, Atlanta. Contact Bill Brobst, (404) 903-6306.

17: SCTE Pocono Chapter seminar, Holiday Inn, Hazelton, PA. Contact Anthony Brophy, (717) 462-1911.

18: SCTE Dixie Chapter seminar, Montgomery, AL. Contact Charles Hill, (205) 880-1673.

18: SCTE Great Lakes Chapter seminar, transportation systems, Holiday Inn, Livonia, MI. Contact Jim Kuhns, (810) 578-9437.

18: SCTE Piedmont Chapter seminar and testing session, FCC testing requirements:

Planning ahead

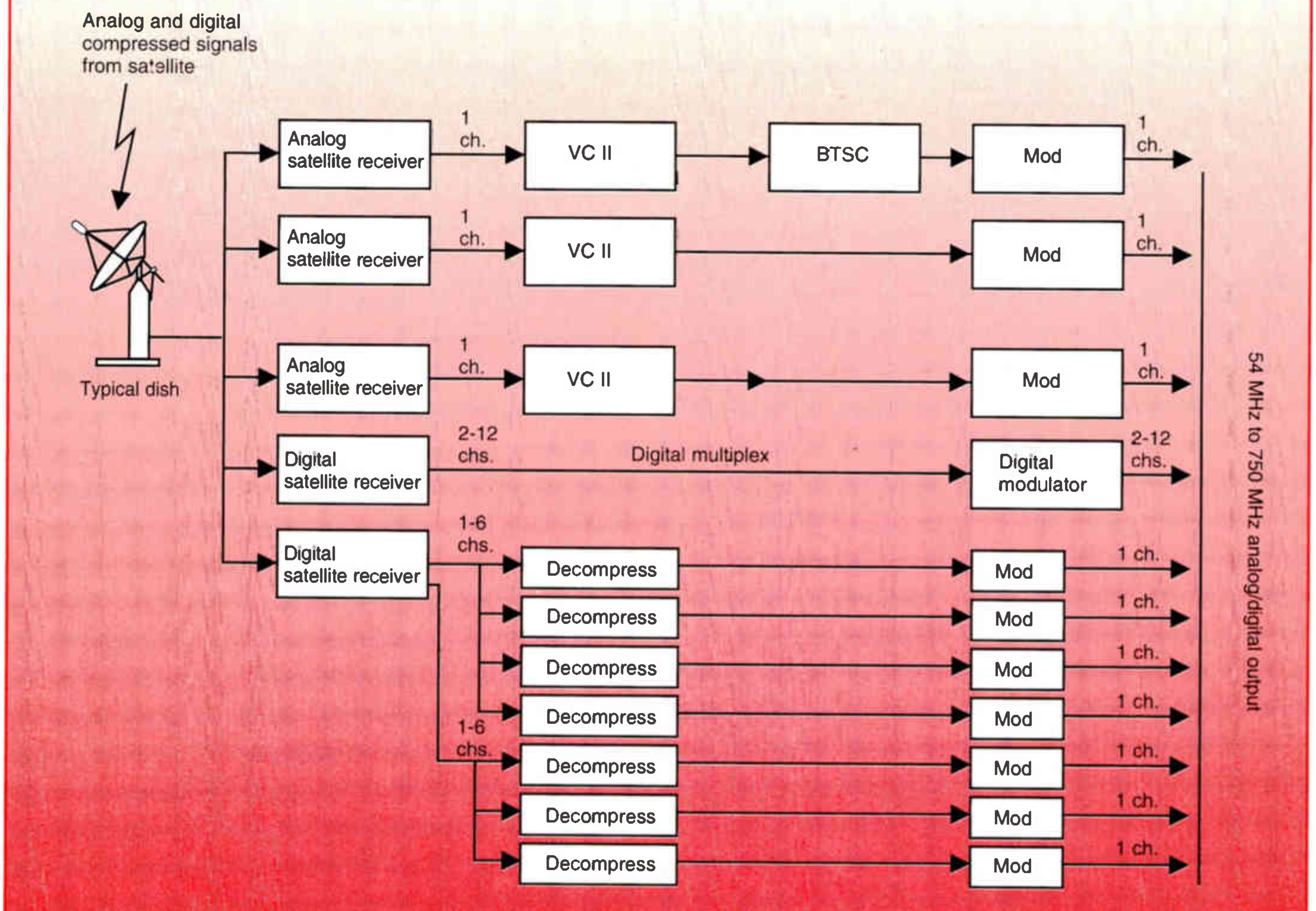
June 15-18: Society of Cable Television Engineers Cable-Tec Expo, St. Louis. Contact SCTE (215) 363-6888.
July 10-13: New England Cable Show, Newport, RI. Contact (617) 843-3418.
July 13-17: Colorado Cable Show, Vail, CO. Contact (303) 863-0084.
Aug. 1-3: Eastern Cable Show, Atlanta. Contact (404) 252-2454.
Sept. 19-21: Great Lakes Cable Expo, Indianapolis. Contact (317) 845-8100.
Oct. 5-7: Atlantic Cable Show, Atlantic City, NJ. Contact (609) 848-1000.
Oct. 11-13: Mid-America Cable Show, Kansas City, MO. Contact (913) 841-9241.
Nov. 13-15: Private Cable Show, Atlanta. Contact (713) 342-9826.
Nov. 30-Dec. 2: Western Cable Show, Anaheim, CA. Contact (510) 428-2225.

video and system tests, Charlotte, NC. Contact Mark Eagle (919) 477-3599.
18: SCTE Rocky Mountain Chapter seminar, CableLabs: in-home wiring and digital transmission tests, CableLabs, Louisville, CO. Contact Leslie Ellis, (303) 393-7449.
19: SCTE Lake Michigan Chapter seminar, customer relations, Days Inn, Grand Rapids, MI. Contact Karen Briggs, (616) 941-3783.
19: SCTE Southern California Chapter seminar, service: tap-to-bridger, Alhambra, CA. Contact Tom Colegrove, (805) 252-6177.
19: SCTE Wheat State Chapter seminar, Wichita, KS. Contact Jim Fronk, (316) 792-2574.
19-20: Scientific-Atlanta training session, headend and earth station, Atlanta. Contact Bill Brobst, (404) 903-6306.
20: SCTE Central Indiana Chapter seminar, engineering management and professionalism review, annual election of board members to be held, Indianapolis Motor Speedway Motel, Indianapolis. Contact Al Orpurt, (317) 825-8551.
21: SCTE Chaparral Chapter seminar, digital compression. Contact Scott Phillips, (505) 761-6253.
22-23: SCTE Old Dominion Chapter seminar, BCT/E Category VII, engineering management and professionalism review, safety, Installer and BCT/E certification exams to be administered, Holiday Inn, Richmond, VA. Contact Maggie Fitzgerald, (703) 248-3400.
22-24: The National Show, New Orleans. Contact the National Cable Television Association, (202) 775-3629.
24: SCTE Desert Chapter testing session, BCT/E and Installer certification exams to be administered, Redlands, CA. Contact Greg Williams, (619) 340-1312, ext. 277.
26: SCTE New England Chapter seminar. Contact Tom Garcia, (508) 562-1675.
27: SCTE Wheat State Chapter testing session, BCT/E exams to be administered, Great Bend, KS. Contact Jim Fronk, (316) 792-2574.

June

1: SCTE Ark-La-Tex Chapter seminar, bench repair, Shreveport, LA. Contact Randy Berry, (318) 238-1361.
1: SCTE Rocky Mountain Chapter seminar, competing technologies, NCTI office, Littleton, CO. Contact Leslie Ellis, (303) 393-7449.
8: SCTE Badger State Chapter seminar, safety, Holiday Inn, Fond du Lac, WI. Contact Brian Revak, (608) 372-2999.
8: SCTE Central New York Meeting Group seminar, BCT/E Category VI, Ramada Inn, Syracuse, NY. Contact Vince Cupples, (315) 452-0709.
8: SCTE Heart of America Chapter testing session, BCT/E exams to be administered, Kansas City, MO. Contact David Clark, (913) 599-5900.
9: Society of Cable Television Engineers Satellite Tele-Seminar Program to be shown on Galaxy I, Transponder 14, 2:30-3:30 p.m. ET. Contact SCTE national headquarters, (610) 363-6888.
9: SCTE Gateway Chapter seminar. Contact Duane Johnson, (314) 272-2020.
13-16: Siecor fiber-optic training course, fiber-optic installation, splicing, maintenance and resoration for cable TV applications, Hickory, NC. Contact 1-800-SIECOR1, ext. 5539.
14: SCTE Central Indiana Chapter seminar, BCT/E exams to be administered. Contact Al Orpurt, (317) 825-8551.
14: SCTE Southeast Texas Chapter seminar, Installer and BCT/E exams to be administered, Warner Cable office, Houston. Contact Rosa Rosas, (409) 582-4855.
14-15: Scientific-Atlanta training session, design considerations and sweep and balance, Atlanta. Contact Bill Brobst, (404) 903-6306.

Figure 6: Analog/digital headend



analog spectrum. They will use more stock and trade entertainment programming on the millions of analog-based consumer products for many years to come.

Depending on the current and expected addition of analog channels, the upper boundary for traditional analog video signals may fall somewhere between 450 MHz and 650 MHz. 650 MHz has been used for planning purposes by several companies. Of course, this boundary does not have to remain stationary and will be heavily influenced by how quickly or slowly satellite programmers convert to video compression feeds, price/availability of digital compression set-tops, and other factors such as the normal system rebuilds or refranchising requirements. There are certain frequency thresholds that planners should keep in mind, such as normal upper frequency tuning capabilities of their current mix of existing set-top converters. For example, the fact that a system's entire universe of existing set-tops has a tuning limit of 550 MHz may set a practical analog boundary. Of course, the system could create a special tier of analog services above the current set-top cut-off tuning limit if new set-tops are ordered just for those wishing to take such a tier.

Special precautions

Much digital experience at the system level has been learned from the ongoing system installations and daily operating issues of the digital music services. While the data rates and modulation techniques are different from those used in digital compression, digital music has been an important first step by the industry to better understand system digital carriage issues. Based on this and field studies, chief engineers' system preparation for compression technology can be divided into four broad areas: satellite reception, headend, distribution and subscriber drops.

Satellite reception

Generally speaking, the requirements for digital compression video signal are essentially the same for good analog signal satellite reception.

• *Dish size and location.* If the system is receiving an analog satellite signal free of "sparkles" and terrestrial interference without filters, the system passes the first major and expensive-to-correct issue regarding digital reception: wrong size or poor location of dish antenna. If the site uses a digital filter to correct any terrestrial interference, the filter may cause poor reception of digital signals.

• *LNBs.* There are, however, some potential hidden trouble areas for digital reception even if the analog performance is excellent. The first is the LNB. Some older or incorrectly functioning LNBs may have center frequency and stability performance levels that, while not yet affecting the more forgiving analog signals, can result in poor digital performance. Some digital satellite receivers have a ±2 MHz AFT range. And while additional step search circuits may actually be

Society elects new directors

By Bill Riker
President, Society of Cable Television Engineers

One of the most important rights of SCTE members is their ability to vote in the annual election for the purpose of choosing qualified, committed individuals to represent them on the board of directors. At the start of each year, an election package is mailed out to the total active membership. The package includes biographies of each candidate, which are made available so that voters have access to the information they need to make a well informed decision.

March 28 marked the official closing of the election to fill eight empty seats on the Society's 1994-95 Board of Directors. At final count, 24% of the membership participated in electing the following directors:

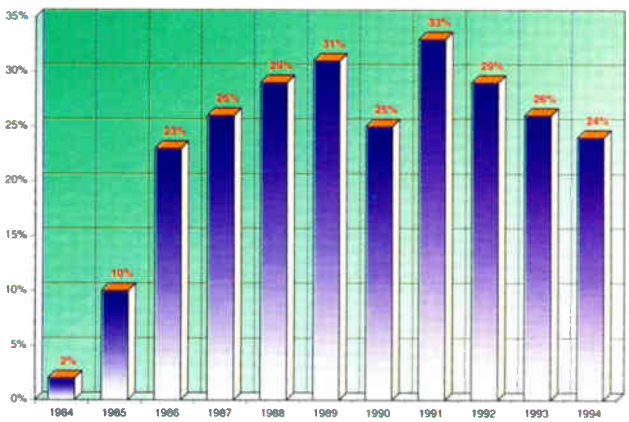
Re-elected to their current positions on the board are: At-Large Director Tom Elliot of TCI; Region 7 Director Terry Bush of Trilithic, serving Indiana, Ohio and Michigan; and Region 10 Director Michael Smith of Adelphia Cable Communications, serving Kentucky, North Carolina, Virginia and West Virginia.

Newly elected to the board are Region 3 Director Andy Scott of Columbia Cable, serving Alaska, Idaho, Montana, Oregon and Washington; Region 4 Director Rosa Rosas of Lakewood Cablevision, serving Oklahoma and Texas; Region 5 Director Larry Stiffelman of Comm/Scope, serving Illinois, Iowa, Kansas, Missouri and Nebraska; Region 8 Director Steve Christopher of Comm/Scope, serving Alabama, Arkansas, Louisiana, Mississippi and Tennessee; and Region 12 Director John Vartanian of HBO, serving Connecticut, Maine, Massachusetts, New York, New Hampshire, Rhode Island and Vermont.

These individuals will join the seven existing board members currently serving their 1993-1995 terms, including At-Large Directors Wendell Bailey of the National Cable Television Institute and Wendell Woody of Sprint; Region 1 Director Steve Allen of Jones Intercable, serving California, Hawaii and Nevada; Region 2 Director Pam Nobles of Jones Intercable, serving Arizona, Colorado, New Mexico, Utah and Wyoming; Region 6 Director Robert Schaeffer of Star Cablevision, serving North Dakota, South Dakota, Minnesota and Wisconsin; Region 9 Director Hugh McCarley of Cox Cable, serving Florida, Georgia and South Carolina; and Region 11 Director Bernie Czarnecki of Cablemasters Corp., serving Delaware, Maryland, New Jersey and Pennsylvania.

The SCTE Board of Directors is charged with representing the best interests of the organization, including its total membership as well as the chapters and meeting groups within each director's region. As a commitment to the continued growth of the Society, the duties and responsibilities of each director include: mandatory attendance at regular and special board meetings (average four per year); acceptance of specific assignments dictated by action taken at board meetings; visiting all chapters and meeting groups within a region at least once a year; establishing basic policies that further the goals and objectives of the Society; establishing, approving and determining the priority of existing and future programs benefiting the membership, chapters, meeting groups and the industry as a whole; reviewing the relevance and validity of programs and services; supporting and defending policies and programs adopted by the board; offering support for the development of chapters and meeting groups; being aware of Society programs, benefits and policies and promoting membership in and support of the Society.

SCTE Annual Election
(percentage of membership voting)

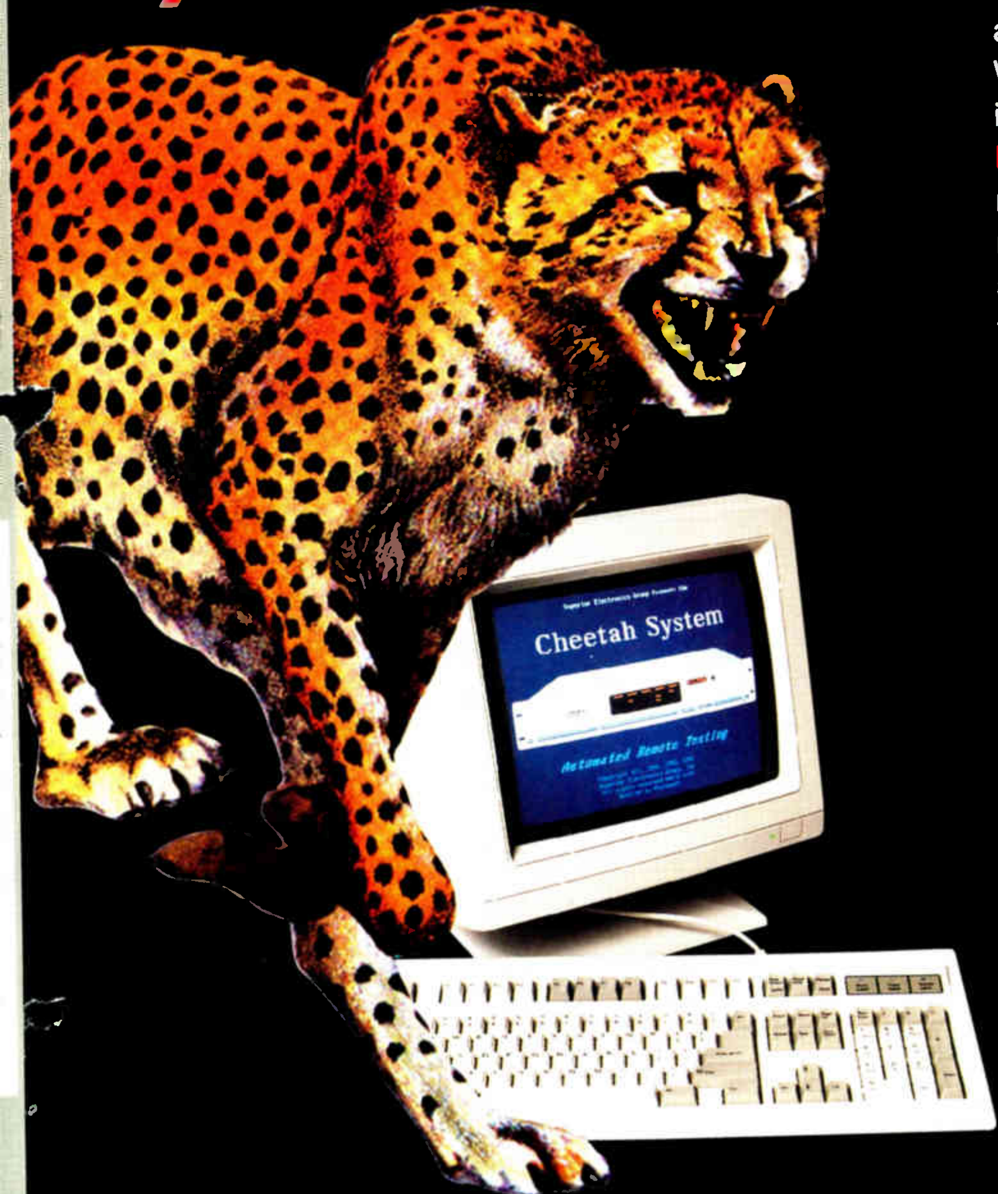


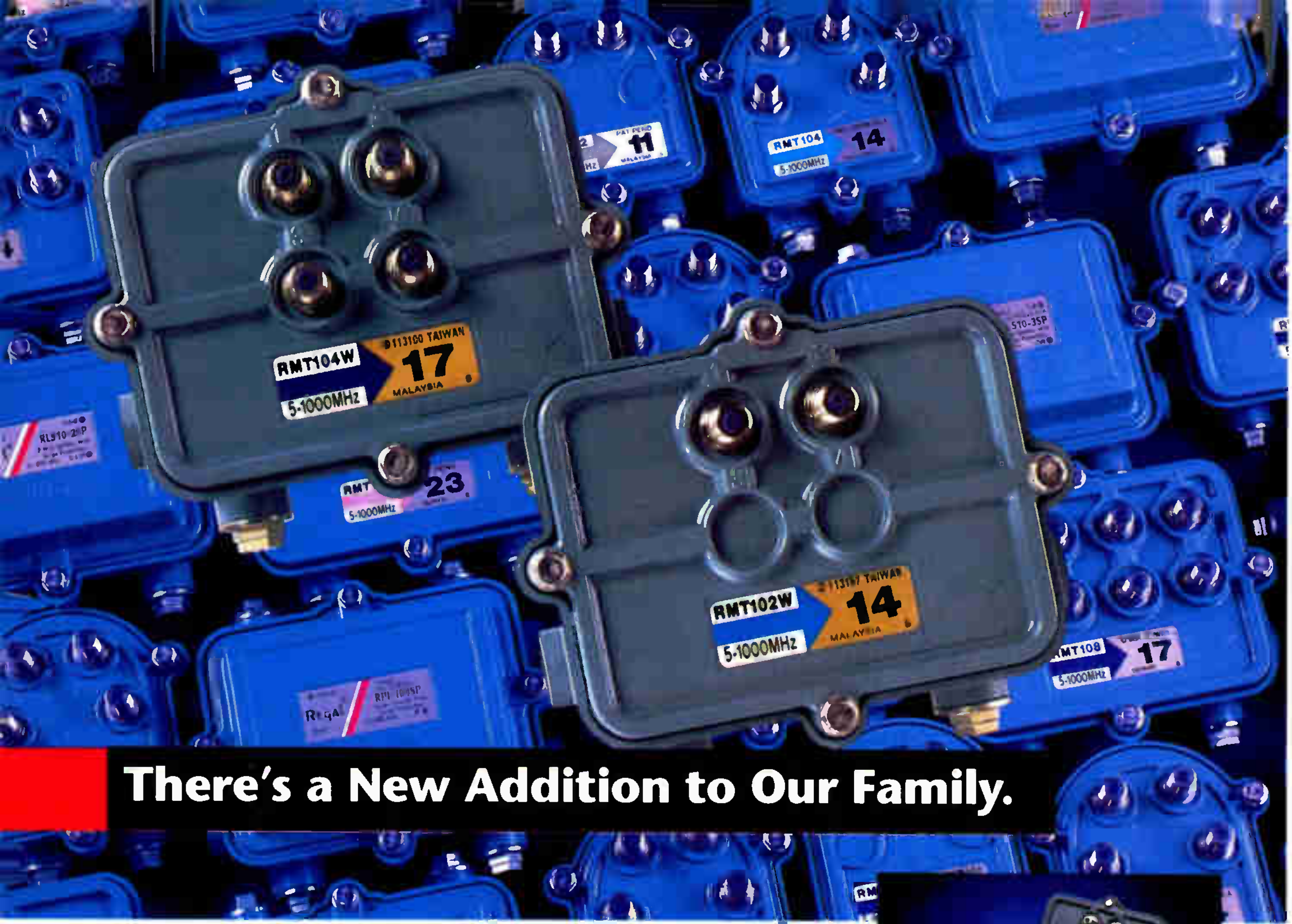
SWOT

The role of the SCTE Board of Directors is especially critical at this time due to the changing landscape of the telecommunications industry. As cable and telephone companies merge, it is more crucial than ever that the Society remain on the cutting edge of major developments that will effect all industry personnel, from technician to company president.

To this end, the Society's Planning Committee has scheduled a "SWOT analysis," to assess the strengths, weaknesses, opportunities and threats relating to broadband communications technology. The group also will recommend directions that SCTE should pursue in order to meet the technical training needs of our rapidly evolving business.

New board members will take their seats at the next meeting to be held June 14 prior to Cable-Tec Expo '94 in St. Louis. The board also will elect the Society's officers for the coming year at that meeting. **CT**


Cheetah System
Automated Remote Testing



There's a New Addition to Our Family.

They're here! Regal wide body taps from ANTEC – developers of the first 1 GHz tap and line passive products for the cable industry.

Regal 1 GHz two-way and four-way wide body taps meet the needs of your growing network by affording you flexibility in system design and construction. These wide body taps allow you to upgrade any existing plant to 1 GHz without extension connectors.

Regal wide body taps offer:

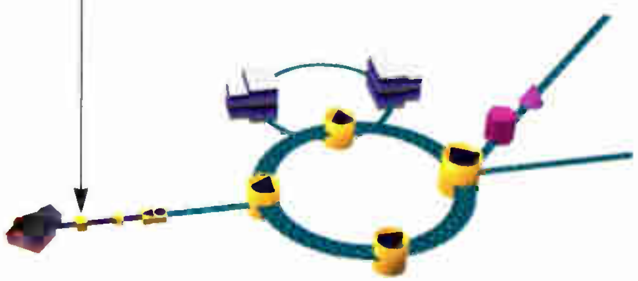
- 1 GHz bandwidth to accommodate emerging technologies such as Near Video On Demand, HDTV, and Digital Audio.
- Premium components for superior RF performance and dependability – the trademark of Regal products.
- Most extensive selection of main line distribution passives in the cable industry – including narrow and wide body taps as well as traditional and surge protected line passives.

Contact your local ANTEC representative and meet the new additions to our Regal product family.

Call 1-800 TO ANTEC.

Reader Service Number 5

Our Cable Integrated Services Network (CISN) is a "blueprint" for building a broadband network that accommodates interactive services in a 1 GHz spectrum. The Regal family of products by ANTEC supports this vision.



REGAL by ANTEC

able to hunt for the desired digital ±5.5 MHz, some older LNBs have been measured to be 50 MHz off center frequency.

There also is the so-called "oil can" effect problem exhibited by some brands of LNBs. This problem is caused by the sun warming the LNB housing, which causes thermal stresses to build until there is a sudden release that causes a "pop." This sudden movement, much like the older oil can, results in a microphonic disturbance to the received satellite signal. For analog signals, this disturbance is almost never noticed. But in the digital domain such a disturbance — depending on where in the digital stream it occurred — could result in a several second loss of digital pictures and sound.

• *Reflections.* Normally, reflections would not exist in the LNB to headend path but bad lead-in cables and loose connectors have been found in some installations. It is not uncommon for system technical staff to overlook LNB connectors and the age and condition of lead-in coax in their normal quality assurance routine.

Headend considerations

It is in the headend that most system engineers begin to wonder about the future impact of digital compression technology on their operation. This is probably because the first production units are just being deployed and therefore most industry system engineers have not yet seen a digital satellite receiver, digital demodulator or a digital modulator.

As Figure 6 shows, the actual wiring arrangement of a digital satellite receiver is, for all practical comparisons, exactly the same as the familiar analog counterparts. There are several different possibilities. They depend on whether the system is just receiving a digital satellite signal in the headend and converting it to analog to send it down the system on an available analog channel as usual, or whether the system will actually pass the received digital signal down the cable system in its digital form to digital set-top decoders.

In both cases, the shared LNB feed is connected to the digital satellite receiver input using standard connectors and procedures identical to analog satellite receivers. In the case of a properly authorized digital integrated receiver decoder, the output will be standard NTSC baseband video and baseband audio, which would be connected to the appropriate standard analog channel modulator for normal analog transmission down the system to analog set-tops or cable-compatible TV sets.

"The list of supporters of the MPEG-2 video compression standard process reads like a 'Who's Who' of the major worldwide consumer electronic, computer, telephone and cable TV industries."

In the case where the system has digital set-tops, the system will need to transmit the necessary digital signals down the system. While the specifics of different manufacturers' equipment may vary, provisions are made to partially demodulate the received satellite data signal and connect this data output to the input of a system digital modulator that in turn remodulates the digital information using QAM digital modulation down the cable TV plant. Certain system control, messaging and subscriber authorization, if necessary at the system level, can be inserted into this data stream.

Plant considerations

Different manufacturers will recommend minimum plant operating performance for their products. In general, digital signals should be more tolerant to system operating environments than analog signals. The following are several plant issues that chief engineers should recognize.

• *The threshold effect.* While analog signals tend to deteriorate linearly with increasing cause, digital signals (especially those with error correction processing) will tend to perform well until a threshold limit is reached and the limits of its error correction ability are exceeded. The result is a digital signal that may perform well in a subscriber's home but may be hiding system performance problems that should be fixed. As these problems continue to deteriorate, the apparent performance suddenly collapses suggesting an intermittent, when in fact the root problem simply crossed the performance threshold. This can play havoc with troubleshooting because technicians are looking for radical plant environment changes instead of "just-at-threshold" events.

• *System noise and distortion.* Digital signals are not as sensitive to system noise and distortion issues as analog signals. Even analog conditions of low 40s signal-to-noise (S/N) and distortions below 60 dB would not generally be an issue with digital transmission performance.

• *Ingress/egress.* Digital signals are generally less prone to interference from ingress as well. And, if the system is meeting the Federal Communications Commission signal leakage rules there should not be any general service problems that would not also have caused interference to a system's analog signals. There is an important exception. When the ingress or egress is caused by a loose connector or cracked cable that is not stable — that is, intermittently making contact and breaking contact — the resulting near square wave changes in level can cause decoders to lose their data synchronization. In comparison, analog signals might see some amount of flashing and an occasional pictures would freeze or go black, which would cause higher subscriber irritation.

• *Sweep systems.* High level sweep systems will interfere with comparison signals if allowed to sweep through the spectrum used for digital transmission. Engineers should contact their sweep system manufacturer for recommend procedures to prevent interference.

• *Ghosting.* Digital signals can be very adversely affected by certain ghosting situations, especially if the reflective ghosts are very close in. Even with adaptive equalization, performance can be unacceptable when particularly strong microreflections synchronize with the data pulses. There is much ongoing research in this area. It is a key issue for the cable TV industry to fully understand because it will affect future high-speed data transmission-based services. Fiber-rich architectures have some advantage because the fiber design significantly reduces the distance the digital signals passes through the coax portion of the plant where more probably would consist of high density MDUs.

General system layout

Due to the general size and shape of the city and taking the economics of the build into consideration, a decision was made during the franchise process to serve the system from two headend/hub locations. Each hub would feed about one-half of the system. Hub boundaries were defined by the city limits and the Jones Fall Expressway.

The main downtown area, referred to as the core area, consists mainly of businesses with a few residences scattered throughout. City government offices are generally located in this area. For this reason, subscriber plant would be extended only to those areas with dwelling units. The balance of the core area was to be fed with a high split institutional network.

After testing over-the-air reception and analyzing potential terrestrial interference levels, a site in the east hub was selected for the main headend location. Also considered during the site selection process was the need for a fairly well-centralized location within the hub boundary so that trunk cascades could be held to a minimum. Prior to final equipment selection, it was felt that maximum trunk cascade would have to be kept within the 20 to 24 amplifier range. A similarly located site for the hub was tentatively identified in the west half of the city. The main headend was designed to be the primary reception facility. It would feed all signals to the hub facility for distribution in that hub area. High levels of microwave interference and poor over-the-air reception limited the practicality of placing more than one reception facility within the franchise area. The main headend and hub were to be interconnected via a two-way link. Single-mode fiber was eventually selected for this purpose over FM coax or microwave because of its relatively low cost and excellent technical parameters.

Like any large city, Baltimore has areas that are not as wholesome as others. Discussions with the other utilities convinced us that it would be beneficial to exercise caution in the placement of line electronics. To this end, two separate design methods were proposed. The first called for line electronics to be located wherever they actually fell in the design. The second method called for electronics to be placed only on street poles rather than down inside an alley or backyard easement. The second method would have to utilize high gain power-doubling or quadra-powered amplifiers so as not to shorten the overall effective length of the feeder lines. Higher plant and associated powering costs had to be included in considering this approach. The actual design would be a combination of both approaches, rather than exclusively one or the other, to provide the most efficient system possible for the physical circumstances in each area.

Aerial system layout

Initial on-site inspection of the Baltimore area indicated that the vast majority of the plant would be aerial. In fact, about 85% of the plant would be built above ground. As previously noted, most of the existing utility plant was built on poles located on streets or in alleys.

What started out as a fairly straightforward aerial cable plant was quickly complicated by a number of factors. The first of these, and a major item in the overall design, was a lack of continuity. Many of the alleys are "L" or "T" shaped. Feeds into these alleys must come from a lateral street. The lateral runs must be placed at least every other street and sometimes at every street in order to pick up all the alleys. The end result was a design that is not as efficient as one with straight alleys.

A second complicating factor was the lack of aerial crossings where the alleys were straight. As previously noted, in one particular part of the city there was a complete restriction against aerial cables connecting the alleys over the street. At the last pole in each alley, the cable, if it needed to continue across the street, must be placed in a riser and transverse the road underground. On the other side it is brought up in another riser and continues aerially. This process adds a lot of cable footage to each run for the risers. Each alley would contain only three or four poles. The end poles are anchored, so they must be set in from the street 15 to 20 feet. Since few of these poles are set on the street, there are limited numbers of lateral routes available. Again, design efficiency suffers from a lack of flexibility because of the physical configuration of the existing utility system.

The third complicating factor was

the age, condition and size of the existing utility poles and plant. These items directly affect the design and must be included in the overall planning considerations for the system layout. The existing aerial utility plant in Baltimore has been in place for many years. The poles are relatively short and in the kind of shape one would expect for the age of these installations. The designer must keep these factors in mind since there is not a lot of room available on the poles for cable TV equipment. Rearrangements on this plant are costly and time-consuming so great care must be exercised, where possible, in the placement of multiple devices at any one location.

All of these factors occur in the area of the city with the highest percentage of row homes. This means that plant in this area would be passing 600 to 800 homes or more per mile. With a systemwide average of 48 poles per mile, each pole location would be feeding 12.5 to 16.6 passings. Some isolated cases existed where 50 or more telephone drops were required at an individual pole. Similar numbers of cable drops could be anticipated unless techniques besides dedicated taps were used.

Underground system layout

The underground portion of the Baltimore plant was a much smaller part of the overall build but no less complicated than the aerial plant. The city, from the outset of the project, was concerned about damage to the streets resulting from underground construction. For this reason it originally requested that the winning bidder consider using existing conduit within the franchise area. Attempts were made to determine the exact location and condition of any such conduit systems. Indications were that the city and the power and telephone companies all had unused conduit in place. The city's conduit was determined to be unusable for various reasons. The power company did not have sufficient conduit available and the use of what was there was eliminated by grounding and isolation strictures required by the city and the phone company. The telephone company had conduit available but placed so many conditions on installation procedures that this was not a viable alternative. Any of the existing conduit systems, if usable, would have placed severe restrictions on the ability to route the plant efficiently.

The city's concern over street damage arose from the composition of the streets themselves and the methods used to do underground construction up to that time. Many of the streets consist of several layers of various materials including cobblestone, asphalt and concrete. Some streets also contain buried trolley tracks. As information developed regarding the exact location of the streets with heavy substrata this data was supplied to the designer so that these streets could be avoided wherever possible. The actual construction utilized a rock saw to cut 4-inch wide slits rather than the 2-foot wide trenches, which had always been done before. The city's acceptance of this construction method freed the designer to route the system as needed for the most efficient design.

Cable

The initial decision to build the Baltimore plant at 550 MHz narrowed the equipment considerations to the latest (at the time) available gear. Cable selection was based on the need for very low attenuation due to the high design frequency and the requirement that any cable used be extremely easy to handle because of the physical difficulties expected to be encountered during construction. Other factors taken into account for cable selection included availability and cost. Considerable attention was paid to the cascade lengths that would result given the attenuation of various routing schemes and spacings, the cables were compared to see which would yield the lowest total amplifier usage. The cable that was finally selected combined a low attenuation with good handling characteristics and was available in sufficient quantities in the time frames needed.

Drop cable

Drop cable was analyzed in much the same manner as the plant cable. A drop budget was devised that detailed the signal requirements for a typical installation. Each drop had an average length of 150 feet and had to provide a specified signal level to the converter. Each installation also included the loss for a two-way splitter. This method of drop budget planning also was used to determine the optimum tap output levels and tilt feeder design. Drop budget considerations included overall feeder line configuration in the analysis since different tap attenuations determined overall line extender requirements and usage levels.

In addition to these considerations, the shielding effectiveness of the different cables was carefully analyzed. This was considered to be an especially important factor in a major urban market such as Baltimore. Naturally, the cost and availability of the cables (and the connectors as well) also entered into the selection decision. The cable type finally chosen was a tri-shield construction RG-6 that used a commonly available connector.

Active devices

The selection of the system amplifiers was perhaps the most difficult aspect of the entire design criteria. The first step in this area was to decide on an overall design approach. For various reasons, a more or less standard tree-and-branch approach was selected over switched-star or other configurations. Once this decision was made, several amplifier manufacturers were contacted to obtain detailed specifications of their gear.

As in the case of cable, a thorough analysis was done on paper of the various brands of equipment. The analysis was done in several stages, the first being to find amplifiers with sufficient gain to make the spacings assumed during the cable selection process.

The second stage consisted of drawing up a list of minimum operating specifications for the systems. These included carrier-to-noise (C/N), composite triple beat (CTB), cross-modulation (X-mod), single second order (SSO), composite second order (CSO) and peak-to-valley response for several different cascades. All of the amplifiers were subjected to mathematical analysis of various combinations of types (i.e., standard, feedforward, power-doubling, etc.) with varying amounts of gain and operating levels to determine performance.

The third step was the preliminary selection of the amplifier supplier. This was followed by physical testing of amplifiers in environmental chambers to determine actual as opposed to theoretical performance. The results of these tests led to the final refinement of operating levels and system specifications. Included in the final spec callout, in addition to the items noted previously, were hum modulation, thermal control limits and powering details.

Coincidental to the development of forward system operating specifications, the return system also was specified. The same steps were used in the analysis and the same specification categories detailed. An operating spec for the institutional network also was devised based on the subscriber system equipment and cable vendors. In all instances, the derivation of system operating specifications was based on worst-case conditions.

Passives

The selection of system passives, including taps, was based primarily on the determination of the amplifier vendor. Taps had already been analyzed in some detail in the drop budgets. The main criteria for passives was insertion loss at the high frequencies and the relative flatness of attenuation over the passband. Again, lab tests were performed on the passives to confirm published specs. The vendor supplying the system actives also was picked to supply the passives.

Power supplies and powering

Power plays a much larger role in expanded bandwidth systems than it ever has before. In order to carry a high number of channels with acceptable distortions, an operator must use one of the newer (at the time) amplifier technologies. Feedforward, power-doubling and dual power-doubling (quadra-power) amplifiers provide the performance edge needed, but all of these devices use high amounts of power compared to standard IC technology. In addition, many current franchises call for the inclusion of standby power capacity. Even without this requirement, most operators will at least consider using standby units to protect potential pay-per-view revenue.

In order to determine powering requirements, sample designs were done for several areas of various densities using the cable and amplifiers selected for the system. The test designs showed that, at best, a power supply would be required for each three miles of plant. In very dense areas and depending on feeder routing as determined by local physical requirements, a power supply per mile may not be uncommon.

A high output power supply was needed for this type of system, so consideration in this category was limited to those suppliers capable of 14 or 15 amps of power. Because of the pole clutter of existing aerial utility plant the physical size of the supply also had some bearing on the final decision. The unit that was selected had a 15 amp rating and held three batteries in the lower portion of the cabinet.

In powering a system, United would usually load a power supply to 80% of its rated output. This approach was used because it is felt that the supply is most efficient when loaded in this range and also because it allows a little cushion should the future addition of a line extender or two be needed. Powering and power supply placements were both critical items in this particular design for a number of reasons. First, overall costs, both initial capital and ongoing operating expenses can be significantly reduced by efficient powering of the system. Second, system passives (especially amplifier chassis) are not capable of passing high amperage so extreme care must be used in selecting power supply locations within the plant. The total load of a 15 amp supply must be nearly evenly split between the two outputs of the power inserter so that high amperage on the line does not damage passive devices. Power supply placement in Baltimore could be complicated by pole limitations. Consequently, the designer had to be provided with extremely accurate strand map data to minimize the cases of power supply relocation because of utility limitations.

Strand mapping considerations

In a design of the size and complexity of Baltimore, the importance of strand mapping cannot be overemphasized. If the success of the overall design hinged on any one factor it would be this one. It has been previously noted that there were many unusual situations and difficulties facing the design of this plant from extremely high densities to severe routing limitations to prohibitively expensive underground construction areas. The street crossing area required very accurate pole placement and footage information to be designed.

The strand mapping specification was designed to take into account all of the special problems of the Baltimore design. All footages had to be wheeled where possible or obtained by optical tape measure. Pole heights, where risers were known to be required, were to be indicated on the maps. Accuracy for all measurements had to be within 2%.

"The ultimate goal was a cable system that functioned correctly to provide the highest quality signals possible for the life of the plant."

All streets, street names and alleys were required to be shown in their entirety. Street widths, as drafted, were to represent the actual right-of-way. All bodies of water, parks, cemeteries or any other physical features that could hinder routing were to be indicated. Railroads, highways and existing or potential crossings for both were to be shown.

All homes were designated by address with lot lines indicated. Row homes were to be identified and actual house counts placed near the feeder pole. Businesses, churches, schools and government buildings were all to be shown on the maps as well. The drafting specifications for all items were called out in great detail so that the final maps would be consistent and as readable as circumstances allowed. Accuracy in the drafting process, overlaps and border matching for example, was emphasized in the strand mapping spec. Because of the density and clutter, and because the greatest degree of accuracy possible was desired, a scale of 1 inch = 50 feet was designated, even though this would mean a very large number of maps. Key maps were specified for a 1 inch = 500 feet scale.

Routing information was to be provided on bluelines of the strand maps. All possible routes, aerial and underground, were to be indicated to allow the greatest degree of flexibility to the designer. Additionally, certain pole information, such as existing transformers or heavy drop clutter, was to be shown so that redesign could be minimized. The strand mapping effort was begun well in advance of the design so that a solid base of information could be established.

The design criteria

Because of the amount of information required to do the Baltimore design correctly and the numerous special considerations involved, it was decided that a single document was necessary to provide a comprehensive reference for the designer. It was hoped that this criteria would be thorough enough to give the answers to any question that might arise. Using this resource, the designer should not encounter time-consuming delays when an unusual situation comes up. Further, the depth of the strand mapping information should minimize field verifications that also would delay the design.

Design delay could not be tolerated in this project. Makeready engineering was to be based on design so that only contacted poles needed to be engineered and rearranged.

The smooth flow of makeready depends on the accuracy and consistency of the design. The business plan and projected revenue flows are dependent on the scheduled completion of construction and design becomes the pivot on which all of this turns.

The criteria had to incorporate a section that dealt with MDUs and row homes. Initially, row homes were to be treated as individual dwelling units and tapped accordingly but this soon proved to be impractical in some areas. In the high density sections of Baltimore, dedicated tapping would have required upwards of 48 tap ports on each of a high percentage of the poles. The row home design method was changed to treat them similarly to apartment buildings, which is in essence what they were. Based on the strand map information, each row home was to be fed with a single "hot drop" that would supply enough signal to a splitter box to meet the minimum level requirements for the number of units involved. Maximum level on any one drop was limited to 24 dBmV to help minimize future leakage problems on the high level drops. MDUs were handled in a similar manner. A chart was devised that called out the tap and splitter configurations required for any given number of units. Depending on size, MDUs were fed with either high level drops, feeder line extensions or trunk extensions. With all of this information available, the designer would be able to move through the dense population areas and MDUs with an absolute minimum of delay.

The design criteria also called for specific treatment of the underground design. The designer was directed to add specified amounts of footage the design to account for the numerous risers in the street crossing area. Additionally, vault, manhole or pedestal locations were detailed as to cable looping requirements so that this extra footage also could be added to the design. Wherever such information was available the strand maps were to indicate that streets contained heavy subsurface materials so that these streets could be avoided if possible. Again, the idea behind this requirement was to minimize design and subsequent construction delays due to uncuttable streets.

The aerial portion of the criteria dealt specifically with the two design approaches. In areas where the second approach was to be used, as designated by the construction manager, all actives were to be located so as to be accessible from a bucket truck. Specific items included in this section (to allow for the second approach) included backfeed limits, the use of and levels for high gain bridgers and line extenders, and the use of trunk sized cables in feeder lines to make reaches and power supply placement.

The entire design criteria document, when completed, consisted of some 35 pages divided into three sections plus a 16-page bill of materials that detailed the allowable equipment for each design approach.

The first section of the criteria dealt with general information and was prepared in the format of a summary of operating levels, performance specifications, cable types and attenuations and some powering data. This section also contained a question-and-answer portion that supplied the designer with specific answers to certain situations that could arise.

The second section was a detailed listing of all operating levels. These were given for the input and output of each type of amplifier in both the forward and reverse directions. Feedermaker levels, tilts, tap levels and feeder line equalizer specifications were given in this section. Also detailed were the amp equalizer specs. Equalizer values were called out for each type of amplifier and a footage window was provided for each trunk equalizer value. Similarly, a table giving total passive losses for each value of line extender equalizer was given. Insertion losses for taps and other passives were detailed for both forward and reverse design.

This section also provided detailed powering assumptions for each station configuration. Cable attenuations were called out for forward and return frequencies. All attenuations used in the criteria were maximum values rather than nominal values. Trunk cable attenuations were increased by a factor of 5% to allow for future aging of the plant. The use of trunk sized cables in the second approach to feeder design was covered in detail in this section and appropriate losses, without the 5% aging factor added, were given.

The second section then provided the MDU chart for reference. Thermal equalizer usage and relevant technical data was detailed. The second section was completed by inclusion of the published specs for all passive devices.

The third section of the criteria began with a narrative system description. This detailed exactly what the system was and the overall configuration to be used. Amplifier types were called out and specified for location within the cascade or design approach. System performance specifications were given for the forward and reverse of both subscriber and institutional networks. Finally, performance testing and recording requirements were called out for the system. Procedures for the review and approval of strand and design maps were given. A problem resolution procedure, specifying contacts and lines of authority, was the final step in the criteria.

The appendix contained two eight-page BOMs that provided the designer with an exact list of equipment that is to be used in both design approaches. Pricing was given so that accurate BOMs could be drawn from finished design.

Summary

Faced with a complex and technically advanced system in the city of Baltimore, a design specification that provides the designer with as much information as possible is an absolute necessity. The design criteria that developed as a result and described in this article meets that requirement. The Baltimore system could be designed in a timely and consistent manner using the methods specified in the criteria. Accurate design of this system was strived for in order to have a smoother and more cost-efficient construction effort. The ultimate goal was a cable system that functioned correctly to provide the highest quality signals possible for the life of the plant. **CT**

Acknowledgments

The author would like to thank Judy Scharf, United Cable TV; John Martin, Jerrold Electronics; and Fred Slowik, Jerrold Electronics.

Reader Service Number 40

March 1994

BACK TO BASICS

Ground/bond that drop

The training and educational supplement to Communications Technology magazine.

Geri Saye

Table of Contents

Laser transmitter

Ipitek announced a line of AM CATV laser transmitters for use in its FiberTrunk system. The units are offered in optical powers from 4 to 16 mW (+12 dBm) in 2 mW increments, and come in frequency ranges of 550, 610, 750 and 900 MHz. The wide bandwidth and high optical power allow the user to transport up to 100 video channels, or to use digital overlay techniques over an optical link budget of 15 dB.

The transmitter modules incorporate input automatic level control to ensure an optimum optical modulation index even when the channel count is changed. Automatic power control and temperature compensation circuitry stabilize the laser against temperature and aging effects. Advanced predistortion circuitry is used to provide excellent laser linearity.

The FiberTrunk chassis can support up to four laser transmitter modules, two upstream receiver modules and a status monitor module. The modular structure allows easy network expansion or upgrade. Dual power supplies with automatic switch-over prevent network outages due to power supply failure.

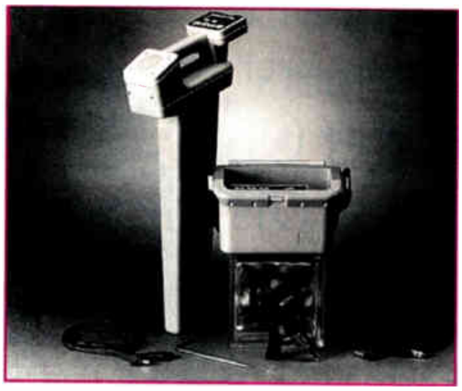
Reader service #208

Interface package

Cable Leakage Technologies (CLT) introduced a product interface for the Wavetracker digital RF tracking/mapping system, to include the Searcher Plus by Trilithic. This compliments the introduction of coherent spectral analysis (CSA), a process for high-speed data collections and interpretation of signal leakage.

After importing rideout information (Wavetracker diskette) to CLT's processing software, colored symbols provide detailed information concerning RF leakage (with video), other interference and power line interference.

Reader service #207



Cable locator

A new cable locator offering pinpoint locating of underground telephone, CATV and power cables is available from the 3M Telecom Systems Division.

The Dynatel brand 2210 locates cable path and measures cable depth and relative signal current in the target cable with a push of a button. The unit also locates active power cable with a direct readout of cable depth. It incorporates an improved peak locating mode that provides a sharp peak response, allowing easy discrimination between adjacent cables. The unit gives a digital readout in inches and also provides an audible continuity test.

Users of the unit can find cables or conductors through one of two active frequencies (577 Hz and 33 kHz) or one passive power frequency (60 Hz for U.S. models, 50 Hz for O.U.S. models). The 577 Hz tone is applied by direct metallic connection and is used for extended distance locating. The 33 kHz tone is useful for precise cable locating over medium distances and is applied by direct connection or induction using either a 3M brand Dyna-Coupler or the unit's internal antenna.

The unit consists of a transmitter with built-in circuit continuity tester, frequency and output level selections and a one piece hand-held receiver. The cable locator's receiver weighs 4 pounds (1.8 kg) and its transmitter weighs 6 pounds (2.7 kg).

Reader service #206

Emergency bulletin system

Video International Inc. introduced its EBS-2 emergency bulletin system. The multichannel bulletin system is designed to offer the CATV industry broadcast-quality character generator messaging at a very low cost. The system is expandable from typical 36 to 54 channel headends to over 500 channels. Each channel includes self-contained genlock and baseband video keying.

Typical emergency crawl messages can be overlaid to avoid total interruption of normal programming. The system also can display in closed-caption style as well as full-page messages. It will accept message data automatically from the national EBS system, regional disaster agencies (e.g., sheriff) and from a local cable office keyboard. A combined video/audio system also will be available.

Reader service #205

Portable transport system

Telecast Fiber Systems Inc. is now offering what it says is the industry's first portable single-mode fiber-optic video/audio transport system. The Viper-X enables telephone companies and CATV companies to use a miniature, lightweight field unit to backhaul video and audio over existing single-mode fiber-optic trunks.

The system is an expanded version of the company's Viper mobile fiber-optic communications/command/control system. All the fiber-optic terminal equipment is housed in a weather-resistant, 6 pound enclosure measuring 9 x 9 x 2 inches. Each enclosure modularly accommodates up to three video channels, six audio channels, bi-directional intercom and bi-directional data. The system operates over a wide temperature range, indoors or outdoors, and can run on 12-24 VDC or AC. Rack-mount units are optional.

The system solves the problems faced in providing coverage of remote

(Continued on page 96)

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13	39	65	91	117	143	169	195	221	247	273	299
14	40	66	92	118	144	170	196	222	248	274	300
15	41	67	93	119	145	171	197	223	249	275	301
16	42	68	94	120	146	172	198	224	250	276	302
17	43	69	95	121	147	173	199	225	251	277	303
18	44	70	96	122	148	174	200	226	252	278	304
19	45	71	97	123	149	175	201	227	253	279	305
20	46	72	98	124	150	176	202	228	254	280	306
21	47	73	99	125	151	177	203	229	255	281	307
22	48	74	100	126	152	178	204	230	256	282	308
23	49	75	101	127	153	179	205	231	257	283	309
24	50	76	102	128	154	180	206	232	258	284	310
25	51	77	103	129	155	181	207	233	259	285	311
26	52	78	104	130	156	182	208	234	260	286	312

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

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

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

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

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

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

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

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

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

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

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

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

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

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15	41	67	93	119	145	171	197	223	249	275	301
16	42	68	94	120	146	172	198	224	250	276	302
17	43	69	95	121	147	173	199	225	251	277	303
18	44	70	96	122	148	174	200	226	252	278	304
19	45	71	97	123	149	175	201	227	253	279	305
20	46	72	98	124	150	176	202	228	254	280	306
21	47	73	99	125	151	177	203	229	255	281	307
22	48	74	100	126	152	178	204	230	256	282	308
23	49	75	101	127	153	179	205	231	257	283	309
24	50	76	102	128	154	180	206	232	258	284	310
25	51	77	103	129	155	181	207	233	259	285	311
26	52	78	104	130	156	182	208	234	260	286	312

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

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

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

D. In the next 12 months, what cable equipment do you plan to buy?
30. ___ Amplifiers
31. ___ Antennas
32. ___ CATV Passive Equipment including Coaxial Cable
33. ___ Cable Tools
34. ___ CAD Software, Mapping
35. ___ Commercial Insertion/ Character Generator
36. ___ Compression/Digital Equip.
37. ___ Computer Equipment
38. ___ Connectors/Splitters
39. ___ Fleet Management
40. ___ Headend Equipment
41. ___ Interactive Software
42. ___ Lightning Protection
43. ___ Vaults/Pedestals
44. ___ MMDS Transmission Equipment
45. ___ Microwave Equipment
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Cliffwood Beach, NJ 07735

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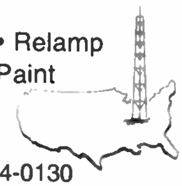

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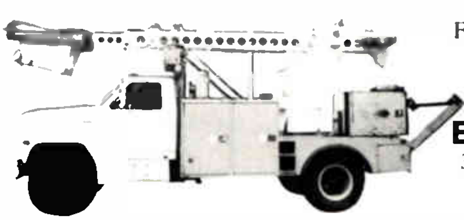

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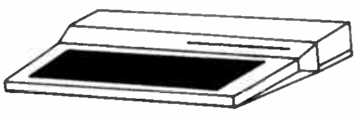

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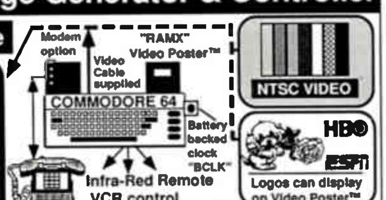

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*Hi-Res fonts, Video Page & Character Generator *Store more than 600 pages Logos & pictures stored on cartridge *16 colors, 5 fonts, Crawl, Flash, Special effects *Two (240 ltr.) variable size crawls per page *Accurate real time clock & date *Restores & displays pages, time & date even if power fails! *Low cost C64 computer (NTSC + Ch 3/4 out) *100 Time and date control events *Infra-red controls up to 8 VCR's *Transfer & control via modem *Control model "RMAV" & external relays + VCR's *NTSC color bars* Satellite touch-tone decode commercial insert*User friendly, Demo & Instructional VHS tape

Model * Price * Description of "Video Poster" ™ Options: *Call for Demo tape*

Model	Price	Description
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"Modem"	$ 89.95	1200 baud Hayes compatible plug-in modem for remote page transfer
"BCLK"	$ 69.95	Battery clock (with RAM) restores time & date if power fails
"PK8"	$179.95	Relay control, Touch-tone decoder, infra-red senders, 8 analog inputs
"WX1"	$189.95	Temp. deg. C. or F. + Humidity sensors; Req. PK8
"WSDM"	$279.95	Anamometor Wind speed and direction; Req. PK8
"1541"	$189.95	Optional disk drive; external unlimited back up for RAMX
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"TSP1"	$379.95	Text-to-speech computer voice message each screen.
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(Continued from page 88)

televised events such as teleconferences, sports, news and concerts. It permits CATV and telco providers to quickly link into their existing cable plant and use 1/4-inch diameter field cable to extend to an additional kilometer from the cable plant access point. The system meets EIA/TIA-250-C (short haul) specifications over unrepeatered distances exceeding 15 kilometers.

New 18-bit digital audio channels deliver 90 dB signal-to-noise ratio (S/N) and accept both microphone and line inputs. The bi-directional 10 MHz FM video channels deliver better than 70 dB S/N. Dual intercom channels are optional.

Reader service #204

LAN test kit

EXFO combined a fiber-optic visual fault locator, a multimode power meter (germanium detector) and a multimode light source in one unit for the troubleshooting and testing of fiber LANs.

The TK-017 contains the company's FLS-230A fault locator, a unit designed for the most difficult conditions. According to the company, this 650 nm semiconductor laser launches three times more visible light than conventional fault finders. The FOS-124 is an 850 and 1,300 nm wavelength light source. The FOT-22 power meter reads attenuation in dBs and power in dBms and watts. The package includes an FOA-32 AT&T ST adapter, battery charger/adapter and a rugged carrying case.

Reader service #203

Cable TV modem

Zenith Electronics Corp. announced the ChannelMizer 500 cable TV modem that features a standard Ethernet port for data transmission with a direct coaxial cable attachment. The unit will allow cable operators to take advantage of the industry standard Ethernet interface as the entertainment and information lanes on the digital highway begin to merge.

This permits virtually universal connectivity of computer equipment, including Apple Macintosh computers, IBM PCs and compatibles, graphic workstations, routers, bridges, file servers, terminal servers or X terminals.

According to the company, the modem delivers information at speeds typically 1,000 times faster than telephone data modems. This allows the delivery of digitized video, hypertext documents and Joint Photograph Experts Group graphics via the Internet or commercial on-line services — information that generally cannot be sent over telephone data modems due to limited bandwidth.

A range of interactive applications can be supported for distance learning, professional service groups in the health, legal and financial sectors, work-at-home and high-speed access to on-line computer services. An information service network deployed over cable TV offers businesses a high-speed alternative link between offices and facilities in the local loop.

Instead of employing telco links (such as T1, dedicated phone circuits or dial-up lines), the local cable TV system could support metropolitan connectivity for mainframes, personal computers, Ethernet LANs, network bridges/routers along with document and graphic image transfers.

The modem is fully compatible with the company's HomeWorks residential PC gateway for cable TV. The architecture supports the delivery of four separate 500,000 bit-per-second subnetworks on a standard cable TV channel over a span of 100 miles.

The system permits the formation of TCP/IP-based cable TV networks by interconnecting standard LAN routers via Ethernet to the modem.

Reader service #202

Coupler

AOFR announced what it says is the industry's first single-mode wideband, monolithic 1 x 4 coupler. The dual-window couplers are compact and provide a nominally equal coupling ratio at both 1,310 and 1,550 nm, primarily for use in CATV and fiber-in-the-loop applications.

Reader service #201

Operating system

U.S. Computer Services added DDP/SQL, an IBM UNIX-based operating system and hardware platform, to its Tandem Non Stop SQL offering.

A UNIX version of the system will be available on the IBM RISC System/6000 open systems platform. It also will utilize IBM's UNIX operating system, AIX, and Oracle Corp.'s Version 7 relational database.

The system was designed to support this environment with a standards-based, open systems foundation, and supports a variety of hardware platforms.

Reader service #200

Demodulator/modulator

Telecommunication Products Corp. unveiled the IFDM-1000 intermediate frequency demodulator/modulator. The unit accepts an IF signal from the external IF loop of a processor and demodulates it to baseband video for signal processing. It then modulates the processed baseband video back to IF to reinsert into the processor.

The product was created as an economical means to deliver a baseband video signal to Intelvideo's impulse noise reducer or other baseband signal processing equipment.

Reader service #199

Test signal generator

Multidyne announced the TS12-10B series of 10-bit NTSC video and audio test signal generators for the testing and maintenance of cable TV systems, video fiber optics and DS3 telephone compressed digital video. According to the company, the units exceed RS-250C short-haul specifications.

The units are designed to verify compliance with the new Federal Communications Commission in-channel frequency response rule and future rules for chroma delay and gain, differential gain and differential phase.

The 95 to 100 IRE RAMP test signal is used to test signal-to-noise and signal-to-quantizing-noise of digital video systems. Applications include cable TV and Bell Telephone digital video fiber optics, DS3 and DS1.

Reader service #197

BOOKSHELF

The following is a listing of some of the videotapes currently available by mail order through the Society of Cable Television Engineers. The prices listed are for SCTE members only. Nonmembers must add 20% when ordering.

☛ *SLMs: The Technician's Edge* — An in-depth discussion of signal level meters — what they are, what they measure and how they work. It further provides a hands-on overview of the features and operation of the most advanced meters of today. (100 min.) Order #T-1135, $25.

☛ *Applications of Digital Technology* — Digital technology will change the way we do business. This program, featuring Scott Bachman, Roger Brown, Tom Elliot and Jim Ludington, provides an overview of the types of changes to expect. Topics covered include: super highway, driving forces behind computer capacity and digital compression, comparison of CATV delivery to RBOCs, ATM protocol, cable's window of opportunity and applications of digital technology to cable advertising. (70 min.) Order #T-1137, $45.

☛ *Cable and Telephony Integration: Balancing Revenue Opportunities and Network Evolution* — This videotape was produced at Cable-Tec Expo 1993. Cable and telephone companies must transform the services they provide, or they will be transformed by the market. This program, featuring Chris Bowick, Dean DeBiase, Fred Dawson, Larry Lehman and Carl McGrath, provides insight into this process. Topics covered include: network and telecommunications drivers, telco/CATV convergence, competitive access, personal communications networks, two-way interactive and multimedia, CAP opportunities, design network architectures, CATV deficiencies, telco deficiencies, regulatory drivers and new potential services. (85 min.) Order #T-1138, $45.

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

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

To order: All orders must be prepaid. Shipping and handling costs are included in the continental U.S. All prices are in U.S. dollars. SCTE accepts MasterCard and Visa. To qualify for SCTE member prices, a valid SCTE identification number is required, or a complete membership application with dues payment must accompany your order. Orders without full and proper payment will be returned. Send orders to: SCTE, 669 Exton Commons, Exton, PA 19341 or fax with credit card information to (610) 363-5898.

Listings of other publications and videotapes available from the SCTE are included in the March and October 1993 issues of the Society newsletter, "Interval."

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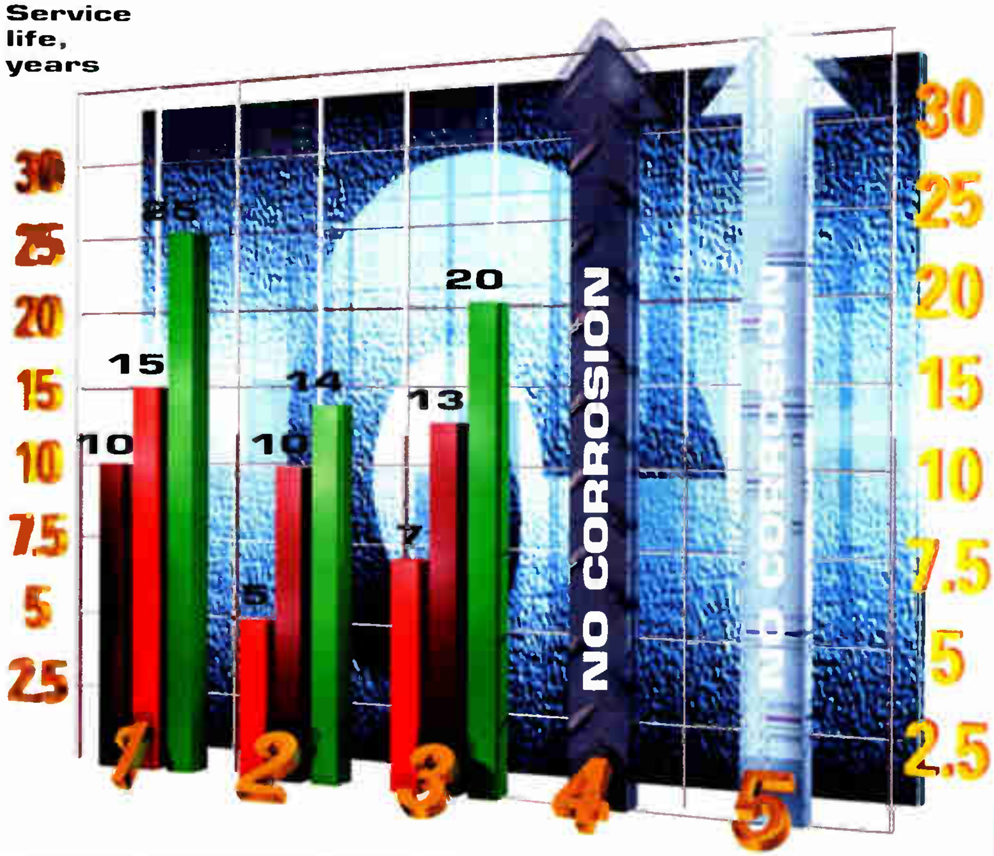

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Impact on fiber: Stimulated Brillouin scattering, laser sources

In this month's installment, our fiber expert answers your questions about how to overcome the limitations of stimulated Brillouin scattering (SBS) in cable TV systems and the impact of a laser source on optical return loss.

Douglas E. Wolfe
Senior Applications Engineer
Corning Inc.

As launch powers of distributed feedback (DFB) lasers continue to increase, how will fiber nonlinear effects such as SBS be dealt with?

SBS is a nonlinear effect that can occur in single-mode fibers when high laser output powers are injected into the fiber. Launch powers of between 7 and 10 dBm have been reported as typical threshold levels required to induce SBS in conventional standard single-mode cable TV transmission systems. When a fiber system reaches the SBS threshold, further increases in injected power into the fiber do not result in corresponding increases in output power at the receiver. For optical signals above the threshold, SBS converts part of the forward traveling transmitted signal in the fiber to a backward scattered one, thus setting a limit to the total fiber injected power. This increased backscattered signal may result in degradation in the carrier-to-noise (C/N) and composite second order (CSO) distortion performance of amplitude modulated video.

Therefore, it is essential to keep the transmitter power launched into the fiber below the SBS threshold. To accommodate higher optical powers, the SBS threshold can be raised by increasing the effective spectral linewidth of the injected source light.

Most directly modulated distributed feedback (DFB) lasers used within the cable TV industry typically will not experience problems with SBS because of their sufficiently wide effective spectral linewidths. However, some externally modulated systems use sources that have very narrow linewidths that easily can result in SBS.

In those cases, the effective spectral linewidth of the laser output signal can be widened by phase modulating it prior to signal modulation. This technique is sometimes referred to as "dithering." In addition, researchers are working on ways to raise the SBS threshold by modifying the fiber design or cabling technique, thereby spreading out the narrow Brillouin spectrum and achieving the same effect as spectrally spreading the source linewidth.

So rest assured, equipment manufacturers will most certainly design solutions into their equipment to avoid SBS limitations in cable TV systems.

Does the type of laser source used (i.e., Fabry-Perot lasers, DFBs and narrow linewidth externally modulated sources) impact the optical return loss specifications provided by optical connector manufacturers?

The type of laser source typically used in cable TV systems has minimal impact on the measurement and specification of optical connector return loss.

The amount of return loss a given system can handle without impacting signal quality is, however, a function of the laser transmission equipment. Different transmission equipment will require different return loss specifications for proper operation. However, the method for determining the system's actual optical return loss is generally independent of the output power or the type of laser transmitter used.

Theory predicts that the amount of reflected power due to physical contact (PC) type connectors decreases with wavelength, and is estimated to change by more than 2 dB over a 250 nm window from 1,300 nm to 1,550 nm. Typical 1,310 nm sources such as Fabry-Perot, DFB and externally modulated lasers (with spectral linewidths ranging between 250 GHz and 15 kHz) have minimal impact on the measured optical reflected power or return loss. The impact of different sources on return loss typically is less than +0.01 dB for cable TV systems operating near 1,310 nm.

To assure that all connector manufacturers are specifying optical return loss using a similar measurement procedure, the Electronic Industries Association has produced a fiber-optic test procedure, "Return Loss for Fiber-Optic Components" (FOTP-107), that specifically defines how to measure optical return loss in connectors. The source spectral linewidth required in FOTP-107 is less than 10 nm (1,250 GHz).

As long as connector manufacturers comply with FOTP-107 when specifying the return loss of their connectors, the added value should represent actual installed system performance. **CT**

If you have a question for CT's fiber expert, mail or fax it to: Ask a Fiber Expert, c/o Communications Technology, 1900 Grant St., Suite 720, Denver, CO 80203; (303) 839-1564.

Be a winner at Cable-Tec Expo '94

By Bill Riker
President, Society of Cable Television Engineers

Cable-Tec Expo (to be held June 15-18 at the Cervantes Convention Center in St. Louis, MO) is widely recognized as one of the industry's best hardware shows. This year, the Society is offering a free trip to Expo '94 as first prize in a new membership drive in conjunction with SCTE's 25th anniversary. Every member who recruits a friend or co-worker into the Society's membership will be eligible to win the registration fee, lodging and up to $500 in travel expenses to St. Louis and Expo '94. Start now to spread the word about what you as a member already know ... membership in SCTE is an investment in your future! Then, simply fill out the application included in our ad in this issue of *Communications Technology* (page 17) and send it to: SCTE national headquarters, Contest Dept., 669 Exton Commons, Exton, PA 19341. The grand prize winner will be chosen on May 1, 1994. The more members you recruit, the better your chances are to win! Take a look at what Cable-Tec Expo '94 offers.

Another info-packed Expo

This information-filled, four-day program begins with the Engineering Conference, to be held on June 15. Four panels of CATV and telco engineering leaders will discuss matters of vital importance to the industry's present and future in view of the rapid convergence of both the cable and telephone fields.

Sessions for the conference include:

- Regulation and the Cable Industry with moderator Steve Ross of Ross and Hardies and SCTE Of Council; Wendell Bailey of the National Cable Television Association; Dave Large of Intermedia Partners; Helena Mitchell of the FCC; Allen Stilwell of the FCC; and John Wong and the FCC.
- Advances in System Architectures with moderator Jim Ludington of Time Warner Cable; J.R. Anderson of ANTEC; Don Gall of Time Warner Cable; John Mattson of Northern Telecom; Karl Poirier of Triple Crown; and Doug Wolfe of Corning.
- Digital Transmission Techniques with moderator Tom Elliot of TCI; Guy Beakley of Stellacom; David Beddow of TCI; and Tony Filanowski of Jerrold.
- Convergence with moderator Larry Lehman of Brooks Telecommunications; Carl McGrath of AT&T; Chuck Merk of Philips Broadband; and Andy Paff of ANTEC.

The Annual Membership Meeting, to be held at the conclusion of the conference, will offer attendees the opportunity to meet members of the Society's national board of directors.

Cable-Tec Expo '94 continues on June 16 with the presentation of 10 breakout workshops on the 16th and 17th. All workshops will be offered three times each day from 8 to 9:15 a.m., 9:30 to 10:45 a.m. and 11 a.m. to 12:15 p.m., allowing attendees the opportunity to participate in six workshops over the course of two days.

Workshop topics and speakers are:

- Addressability and Two-Way Systems with John Cochran of Scientific-Atlanta and Jim Toy of Jerrold.
- Advances in System Powering with Gary Batson of Power Guard and Don Sorenson of Alpha Technologies.
- Basics of Digital Compression and Transmission with Brian James of CableLabs and John Vartanian of HBO.
- CLI, Now and Tomorrow with Bruce Breeman of Cablevision, Robert V.C. Dickinson of Dovetail and Ken Eckenruth of CLT.
- Fault Locating in Fiber-Optic and Coaxial Cables with Duff Campbell of Riser-Bond and Charlie Mogray of Comm/Scope.
- Fiber Installation and Testing with John O'Hare of Corning and Gary Harvey of Siecor.
- Meeting Tomorrow's Technical Training Needs with Bill Nash of TCI, Marv Nelson of the SCTE, and Pam Nobles of Jones Intercable.
- OSHA Regulations and Safety Training with Ralph Haimowitz of the SCTE and an inspector from OSHA.
- One-on-One with the FCC with Michael Lance and John Wong of the FCC Cable Services Bureau.
- Proof-of-Performance Measurements with John Cecil of Hewlett-Packard and Steve Windle of Wavetek.

Expanded exhibit hours

No other activities will be scheduled during workshop periods in order to maximize attendance and participation in the workshops, which have been geared to offer practical experience for system technicians and installers as well as engineers.

> ***"Cable-Tec Expo is widely recognized as one of the industry's best hardware shows."***

This year, the Expo '94 Program Committee voted to expand the total exhibit hours from 12 to 15. To this end, the Expo exhibit hall will be open from 12 to 6 p.m. on June 16-17, and from 9 a.m. to 12 p.m. on Saturday, June 18. It will have its usual focus on education, as over 250 industry suppliers will present live demonstrations of their products, supplies, equipment and services used in the design, construction, installation, repair, maintenance and operation of cable TV systems. These exhibitors have been encouraged to gear their booth presentations toward hands-on training, and a Technical Training Center on the floor will offer additional equipment demonstrations.

In addition, Expo '94 will afford attendees the opportunity to prepare for and participate in the Society's Broadband Communications Technician/Engineer (BCT/E) and Installer Certification Programs, as testing will be conducted June 16-18.

Fun and more

This year's Expo Evening will be the setting for the Society's 25th anniversary celebration. The theme is the "1904 World's Fair." Expo Evening will be held at the convention center immediately following the close of the exhibit hall on Friday, June 17.

Always a highlight of any Expo, the Annual Cable-Tec Games will be held June 15 during the Welcome Reception. Don't miss this thrilling competition, which pits industry personnel from around the country in practical tests of technical skill and knowledge.

Registration packages will be mailed to all 11,000 active SCTE members this month. Nonmembers wishing to receive further information on this year's Cable-Tec Expo should contact SCTE at (610) 363-6888. **CT**

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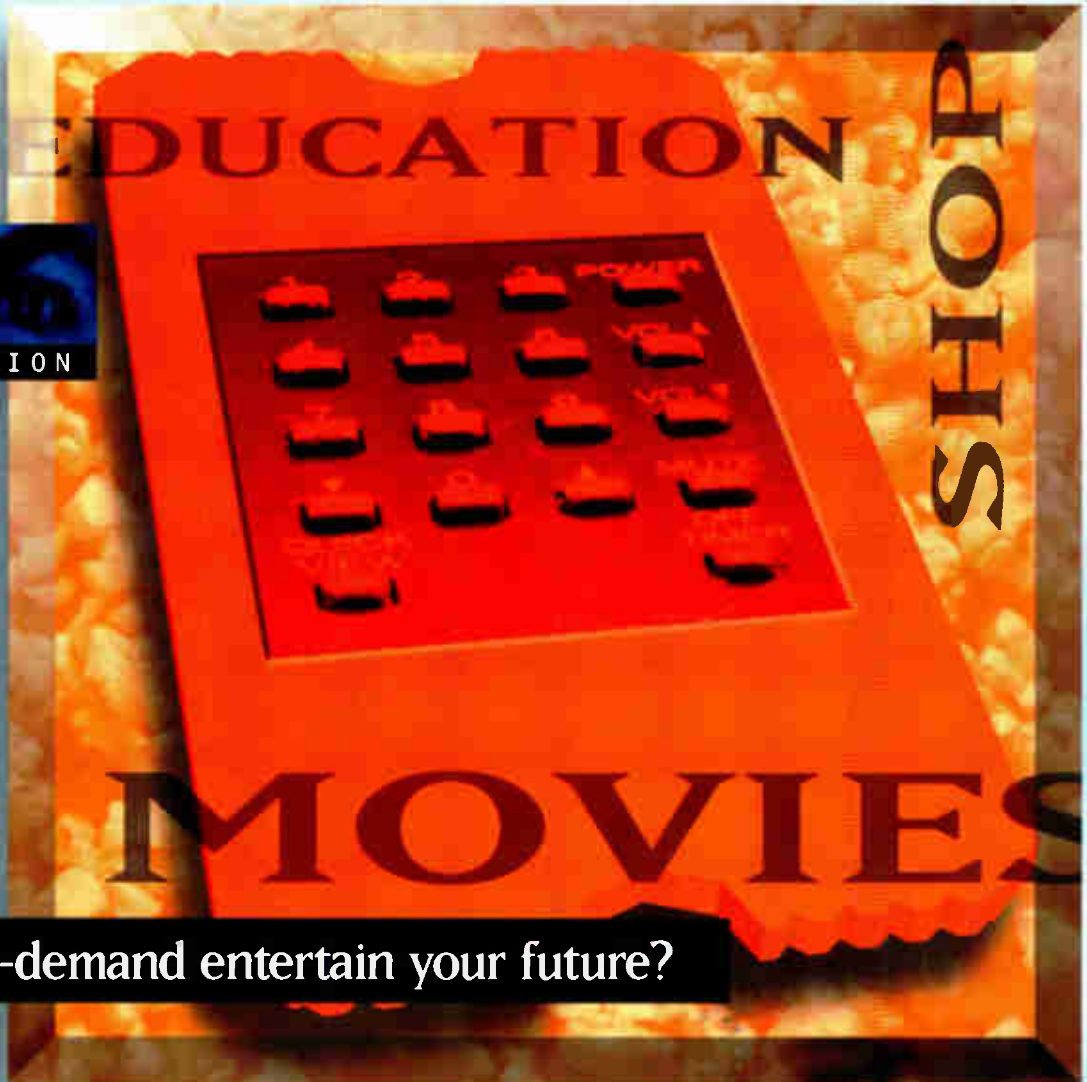

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