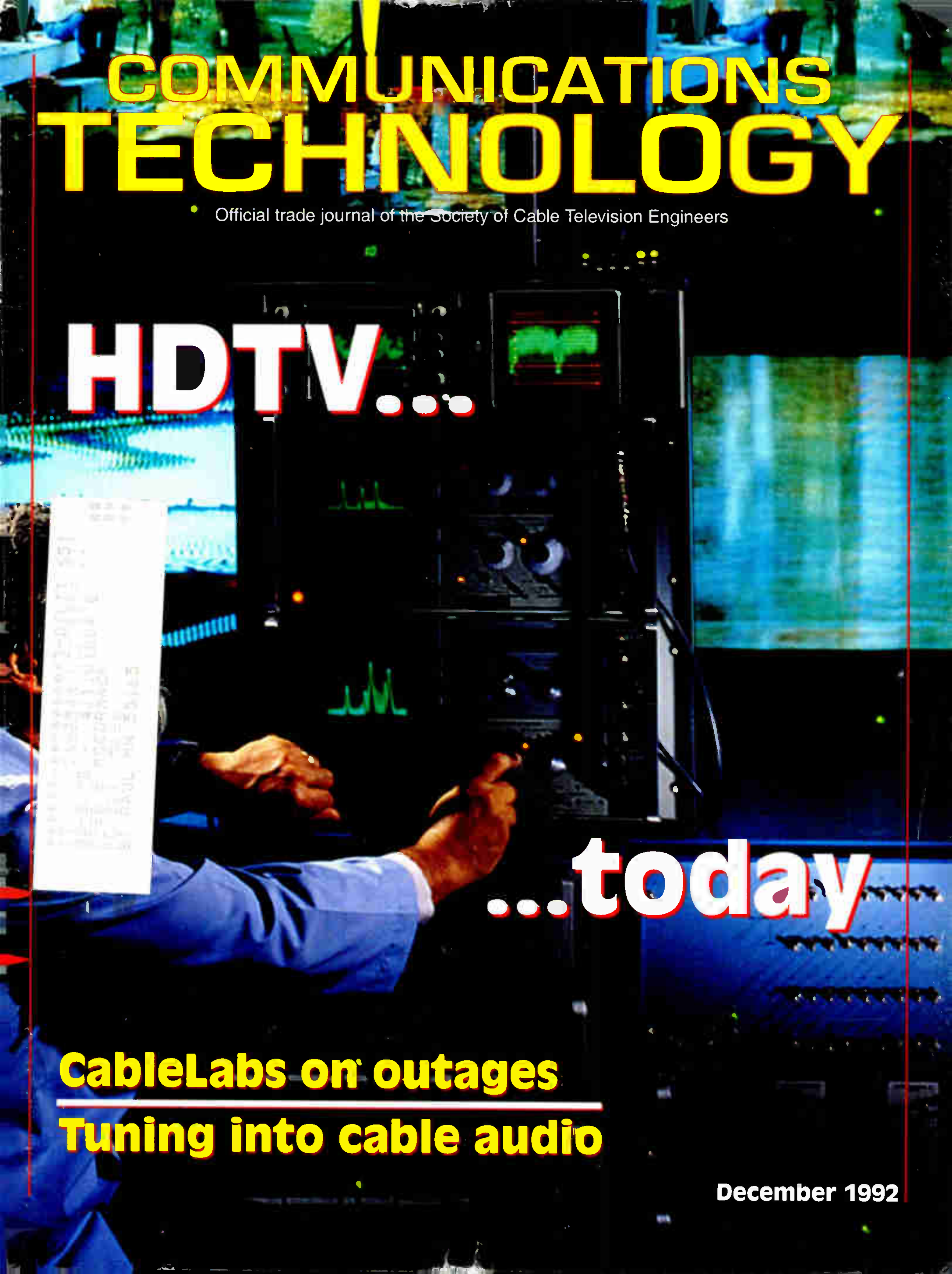
COMMUNICATIONS TECHNOLOGY

Official trade journal of the Society of Cable Television Engineers



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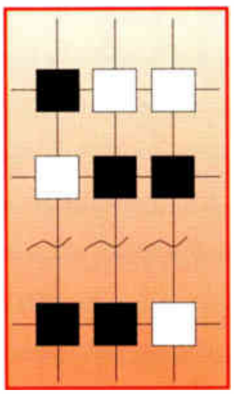

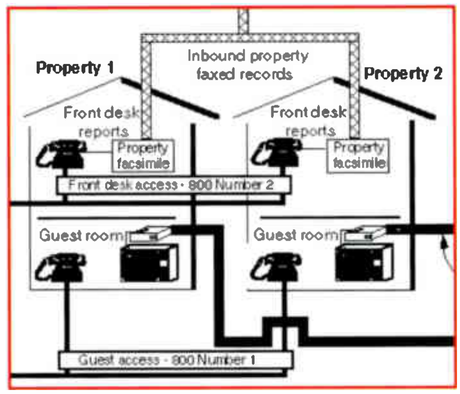

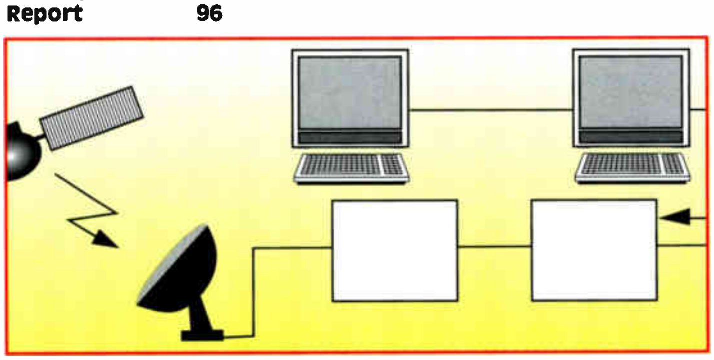

Features

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EDITOR'S LETTER

What a year

Can you believe 1992 has come and gone already? And what a year it was. We saw some pretty exciting technological changes during the past 12 months. One GHz cable systems are now a reality, having gone beyond the lab to field implementation. Operational CATV-based demos of PCS took place, indicating that cable is serious about telecommunications. On the flip side, telcos have been playing with ADSL (which allows VCR-quality video to be transmitted via telco plant), signaling their seriousness about video entertainment delivery — a move some, however, have labeled "a day late and a dollar short." Fiber architectures for cable have evolved to 500-home nodes, though you can expect passive FTF-style networks (except for the laser and receiver) with less than 200 homes per node sometime in 1993.

Speaking of 1993, I chatted with Time Warner's Al Dawkins about next year's schedule for the twice-monthly 40 m CATV ham radio net. For the foreseeable future, continue to tune to 7,235-7,245 kHz LSB at 8 p.m. mountain time on the second and fourth Wednesday of each month.

As we wrap up 1992 and prepare for the new year, what better way to do so than with a light-hearted look at a famous poem? This comes our way from friend Kip Hayes, chief technician for TCI Cablevision of Oregon.

Ronald J. Hranac
Senior Technical Editor

A Special Cable Christmas

'Twas the night before Christmas and all through the place,
No movement was seen, no nary a trace;
Each little converter was placed on the mantel with care,
In hopes that Saint Cableus soon would be there.

The children were out for the count, don't you know,
They were beat after watching the Christmas movies on HBO.
And mom in her jammies and I in my cap
Had just settled in for a well-deserved nap.
When suddenly I awoke, in the yard what a clatter!
I sprung from my bed to see what was the matter.
I ran to the window — my head half a-drift,
There stood a cheerful young man next to a shiny Versa-Lift.

He ran toward my house so agile and brave,
I knew in a moment — it must be Saint Cabe.
He climbed up my chimney and slid down the flu,
He hit the floor scramblin', he knew what to do.
He was dressed in new jeans — and a uniform shirt,
But he was lightly dusted with ashes and dirt.
A bag full of tools were slung on his back,
And he looked like a peddler just opening his pack.

His eyes how they twinkled; his dimples how merry!
His cheeks were like roses, his nose like a cherry.
A shiny white hard hat, slightly cocked on his head,
And his fingers, from the cold, were just slightly red.
He kept himself busy, programming as he went,
HBO for sis, MTV for Ned and Disney for little Brent.

He turned around quickly — no wasted time spent,
With his hand on his hard hat — up the chimney he went.
As his truck pulled away, to zoom out of sight,
He smiled and said, "Merry Christmas to all and to all a good night!"

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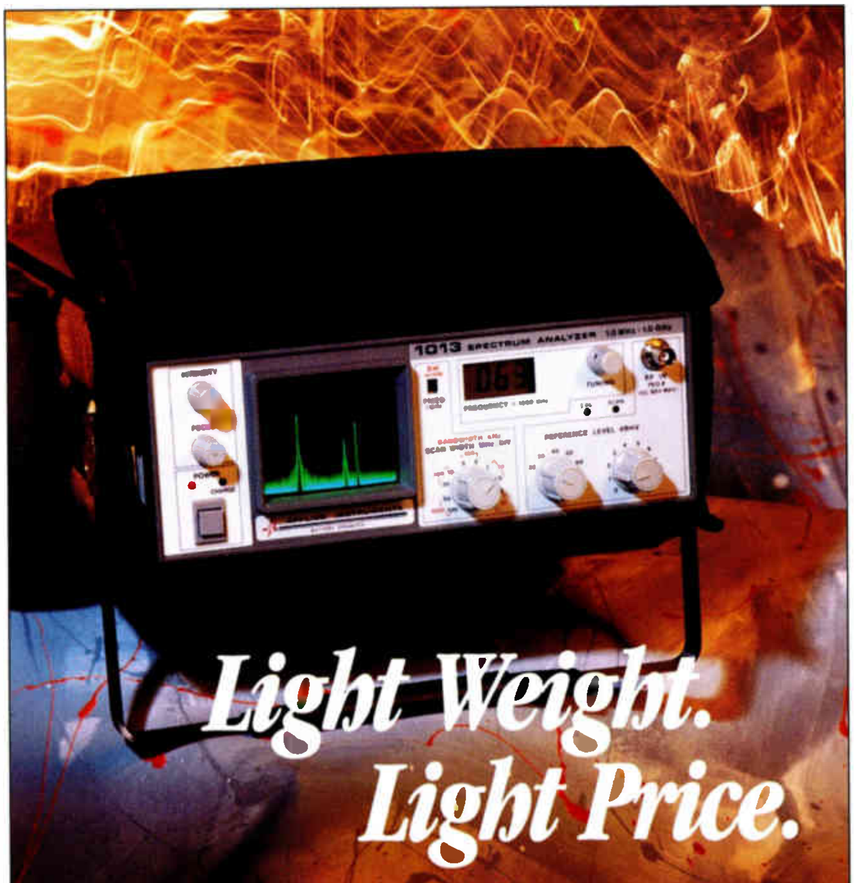

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Mid-America Show hosts Cable-Tec Games

KANSAS CITY, Mo. — For the second year, the Mid-America Cable TV Association Meeting and Show was the site of another heated installment of the Cable-Tec Games where contestants competed for Olympic-style medals and a plaque for the best team. The members of the team that was shut out of all medals last year (the SCTE Great Plains Chapter) vowed to change that this time around, and they lived up to their promise by taking the team title.

Four teams competed in various technical events including: splicing (hosted by Comm/Scope and Gilbert Engineering); test equipment (hosted by CaLan); signal leakage (hosted by ComSonics); fusion splicing (hosted by Optical Networks International); fault location (hosted by Riser-Bond) and signal level meter techniques (hosted by Trilithic and Wavetek). The games were coordinated by the Society of Cable Television Engineers Cable-Tec Games Subcommittee, the Heart-of-America SCTE Chapter and the Mid-America Cable TV Association's Program Committee.

Wendell Woody

The SCTE Great Plains Chapter team (Dale Kirk, Rick Sullivan, Curt Bowles and Bernie Cogan) won this year's Mid-America Show Cable-Tec Games.

The contestants were evenly matched, but the "we shall return" SCTE Great Plains Chapter team of Omaha, Neb., took overall team first place. Second went to the Jones Intercable team of Independence, Mo. The SCTE Wheat State Chapter of Wichita, Kan., took third.

Overall individual winners were: Rick Sullivan of the Great Plains Chapter (first); Dale Kirk of the Great Plains Chapter (second); and Jerry Demeyer of Jones (third).

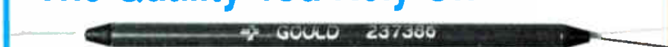
Atlantic Show tech overview

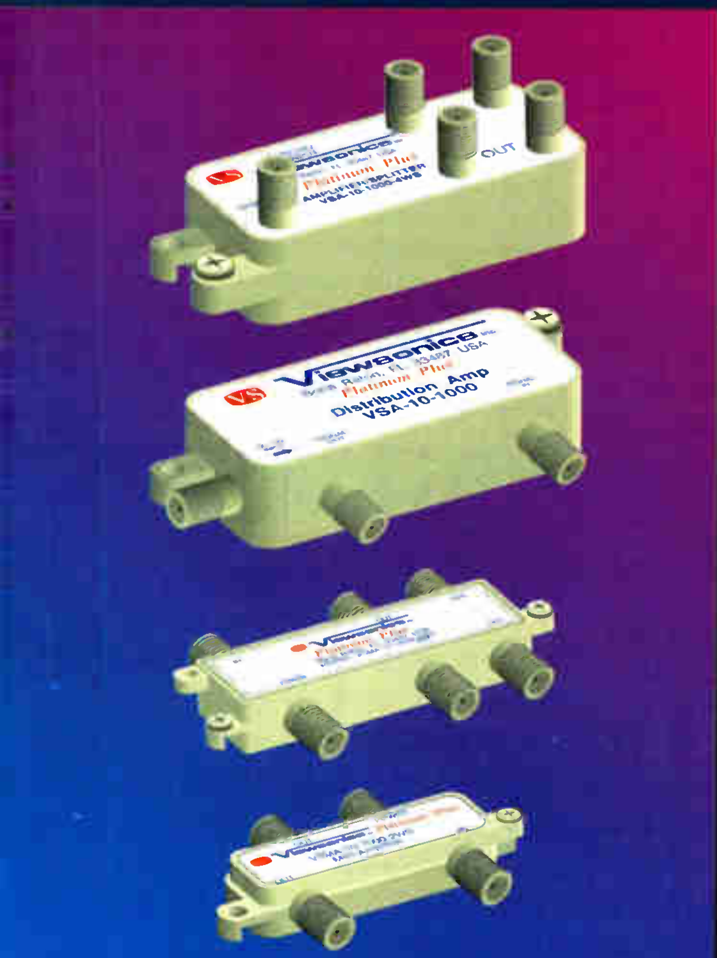
ATLANTIC CITY, N.J. — Meetings of the six engineering subcommittees of the Society of Cable Television Engineers kicked off the technical side of the Atlantic Cable Show held here Oct. 13-14. The subcommittees (in-home cabling, maintenance practices and procedures, EBS, interface practices, design and construction, and CLI) will

all meet again on the afternoon of Dec. 1 at the Western Show.

The first of the SCTE-coordinated tech sessions, "Fiber-Optics Technology Today," began with moderator Joe Van Loan of Cablevision Industries setting the tone by pointing out that fiber optics has grown from a curiosity to a tool of the cable industry. A panel of MSO engineers then shared experiences gained from their companies' implementation of fiber optics. Suburban Cablevision's Ron Cassel said one of his company's goals is to position its networks for alternate access. Detailing the equipment installed to achieve that goal, Cassel stressed the importance of protection and the different powering (48 VDC) required when going into the phone business. Suburban Cable's Chris Patterson said massive headend consolidation has been a major benefit of fiber; the company's Philadelphia area system reduced its headends from 19 to eight. Some of the other fiber strategies Suburban is employing include cascade reduction in rural areas, fiber backbones in urban areas and fiber-to-the-serving area in rebuild situations. Patterson offered several pointers for those considering fiber projects: the use of "bow ties" to provide excess fiber in case of breaks (he recommends every 3,000 feet) and the importance of complete documentation of the build. NewChannels' Don Rocker emphasized the five P's — prior planning prevents poor performance — saying that planning each phase of a build is critical. He also stressed the importance of keeping accurate records, planning restoration procedures and the need for training. Michael Smith of Adelphia Communications offered what he considered the four important areas of a fiber build: 1) planning — there's no such thing as too much; 2) construction techniques — keeping in mind pull tension, roller spacing, back loop locations (Adelphia does it at every highway crossing) and bend radius; 3) documentation — ("without it you're totally lost!") keep a minimum of three sets, one with the restoration kit, one in the headend and the other kept by the tech manager; and 4) training.

The "Emerging Technologies" session was highlighted by a presentation from CableLabs' Brian James on the testing done thus far for the selection of a high definition TV system. (See related stories beginning on pages 20 and 22.) James covered the four categories of tests conducted on each of the HDTV system proposals: objective, terrestrial, terrestrial/cable and cable-specific. The terrestrial tests mainly dealt with over-the-air propagation, while the combined tests checked carrier-to-noise, multipath and discrete carrier interference. The cable-specific ones examined multiple microreflections, second and third order distortions, the effects of high-level sweeps, hum and low-frequency noise, and phase modulation. At the time of this session, the last of the five proposed HDTV systems was still undergoing testing, with the final test results expected this month. The selected system will start field trials next year in Charlotte, N.C. This session was rounded out by Roger Pience of the National Cable Television Association speaking on the new Federal Communications Commission tech standards. Pience mentioned that several months ago the NCTA had filed petitions for reconsideration on certain parameters (the number of test points required in making certain tests and the bandpass and signal level variation through con-

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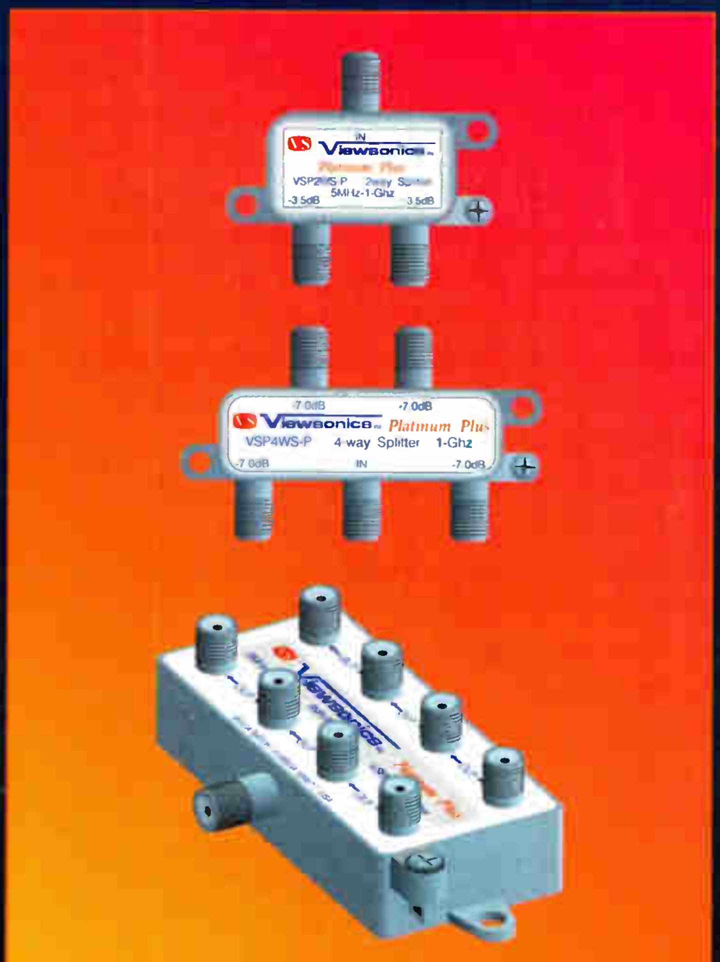
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verters) but as yet, has not received any response from the commission.

It's "the electrician's bible" said Tele-Services R&D's Jim Stillwell when referring to the National Electrical Code during the session on "OSHA. NEC and NESC Codes." Clarifying the fact that local municipalities or states must adopt the NEC to make cable systems abide by it. Stillwell went on to discuss the '93 version. Areas to look at include minor changes in the bonding/grounding requirements for mobile homes, as well as minor changes when using metal conduits and in the use of cable types (CATVP, CATVR, CATV, CATVX) in certain environments. Speaking on the National Electrical Safety Code, Malarkey-Taylor Associates' Jim Kearney began by saying, "Write this down — (908) 981-0060," so you can order a copy of the NESC. He then directed attention to three areas of concern: Rule 224 dealing with communication lines in supply space (wondering aloud about the possibility of power companies getting involved in the cable TV business); Rule 351 on underground cable marking (as of Jan. 1, 1993, underground cables should have an embossed label depicting what's carried on them): and Appendix A, unified clearances, which is important especially in long spans (a computer program to determine sag loading on aerial cables is available from Comm/Scope). Kearney also noted that most states must pass specific legislation to adopt the NESC and to be sure you know which version is enforced in your area. As for the Occupational Safety and Health Administration rules, consultant Roger Keith noted that although there are federal standards. some states have their own versions as well. so it's important to find out which rules apply in which situations. In a nutshell, the purpose of the rules is to ensure a "safe and healthful workplace for employees." Keith went on to outline 10 items that we as an industry should be doing already: 1) OSHA standards — be familiar with them and how they apply; 2) make copies of the regulations available to employees: 3) have OSHA poster (#2203) posted for employees to read; 4) keep accurate records of injuries incurred on the job; 5) cooperate with OSHA inspectors during a visit; 6) train employees regarding safety and keep records of that training; 7) provide safety equipment and make sure its used properly: 8) have a HAZCOM program in place for hazardous materials: 9) have a written fire plan: and 10) stay informed.

The Society's Broadband Communications Technician/Engineer Certification Program had its spot in the limelight as well. The morning of the last day saw the session on "Certification Technology Review" with SCTE's Marvin Nelson (moderator), ComSonics' Paul Biederman and Craig Busch of TKR Cable. each covering two of the program's categories. That same afternoon, BCT/E and Installer certification exams were offered.

Canada starts its own SCTE

TORONTO — The Canadian Society of Cable Television Engineers held its inaugural meeting Oct. 13 here. Created by the Canadian cable TV industry, this new Society is modeled after its U.S. counterpart, the Society of Cable Television Engineers Inc.

The role of the Canadian SCTE will be to:

• Establish standards of professionalism and technical accomplishment;

• Provide training to members through local and regional chapters;

• Promote communications on issues of technical concerns; and

• Develop and publish recommended standards and practices.

At its inaugural meeting, a founding executive board of three members was elected: Ken New, president; Nick Hamilton-Piercy, vice president; and Roger Poirer, treasurer.

"The creation of this Society shows that the cable TV industry in Canada has come of age," said New, "By providing a forum that promotes professionalism and standards of excellence, we are ensuring that Canadian cable TV continues to be a leader in the field."

"This announcement of the launch of a national Canadian SCTE organization sets unprecedented history worldwide," comments U.S. SCTE immediate past President Wendell Woody, who has been instrumental in international relations on behalf of the U.S. SCTE. "It reflects that Canada 'leapfrogged' over the concept of participating in an interim SCTE National Council and moved to establish a fully funded and chartered national organization. It is being supported by the Canadian Cable TV Association under the direction of its Senior Vice President of Technology Roger Poirer. The charter members of the organization include several Canadian MSO companies. The Society is currently in the process of putting together its bylaws and incorporating, and representatives from the Canadian SCTE are planning to come down to meet with our national Society to discuss the ways we can work together.

"This actually will have a benefit to our Society," Woody says. "If the Canadian Society gets its country's technical personnel more involved in training activities, these people will ultimately be more active with our events, such as our annual Cable-Tec Expo and Emerging Technologies Conference, as well as supporting our publications and videotapes."

A call for membership is expected to be announced in a few months, once the Society is fully established. For further information on the Canadian SCTE, contact Ken New at (416) 727-9352 or Chris Rogers at (416) 507-6226.

NCTA calls for tech paper proposals

WASHINGTON, D.C. — The deadline for technical paper proposals for next year's National Cable Television Association Show is Jan. 6, 1993. (Cable '93 — the National Show will be held in San Francisco, June 6-9, 1993.)

One page summaries of prospective papers will be selected in mid-January by an NCTA Engineering Committee subcommittee. Any topic of interest to cable TV engineering managers is eligible, but previously published works and product pitches will not be judged.

Mail or fax summaries with author(s) name, company affiliation and telephone number(s) to: Katherine Rutkowski, NCTA, 1724 Massachusetts Ave., N.W., Washington, D.C. 20036; fax: (202) 775-3698.

☛ Jim (Randy) Randolph was named president of Cadco. He was chosen to head the company following the death of William Barnhart.

Western Show tech sessions schedule

For the eighth consecutive year, SCTE is sponsoring the technical sessions for the Western Cable Show, to be held Dec. 2-4 in Anaheim, Calif.:

Wednesday, Dec. 2

- "FCC/Washington Update" with Bill Riker, SCTE, moderator; Wendell Bailey, NCTA; Susan Herman, NATOA; and John Wong, FCC.
- "Implementing the New Technical Standards" with Chris Middleton, ONI, moderator; Jonathan Kramer, Communications Support Corp.; Joe Mardesich, Comcast; and John Sweeney, S-A.

Thursday, Dec. 3

- "Fiber-Optic Technology from the Operator's Perspective" with Pat Murphy, Cencom Cable, moderator; Marwan Farwaz, Times Mirror Cable; Ray Tyndall, Falcon Communications; and Ron Wolfe, Time Warner.
- "An Introduction to Digital Technology" with Steve Allen, Jones Intercable (moderator); and Gratz Armstrong, H-P.
- "Bandwidth Management and Digital Compression" with Tom Elliott, Catel, moderator; Stephen Dukes, CableLabs; Kevin Hills, Texscan MSI; Carl McGrath, AT&T Bell Labs; and Ed Moura, Hybrid Networks.

Friday, Dec. 4

- BCT/E and Installer Certification testing with Harold Mackey, Times Mirror Cable, proctor.

Joint meeting: Penn/Ohio Chapter, SBE

The SCTE Penn/Ohio Chapter recently held a joint meeting with the Pittsburgh-based Chapter 20 of the Society of Broadcast Engineers. Penn/Ohio Chapter Treasurer Rudy Nizansky of Tektronix TV Systems was instrumental in organizing this meeting, which drew over 100 attendees. It was approximately 65 percent cable personnel and 35 percent broadcast personnel.

"As a member of both SCTE and SBE," Nizansky said, "I thought it would be a good idea to bring our local groups together. We tried to discuss working together and encourage the cable and broadcast people to meet their counterparts."

Among the issues discussed at the meeting were direct fiber from the broadcaster to the headend and ghost canceling. The meeting also featured a panel discussion with the directors of engineering from Pittsburgh-area network broadcast stations KDKA, WTAE and WPXI, as well as engineering managers from TCI, Armstrong and Adelphia. Linc Reed-Nickerson, currently with Tektronix in the Philadelphia area and a former chief engineer with WPXI, served as moderator for the discussion, as he was experienced and well-versed in both the cable TV and broadcast worlds.

One of the many positive results of the meeting was that Nizansky is generating a list of the off-hour phone numbers of the chief techs and master control rooms for

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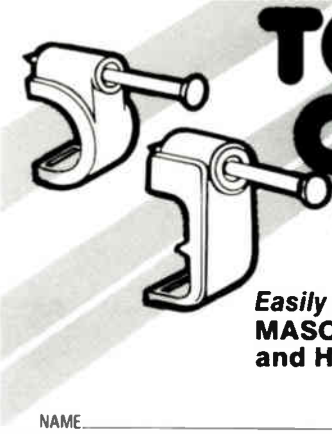

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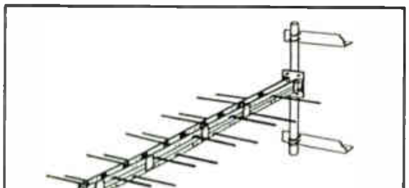

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Pittsburgh's broadcast stations, to give local cable systems people to contact in the event of broadcast reception problems or outages.

Nizansky states, "We all came away from the meeting with the sense that both groups are trying to do the same thing: satisfy the customer. The sense of cooperation between the broadcast and cable industries in western Pennsylvania is alive and well."

Chapter elevated, Senior members named

Six SCTE members have joined the ranks of Senior membership, the highest professional grade for which the Society will accept application. The recipients of this honor are: James Goins, UA Cablesystems; M.J. Jackson, Gilbert Engineering; Herbert Timberlake, Sammons Communications; Neil Tinggaard, TCI; Bryan Wade, King Videocable; and Billy Williams, TCA Cable.

These six members were elevated to Senior member status following a review of their applications by the Senior Member Subcommittee and approval by the national board at its October meeting.

The board also approved the elevation of the Music City Meeting Group of Nashville, Tenn., to full chapter status.

New subcommittee holds first meeting

(Contributed by Bruce Weintraub, Cable TV Montgomery)

The SCTE Maintenance Practices and Procedures Subcommittee met for the first time Oct. 13 in conjunction with the Atlantic Cable Show in Atlantic City, N.J. This meeting was organizational and established some of the parameters and guidelines for the subcommittee members.

We'd like to welcome our initial working group leaders and members: Larry Ross, Lectro Products, secretary; working group leaders Mike Dowling of Hughes Microwave (Headend Working Group), Ernie Gregory of Paragon (Utility Company Interface Working Group), and Jon Ridley of Jerrold (Preventive Maintenance Working Group); and subcommittee members Scott Shelley and Frank Cruse of Arlington Cable Partners, James Parker of C-COR and Dennis Setting of Dacom.

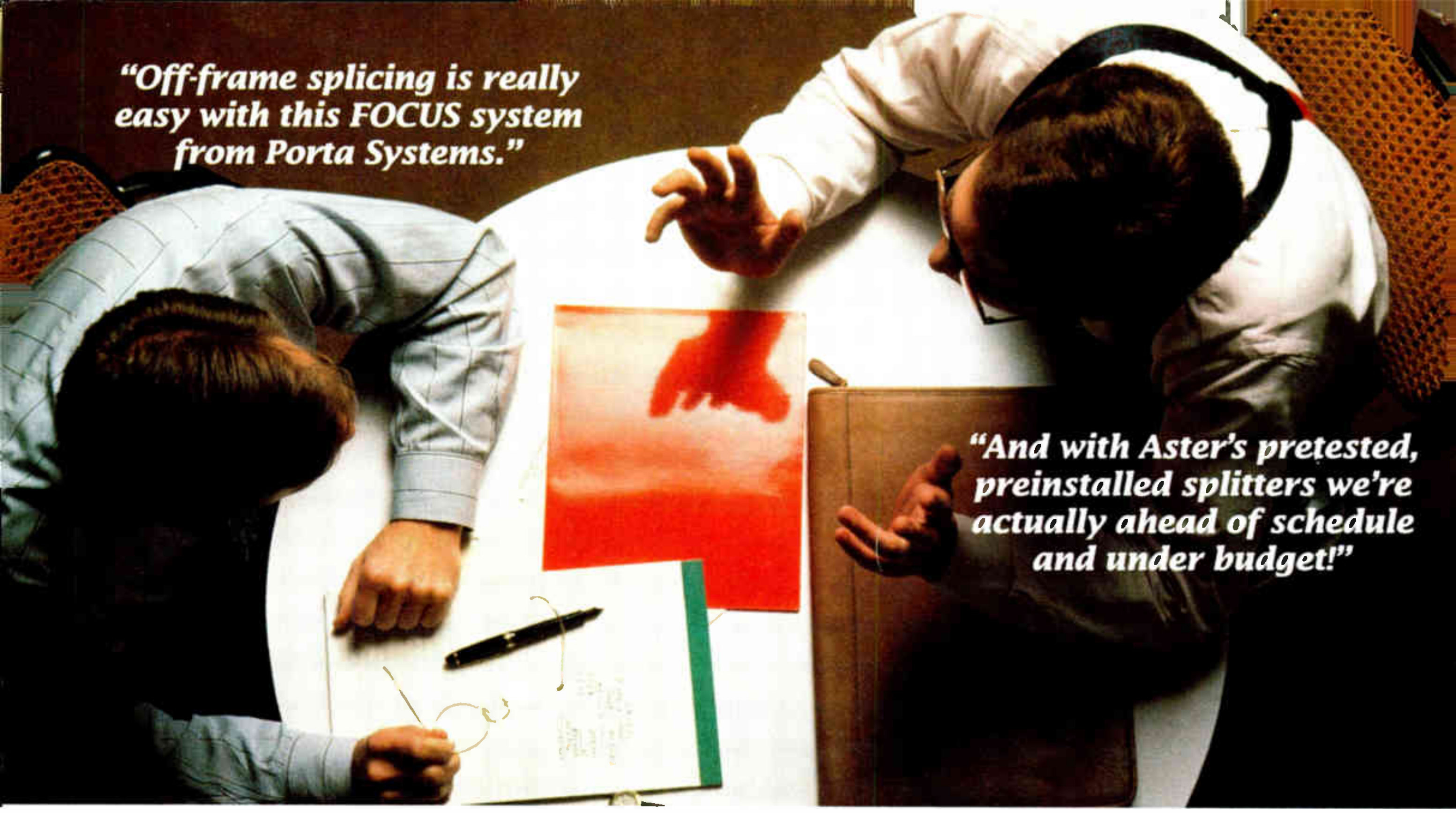
During the meeting we were able to flesh out a basic organizational chart that listed the objectives of each working group. This chart will remain flexible throughout the formulation of the subcommittee, which hopefully will be fully staffed by the time of Cable-Tec Expo '93.

This subcommittee is open to all members of the Society who wish to have input in setting the standards required to maintain cable systems at a level in keeping with the exact standards of our subscribers.

We are looking for members to lead working groups in the areas of damages, outages and customer service, as well as increasing the numbers of members in all of the working groups. Optimally, we will have a two-person working group leadership: one person from the vendor side of the business and one person from the system operator side. This will give us the widest range of input to promulgate procedures and practices for the industry.

For more information on the subcommittee or to sign up for one of the working groups, contact Bruce Weintraub at (301) 294-7760 or Larry Ross at (706) 821-1370.

Please join us at our next meeting at the Western Cable Show Dec. 1 at 2 p.m. in the Huntington A Room of the Anaheim Hilton.



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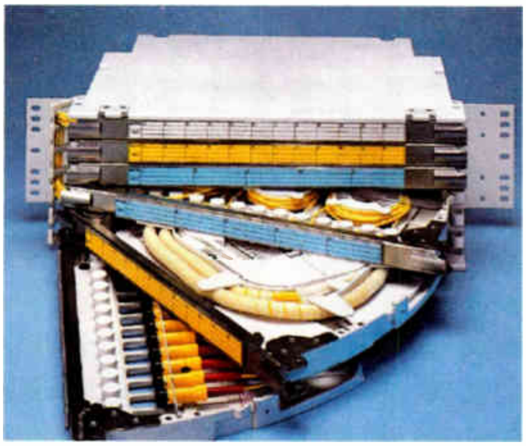

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Reader Service Number 19

Zenith engineers Wayne Luplow and Richard Citta evaluate the AT&T/Zenith HDTV system. Courtesy Zenith Electronics Corp.

HDTV today

By Gerald H. Robinson
Director of Engineering, Headend Products
Scientific-Atlanta

As little as two years ago, high definition TV was *the* technology topic in television. Today HDTV has taken second billing to multichannel digital TV. Is this just another sign that more is better in U.S. TV and that quality doesn't matter? Less cost per channel delivered is certainly better. More choices and flexibility are better, both for the service provider and the consumer.

What about this issue though: Is industry ignoring quality? Today the viewer does not receive television with the full quality available from NTSC composite signals. The causes are noise, interference, distortions and signal processing. Digital modulation will improve quality by eliminating most of these impairments from the received signal. It will do this without the need for a new TV set with different tube and scanning technology. Of course, it still is not HDTV.

The development of HDTV

The focus in HDTV has broadened and shifted since 1985. In the beginning, technology was almost entirely the issue in the public dialogue. The focus broadened to include more business concerns, an area that has become increasingly central in discussions as time has passed. MUSE was the most advanced HDTV system in 1985. Even then, a basic business issue motivated a push for technological alternatives. NHK designed MUSE for satellite transmission and the United States had to deliver HDTV by other media as well. This requirement opened the door to many proposals that claimed to meet this need and to offer other advantages to broadcast TV.

Compatibility with NTSC receivers was a key feature of all these new proposals. You simply had to serve both NTSC TV sets as well as any new HDTV sets. An NTSC signal had to be the basic core signal then. Something else would have to be added to make up the difference between the information required for HDTV and that contained within the NTSC signal. Designers would have to find a way to add information within the NTSC composite without interference or broadcasters would need added spectrum to transmit the augmenting information.

The NTSC signal is already a marvel of electronic signal packaging when one considers the technology available at its inception. Still, proponents found creative ways to stuff a little more in places like the Fukinuki hole. There were troubling issues, though, about how to handle the difference in aspect ratio. Should we add side panels to the NTSC picture like screen extenders or should we squeeze the picture on the NTSC set to a smaller height, reducing resolution but maintaining the creative intent of the director? If the NTSC picture were to be normal height, it could not be simply the middle part of the wider HDTV picture. The part displayed on the NTSC TV set would have to be selectable.

Wouldn't there likely be some differ-

Journalists and policymakers recently witnessed a demo of ATRC's HDTV system broadcast over-the-air by WRC-TV in Washington.

ence in noise or interference between the main channel and a separately transmitted augmentation channel? Even if the impairment were slight, it could be expected to make side panels visible or to be manifest otherwise. How much spectrum could be made available for separate augmentation channels anyway? Some proposed 3 MHz augmentation channels and some 6 MHz. Would taboo channels have to be honored? What about co-channel interference? During this same time, all of those NTSC artifacts that our brains had managed to suppress were called to the attention of the TV community, spoiling our enjoyment of NTSC (and those in our families as we eagerly shared our experience). It was a shared technical headache with lots of opportunity for finding partial solutions that offered a competitive advantage. One can easily see why the focus was on technology. There was little time left over for other issues.

Among the 14 or so original proponents, a few magic solutions presented hope. The most notable employed a "new" modulation technique that was said to be totally orthogonal to amplitude or frequency modulation. Further, it somehow provided almost unlimited information capacity. There was no need for augmentation. An HDTV signal could be added to the NTSC composite without any interference. Alas, physics prevailed and Shannon's "Law" was upheld in the court of public technical scrutiny. Other solutions would have to be sought.

In 1988, Zenith made a proposal that signaled a departure — a spectrum compatible system. A separate channel would be used to transmit all of the HDTV information, independent of the NTSC channel. NTSC artifacts would be left behind and the designers would be free to pursue new modulation formats. Modulation continued to be analog because of its relative spectral efficiency among other things. A number of novel techniques such as dispersion were employed to spread the energy over the channel in a rather flat spectrum not unlike a digital spectrum. The comb-like spectrum of NTSC was maintained to permit further reduction of interference between the HDTV channels and NTSC. Much of this could be thought of as channel coding in that it modifies the baseband signal to produce a more robust transmitted signal.

Well, it was not a bad idea if it would really work. It was an idea that left some room for business concerns to be heard. If the HDTV channel were separate, NTSC could eventually go away. Land mobile interests that were dismayed with the prospect that the TV monster was devouring even more spectrum could at least have hope for the future. There were still issues like taboo channels and co-channel interference but even these were mitigated by the modulation employed by the proposed system.

General Instrument then dropped what might be called the other shoe. It proposed digital modulation. Digital modulation had been suggested for the augmentation channel but GI was proposing a separate HDTV channel with digital modulation. Others also were investigating digital modulation and we soon had a number of such proposals. That made the image compression or coding and the channel coding into separate issues. Image coding technology was well-developed at the outset of the HDTV effort and image processing was digital from the beginning. Every image coding action had to be considered in light of the modulation and the effect of channel impairments so long as modulation was analog. With digital modulation, each issue could be attacked separately.

The situation today

Five HDTV systems are being evaluated by the Federal Communications Commission's Advisory Committee on Advanced Television Systems (ACATS). Four of these employ digital modulation. All of the digitally modulated systems employ motion compensated prediction as a compression method. They also use discrete cosine transformation (DCT) of the prediction residual. More about what these terms mean in a moment.

First we should note there is a lot of commonality here. There are certainly differences as well. The modulation techniques for the terrestrial signal include 16 QAM, 32 QAM and 4-level VSB-AM. The specifics of the algorithms vary. Some of those differences may determine which system is selected. Some differences could be eliminated. Three of the four digital (digital modulation) system proponents have reached an agreement on patents and sharing royalties. This is a far different scene from the 14-proponent landscape of earlier years.

The last system is undergoing tests at the Advanced Television Test Center and at Cable Television Laboratories as this is written. Tests at the Ad-

(Continued on page 44)

Transmission of digital HDTV — Part 2

The following is copyright 1992 by CableLabs Inc. The first installment, which ran in the October 1992 issue of "Communications Technology," covered fundamentals of digital communications systems. This installment will cover the proposed digital HDTV systems being considered by the Federal Communications Commission.

By Majid Chelehmal, Ph.D.
Digital Systems Engineer
Cable Television Laboratories Inc.

In selecting a digital high resolution TV standard for North America by the Federal Communications Commission, a number of companies have built prototype high definition TV systems in hardware for evaluation by the FCC's Advisory Committee on Advanced Television Service (ACATS). These systems have undergone extensive laboratory testing both for terrestrial and cable transmission. After reviewing the test results, a single system will be recommended by the ACATS for further field testing to verify the laboratory results.

Laboratory testing of the digital HDTV systems proposed for terrestrial and cable transmission have been completed. CableLabs successfully tested these systems for transmission over cable and results are currently being evaluated. The digital systems proposed are: the Advanced Television Research Consortium's Advanced Digital HDTV (AD-HDTV), the AT&T/Zenith Digital Spectrum Compatible HDTV (DSC-HDTV), the General Instrument (GI) DigiCipher HDTV(DC-HDTV), and the MIT/GI Channel Compatible DigiCipher HDTV (CCDC-HDTV).

ATRC AD-HDTV system

The ATRC (comprised of member companies Philips, Thomson, David Sarnoff Research Center, NBC and Compression Labs) AD-HDTV system is a two-field 1,050-line interlaced system based on the ISO/MPEG (International Standards Organization/Moving Picture Expert Group) for video and audio compression and quadrature amplitude modulation (QAM) techniques for digital modulation. Two separate 32-QAM carriers are used to transmit a total of 24 Mb/s data through a 6 MHz transmission channel. A high priority (HP) data channel of 1.125 MHz bandwidth and a standard priority (SP) channel of 4.5 MHz are used for this purpose. The resulting modulation system is termed spectrally shaped QAM (SS-QAM). The HP 32-QAM carrier contains important information selected by the encoder for proper receiver functioning and it is transmitted at 5 dB higher energy per symbol (or equivalently power spectral density) than

(Continued on page 48)

Table 1: Major system parameters of FCC proposed digital HDTV systems

HDTV systems	Video system: Format	Video system: Rate	Video system: Compression	Audio system: Channels	Audio system: Rate	Audio system: Compression	Ancillary/control: Channels	Ancillary/control: Rate	Error protection	Total data rate
ATRC AD-HDTV	1,050/2:1 interlaced	HP: 32-QAM = 3.2 Mb/s or 16-QAM = 2.47 Mb/s SP: 32-QAM = 14.54 Mb/s or 16-QAM = 11.58 Mb/s	DCT-MC*	4 or 2 stereo pairs	512 kb/s	MPEG MUSICAM	1	256 kb/s	Reed-Solomon trellis and interleaving	32-QAM = 24 Mb/s or 16-QAM = 19.2 Mb/s
AT&T/ Zenith DSC-HDTV	787.5 progressive	17 Mb/s bi-rate 4-VSB & 2-VSB	DCT-MC	4 or 2 stereo pairs	512 kb/s	Dolby AC-2	1 1	30.21 kb/s 382.7 kb/s	Reed-Solomon and interleaving	4-VSB + 2-VSB = 21 Mb/s
GI DigiCipher	1,050/2:1 interlaced	32-QAM = 17.49 Mb/s or 16-QAM = 12.59 Mb/s	DCT-MC	4 or 2 stereo pairs	503 kb/s	Dolby AC-2	2	252 kb/s	Reed-Solomon trellis and interleaving	32-QAM = 24.39 Mb/s or 16-QAM = 19.51 Mb/s
MIT/GI DigiCipher	787.5 progressive	32-QAM = 18.88 Mb/s or 16-QAM = 13.60 Mb/s	DCT-MC	4/6	503/755 kb/s	MIT-AC	2	252 kb/s	Reed-Solomon trellis and interleaving	32-QAM = 26.43 Mb/s or 16-QAM = 21.15 Mb/s

*DCT-MC: discrete cosine transform motion compensation

Image representation in CATV compression systems

By Carl J. McGrath
Supervisor, Cable TV Lightwave Group
AT&T Bell Laboratories

The deployment of digital transmission technology in CATV broadband networks marks the beginning of a new era of opportunity for CATV service providers. For many, digital transmission will mean a significant increase in available system capacity, perhaps by a factor of 10-to-1 for many types of programming. Digital transmission also will result in improved service quality as robust signal processing techniques are implemented. The continuous cost and performance improvements in digital storage and control systems based on computer very large scale integration (VLSI) will make possible new service offerings and products for the CATV subscriber.

Digital techniques in video production are by no means new. Production facilities have made extensive use of digital techniques for several years, particularly in special effects and creative enhancements to video images. A key attribute of all digital systems is that signal quality need only be compromised or degraded once, in the analog-to-digital conversion process. The degree to which it is compromised (e.g., by the introduction of noise or distortion) is controllable in a very precise manner through the selection of conversion accuracies and sampling formats. Once in the digital domain, multiple serial processing steps, including long distance transmission, are possible with no additional degradation to the original signal.

The design of an optimum architecture for digital TV in the 1990s and beyond is challenging because of the wide variety of applications, the anticipated evolution of consumer monitor equipment and the demands for increased interoperability among the various video products that may find their way into the home entertainment system of the future. Implementation cost, compatibility with existing analog systems and the desire for upward compatibility with an unknown future are all important design considerations. This task is compounded by the rapid advances in digital processing technology that make many new techniques obsolete before they can be implemented in real silicon and software.

Digital sampling systems

One of the many fundamental design decisions that must be made for digital TV is the choice of an image sampling system. That is, deciding on a base (or family) resolution for pictures to be processed. For digital TV aimed at replacing or supplementing traditional NTSC analog systems in a 4:3 aspect ratio, a high resolution format established in the international standards groups CCIR (International Radio Consultative Committee of the International Telecommunications Union), EBU (European Broadcasting Union) and others is an attractive alternative. It is known to the video industry as CCIR 601. Developed in a time frame when only large studios and postproduction systems could afford the cost and complexity of digital component video systems, CCIR 601 today is an excellent fit to the processing power and performance characteristics of digital circuitry and recording media. Extensive documentation and compatibility with both 525-line (30 fps) and 625-line (25 fps) analog formats are additional benefits.

In the following material we'll look at some of the performance characteristics of CCIR 601 and how they influence the design of digital compression systems. For those seeking more detail, a complete definition of the standard can be found in the proceedings of the CCIR: Recommendations 601 for coding and 656 for interfaces. The CCIR publishes new documents every four years, the most current being 1990. CCIR Report 629-3 provides a summary and historical perspective of the evolution of digital TV in CCIR. Several books have been published on the standard and implementation considerations for real-world applications. *Digital Television*, edited by C.P. Sandbank (Wiley and Sons, 1990), is a detailed reference for the design engineer. Digital component recording systems (D1) from Sony, Ampex and others also include extensive documentation on the CCIR 601 format.

"While several options exist, only component systems are ultimately practical for compression systems."

Why component video?

Video signals can be digitized either from component sources (e.g., RGB, YUV) or from composite formats such as NTSC or PAL. The bit rate resulting from the analog-to-digital conversion (A/D) process depends on the bandwidth of the source and the digital accuracy (bits per word) employed. Eight-bit digital-to-analog conversions (D/As) are typical for these applications, although both composite and component video systems are transitioning to 10-bit accu-

(Continued on page 54)

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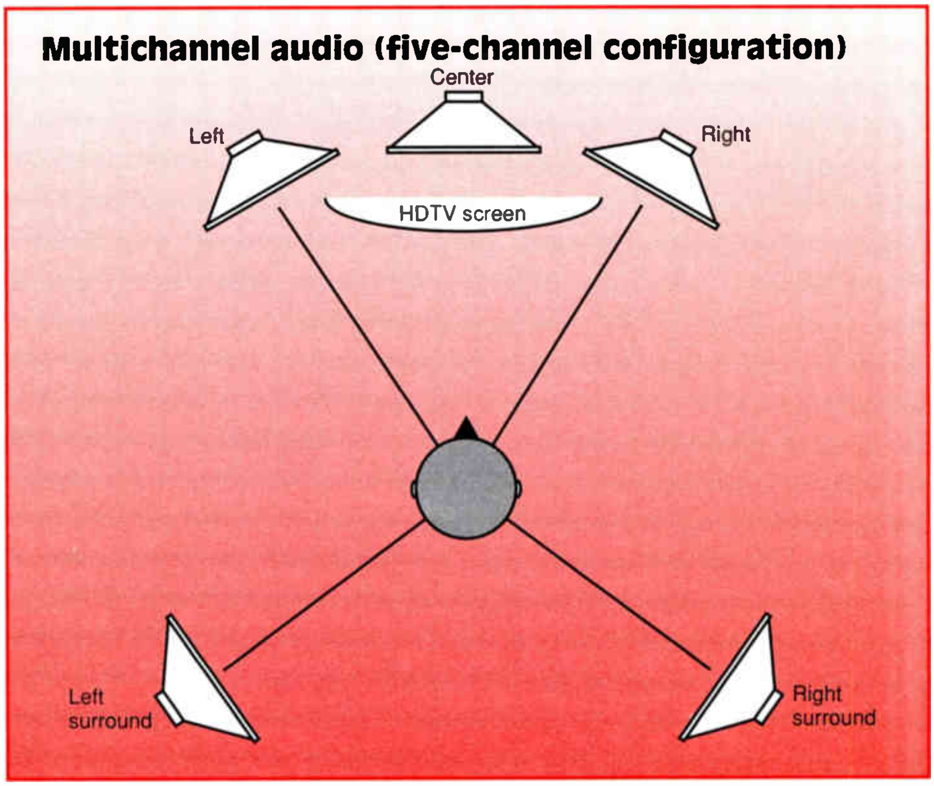
Reader Service Number 21

Audio for HDTV

By Graham S. Stubbs
Consulting Engineer, Graham Stubbs Associates
Chairman, Advanced Television Systems Committee's Specialist Group on Digital Audio and Ancillary Data Services for an Advanced Television Service (T3/S3)



The Federal Communications Commission's second Report and Order on ATV Systems (released on May 8, 1992) includes language that heralds significant progress toward assuring quality of sound performance to match the wider, sharper pictures promised by high definition TV (HDTV). Earlier this year, the Advanced Television Systems Committee (ATSC) published the results of a two-year study with advice and suggestions regarding the digital audio and ancillary data services that should be included in an advanced TV (ATV) service.

The actions taken by the FCC and ATSC resulted from the recent convergence of the following three factors:

1) Advances in understanding the unique factors in sound reproduction to accompany the TV image, and what can be done to optimize TV listening in the home environment.

2) Recent developments in multichannel audio coding, with remarkable improvements in efficient use of data capacity.

3) The desire by several industry organizations (including ATSC) to ensure that although the focus until now has been on the video aspects of ATV, audio and ancillary data services should be treated as essential components of the new technology and should be optimized for a new medium likely to be used for decades.

It probably is widely expected that digital audio for HDTV will be at least as good as the audio compact disc (CD). But much more is possible. The home has become an increasingly important venue for motion pictures, with many viewer's having their first (and possibly sole) experience of films under home conditions.

Sound for television

There are very basic differences between audio intended to accompany a picture image (whether cinema or television) and audio reproduced for entertainment on its own. This fact has been known to motion picture engineers for decades and resulted in a systems approach to audio for movies that encompasses everything from movie sound production to the acoustics of movie theaters. Some interesting lessons can be learned from the motion picture approach.[1]

The motion picture audio engineer's objective is to provide a listening experience in the theater that is as close as possible to the intention of the producer, is constant regardless of wherever the films might be shown, and is independent of where a customer might be seated in the theater. The audio component is intended to complement the picture, not distract from it. Thus, film sound traditionally uses a minimum of three screen audio channels: center, left and right. The center channel is used to localize dialog to the vicinity of the projected image, regardless of the position of the listener within the theater. The use of a center channel also has been found to improve dialog intelligibility. The sound provided from the front (screen) of a movie theater needs to be localized and localization is improved by directional loudspeakers.

Much of the feeling or emotion of a film is conveyed in the music and special effects designed to "envelope" the listener. Surround sound, used for the purpose of envelopment, is typically played from the sides and rear of the listening area and its effect promoted if the left and right surround sound components are de-correlated. In summary, the motion picture image is accompanied by an audio "image" (in the vicinity of the picture image) and surround sound adds to the feeling of involvement in the show.

These principles also are applicable to the home environment for watching television. The biggest single difference from the movie theater is one of size. The acoustics of a living room are different than a theater. In the cinema, reverberation is a significant factor, and background noise from an audience can be an issue. In the home, reverberation is seldom a problem and background noise is (to some extent) under the control of the viewer.

There remain differences in frequency response of the differing acoustic environments that can be equalized out to some extent. The application of a front speaker to localize dialog to the screen is just as applicable in the home and enveloping "surround" sound can greatly enhance enjoyment of the program or movie.

The trend toward multichannel audio for cinema presentations will make movies available for electronic delivery with multichannel digital soundtracks. The psychoacoustical principles applied to movie reproduction will be extended to consumer electronics via multispeaker configurations for home entertainment centers. The introduction of HDTV represents the opportunity to bring to the home not only a wide screen, but additionally an audio/visual experience more truly resembling that of the cinema.

Multichannel audio coding

The audio problem can be considered analogous to video compression. The challenge is to transmit multiple digital audio channels in the data space usually allowed for just one or two channels. Fortunately, the audio data compression system can be designed from scratch considering that multiple audio channels of a *single* program will be encoded. Coding in this fashion allows additional savings in the data rate required over individual channel coding. Still, it yields discrete channel performance in terms of localization.

Even with the use of advanced low bit-rate audio coding technologies, provision of five high quality independently coded discrete channels would require significant data capacity. Current estimates of required bit rates per individual audio channel are as follows:

High quality: 128 kbits/s
Medium quality: 96 kbits/s
Low quality: 64 kbits/s

Thus, five high quality discrete channels might require 640 kbits/sec.

However, the recent developments in composite multichannel audio coding technology show that five-channel audio may be delivered with a data rate only slightly larger than that required by two high quality independently coded channels. A five-channel composite coding mode structure can be predefined as part of the ATV system.

As an example of the use of such a structure, there are three composite coding modes suggested, which offer different numbers of high quality audio channels. The numerical designations (e.g., 3/2) indicate the number of front channels/rear channels. Some audio coding technologies incorporate a low bandwidth channel (<200 Hz) intended to deliver low-frequency enhancement information (subwoofer channel), the use of which would be optional for the program distributor, receiver and viewer. Consider the following:

Number of channels	Numerical designation	Required bit rates
Five	3/2	320 or 384 kbits/s
Three	3/0	256 kbits/s
Two	2/0	192 kbits/s

An example of the use of five-channel coding is depicted in the accompanying diagram showing loudspeaker locations in relation to the viewer and TV screen.

HDTV and digital audio

The selection of an HDTV standard and the introduction of HDTV service creates the first opportunity in 50 years to redesign the TV delivery system as a whole. Advances in the use of digital audio system technology will create the possibility for consumers (read cable subscribers) to enjoy sound matching the expanded viewing experience of new video services. In fact, there is every reason to hope that the digital audio accompanying HDTV pictures will be the best audio available in the home (not the worst as too often has been the case with analog-delivered TV audio in the past). Additionally, there is the opportunity to design into the system from the beginning a new generation of ancillary data services.

An all-digital format for HDTV will make it natural to employ digital audio with all the benefits of experience with CD-quality and the further advantages of composite coding and the delivery of multiple audio channels.

The FCC has called for "extensibility" as one of the 10 selection criteria to be applied by its Advisory Committee.[2] By extensibility, the FCC means "the ability of an ATV system to adapt to future improvements without creating obsolescence."

To further quote the FCC: "ATSC presents a concrete application of extensibility. ATSC states that recent advances in multichannel audio coding technology have reduced the data rate required for five-channel audio nearly to that required for two independent audio channels. ATSC believes that an ATV system should be able to leave open the number and type of digital audio and data services included in an ATV channel, and allow data to be allocated to digital audio and data as needed. It believes this would permit the addition of future new digital services, with older receivers ignoring new data types. It recommends that an ATV system be able to deliver five-channel audio. ATSC states that all ATV receivers would need to decode the provided service (which could vary from one to five channels) into the number of loudspeaker channels to be used.

"While the focus until now has been on the video aspects of ATV, audio is another essential component of this new technology. ATSC appears to recommend a practical means of achieving extensibility in the audio component of an ATV system selected as a standard. We thus direct the Advisory Committee, consistent with our overall implementation plan, to address any new audio developments such as those discussed by ATSC, as well as ATSC proposals for flexible audio and data, in its selection of an ATV system."

(Continued on page 58)

Upgrading your system for digital audio

By Bob Kelly
Applications Engineer
Digital Cable Radio
Jerrold Communications

Any new project requires a certain amount of preparation. Adding a digital audio service is no different. It's not necessarily more difficult than other projects you'll experience — just different in focus.

The big question is "where to start?" You must first understand why digital audio sounds better than any other audio source on cable today. It's simply the same reason a CD player sounds better than an FM radio station. There is no noise or distortion, and it has increased audio fidelity, dynamic range and THD. For example, when you hear a crescendo from a classical piece on a CD player, it sounds as if you are in the recording studio. This digital audio will sound identical from the CD to the receiver at the cable system through a cascade of 50 amps and splits to the subscriber home. Now that you know the why, it's time to talk about "how."

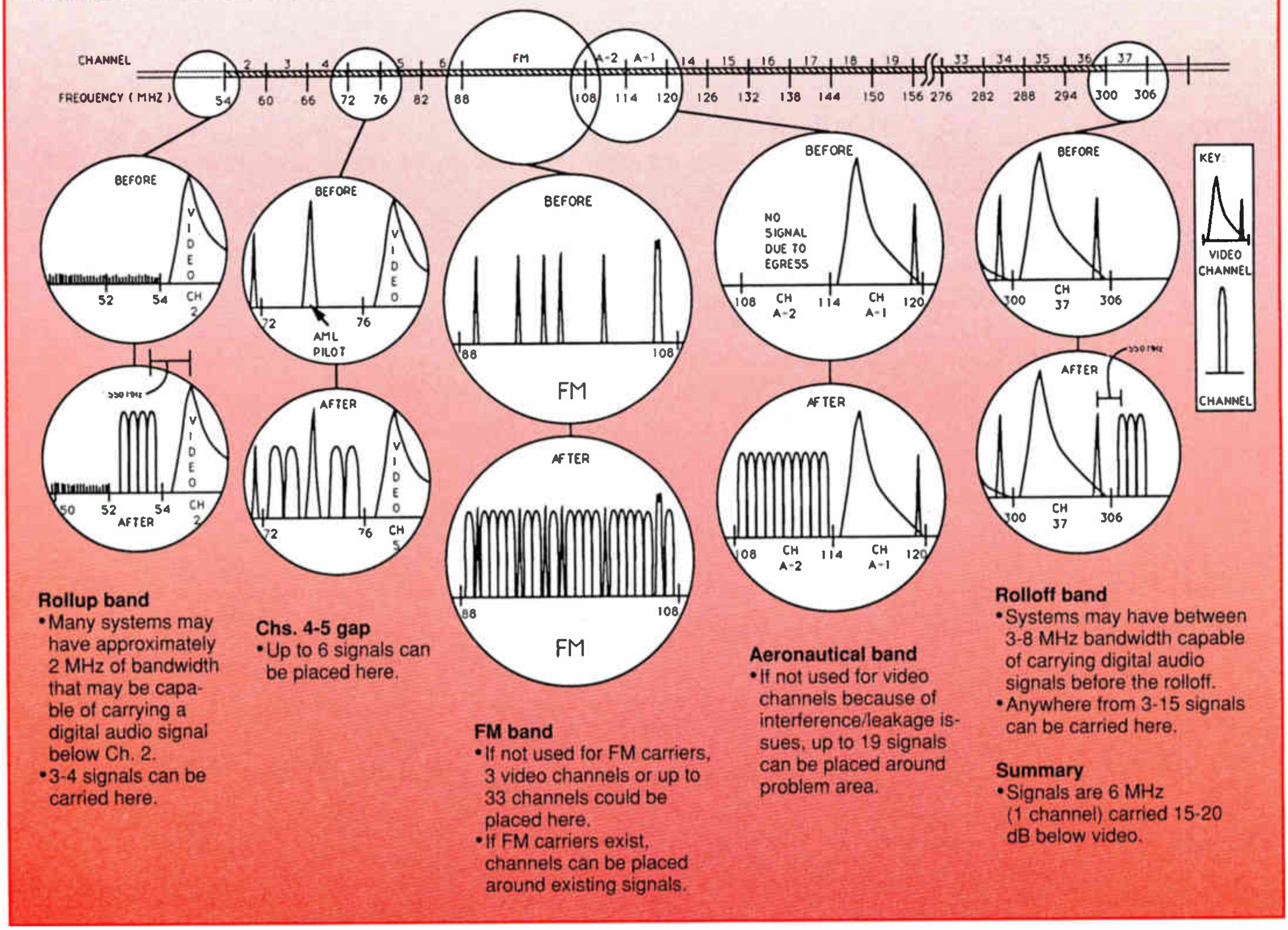
How do we transmit this great audio source and reproduce it at the home? You start with a source of audio worth transmitting — the output of a CD player. Then you encode it with error correction information that makes the signal robust enough to survive the trip up to the satellite and down to the cable system. Given that we have all those bits of 1's and 0's floating around in space, it's our job to receive and transport them to subscribers' home stereos.

Headend

Let's talk reception first. Digital audio signals are received the same way you receive your video signals. A satellite tuner receives the signal and passes it to a processor. Some people assume incorrectly that this signal is delivered on a subcarrier; it is not, it takes up an entire transponder. The difference is the number of audio signals you receive and the performance of that audio. The old analog-subcarrier

(Continued on page 66)

Figure 1: Where are channels carried?



Reader Service Number 23

The dynamics of cable audio services

By Curt Stocker
Affiliate Rep, Western Region
Superaudio

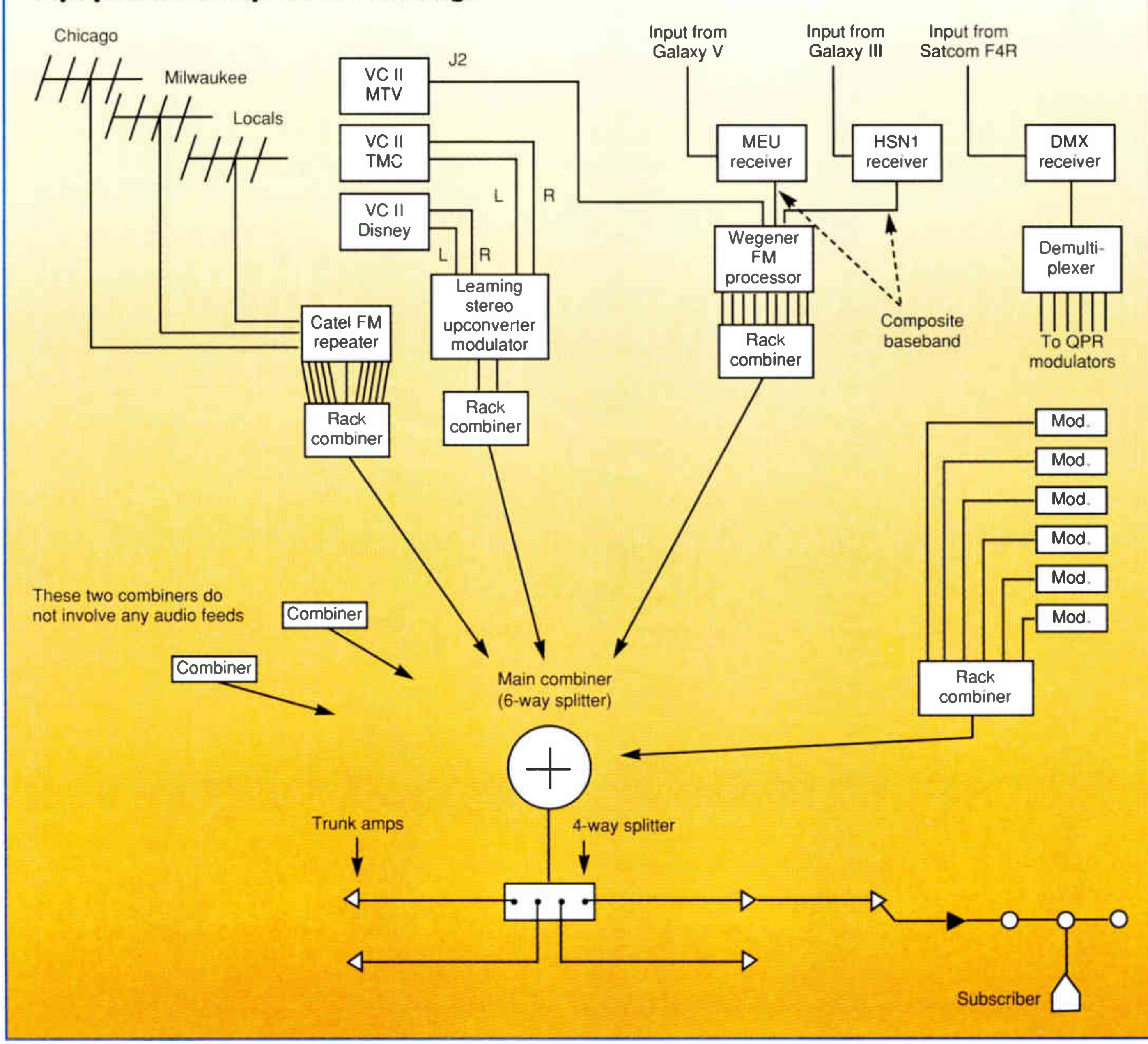
In the early days of cable, audio services were generally overlooked by operators, who were primarily interested in the vast untapped potential of video. It seems they viewed dabbling in audio-only signals as a step backward in the evolutionary scheme of communications.

Eventually, some operators realized they could pull in distant off-air radio signals that standard in-home FM tuners couldn't receive and began to make it available to their subscribers as "value added." But still, it was "just radio" and for the most part ignored by video-oriented operators and subscribers alike.

The concept of enhanced video programming by delivering companion stereo sound over radio is one that dates back to the late '50s. Some of us are old enough to remember when *The Steve Allen Show* demonstrated the concept by simulcasting half its audio feed one night over AM radio. By placing your radio 10 feet from the TV set and tuning to the proper frequency, you could hear the "sound of the future." The show had a ping pong match and you could actually

(Continued on page 70)

Equipment setup for delivering audio services



Original drawing by Ed Jackowski

Reader Service Number 24

Addressable technology for commercial subscribers

By Graham S. Stubbs
Consulting Engineer, Graham Stubbs Associates

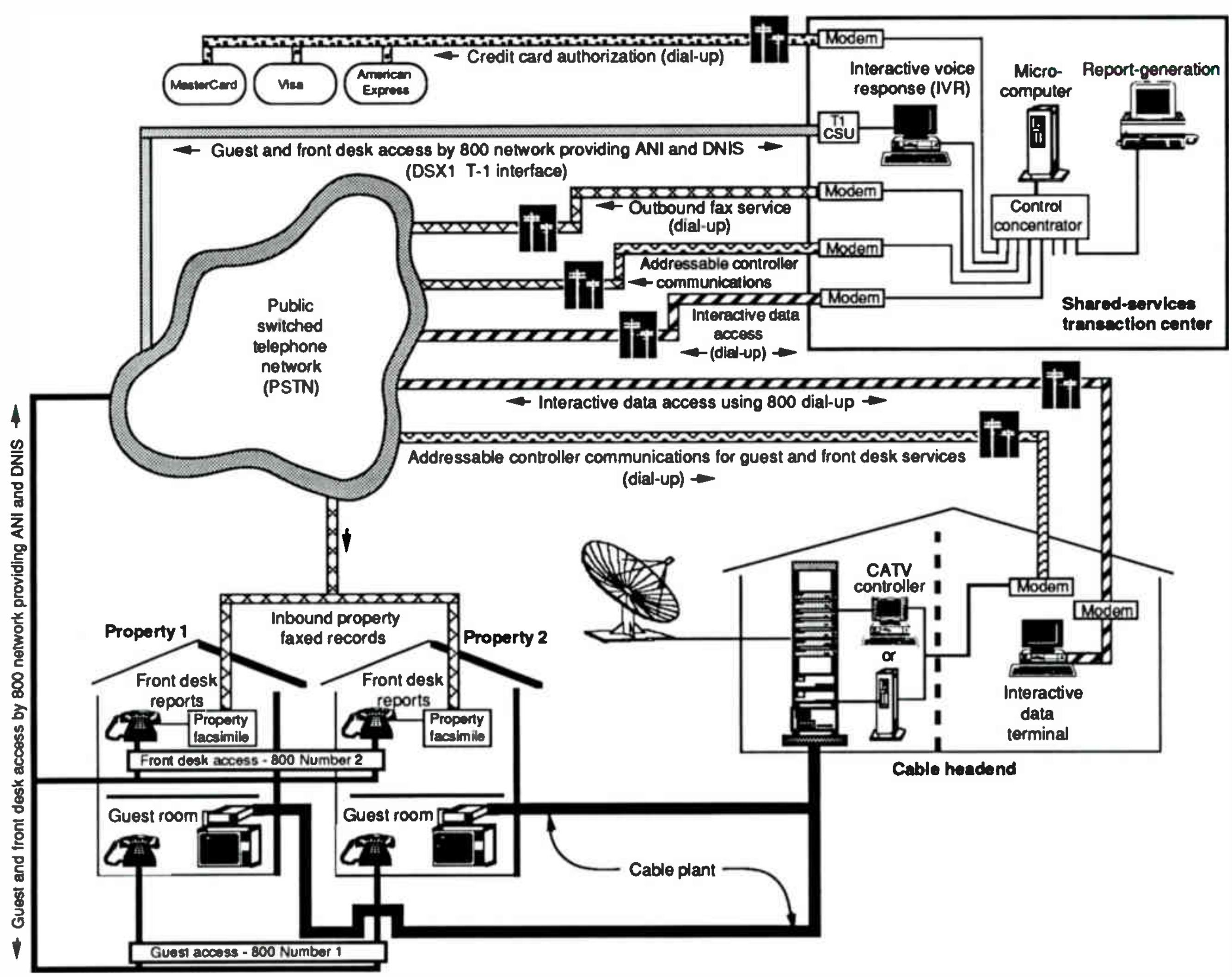
Recent developments in addressable technology promise to open up the potentially lucrative commercial subscriber business to cable services. The commercial subscriber market consists mostly of hotels and motels, condominiums and time-shares, hospitals, college campuses, resorts and other property in which rooms are occupied on a relatively short-term or "transient" basis. The cable industry has intrinsic competitive advantages that could be used for growth in the transient-room market niche. These include:

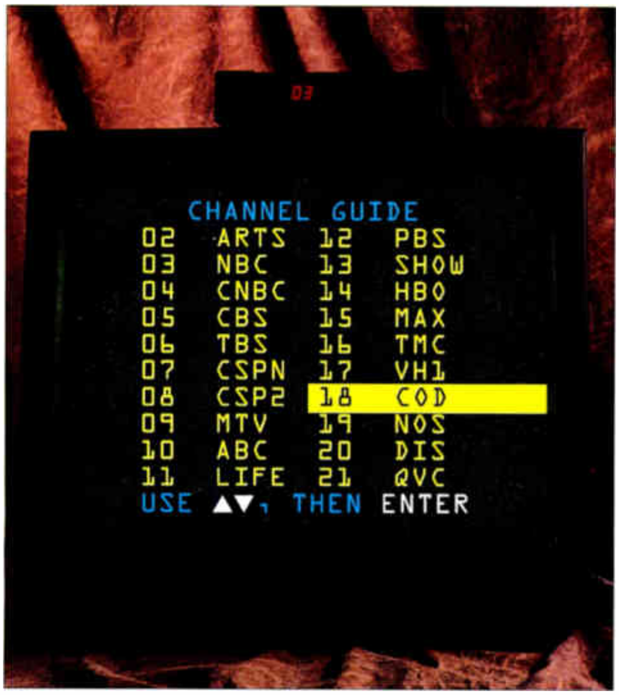
- Cable plant passes most hotels and motels, condominiums, hospitals and college rooms in the country.
- Cable addressable hardware can be applied to advantage; addressable converters can be used in guest rooms to control and deliver services.
- Cable systems have a strong local presence for both sales and service.
- Cable already carries, at low cost, much programming of interest to guests.
- Cable systems can affordably deliver TV services regardless of the size of commercial properties (i.e., are not restricted to larger properties).

However, to date the lack of processes for guest-paid billing has greatly limited the cash flow potential of this market niche. Today, the only cable TV customarily provided in transient-rooms is free-to-guest programming, which is bulk-billed to a hotel or other property as a monthly commercial subscriber at significant discounts compared with residential rates for comparable programming. Pay-per-view (PPV) movies, which have become a

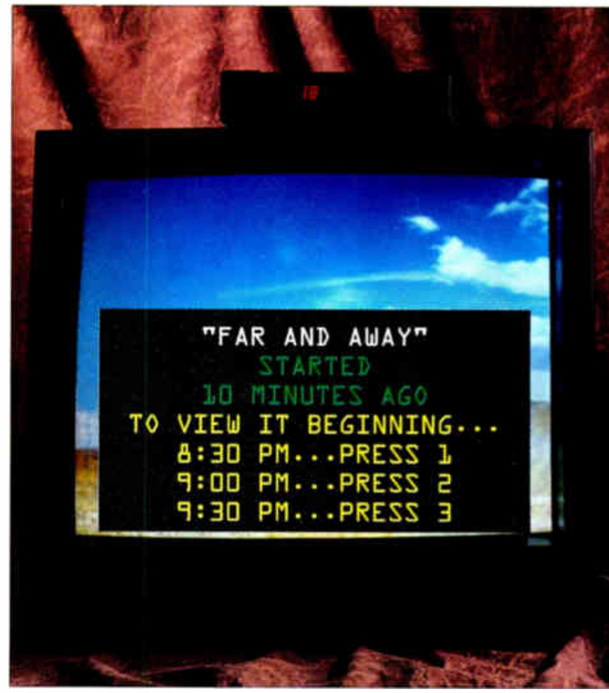
(Continued on page 72)

Network configuration for cable TV-provided service to hotels





SEE IT ALL.



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Reader Service Number 25

Outage management, Part 1: Customer expectations, detection and tracking

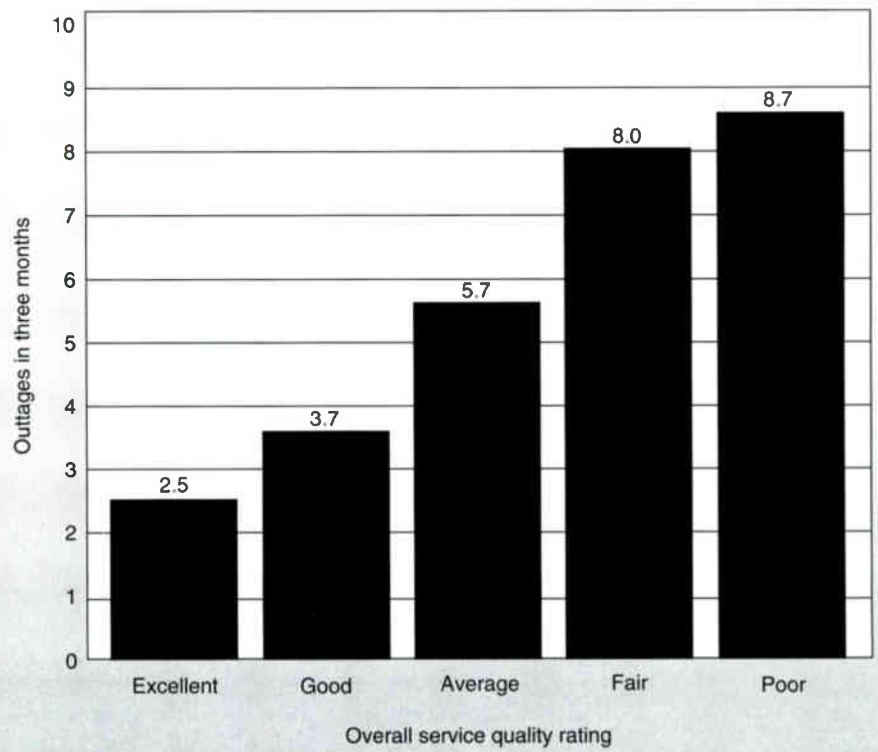
The following is copyrighted by Cable Television Laboratories Inc. The CableLabs Outage Reduction Task Force was organized by several MSOs and the CableLabs staff to address the issues that stem from cable system outages. The intent of the developed solution to outage problems was that it would be fully supported by CableLabs' member companies.

CableLabs published the document "Outage Reduction" as a summary of the Outage Reduction Task Force's work. This is the first in a series of articles adapted from that document. This part covers issues dealt with by the task force's Customer Acceptability Levels Subcommittee. It is important to note that the subcommittee's objectives did not include sponsoring tests of specific equipment and software. The subcommittee members were: Scott Bachman, CableLabs; Michael Miller, Viacom Cable; and Warner Cable's Cyndee Everman, Dave Seibold and Bill Spies.

By Michael Miller
Viacom Cable

It has been said that customer perception may be biased, naive, unfair or just plain wrong, but it is the only perception that counts. Such is the case with cable TV outages. Traditionally, cable system reliability has been viewed as a technical matter addressed by engineers and plant personnel. To be complete, however, any outage strategy must look ultimately to the drivers of the business, which are the customers and their willingness to continue paying for cable service.

Figure 1: Link between outages and customer satisfaction with service quality



Perception of cable quality

How important is system reliability to customers? To set the stage for increased industry focus, it makes sense to first decide if reliability (or lack thereof) really does affect cable customers' perception of the quality of service. Research conducted by one MSO, Viacom, over several years demonstrates the link between reliability and customer satisfaction. Using information gathered from consumer research, outage frequency was correlated against other performance measures. It was found that outages link directly to customer satisfaction with overall service quality as Figure 1 shows.

It is recognized that many of the studies completed on outages are cable company-specific, but this is not to say other companies cannot learn from the research of others. One common factor among most cable companies is that their customer satisfaction surveys often indicate that outages tend to be one of the top three negative marks against a cable company's service record.

One of the major points that the CableLabs Outage Reduction Task Force wanted to stress was that outages are a major (if not *the* major) customer satisfaction issue. The task force's research into outages points this out directly, as will be shown.

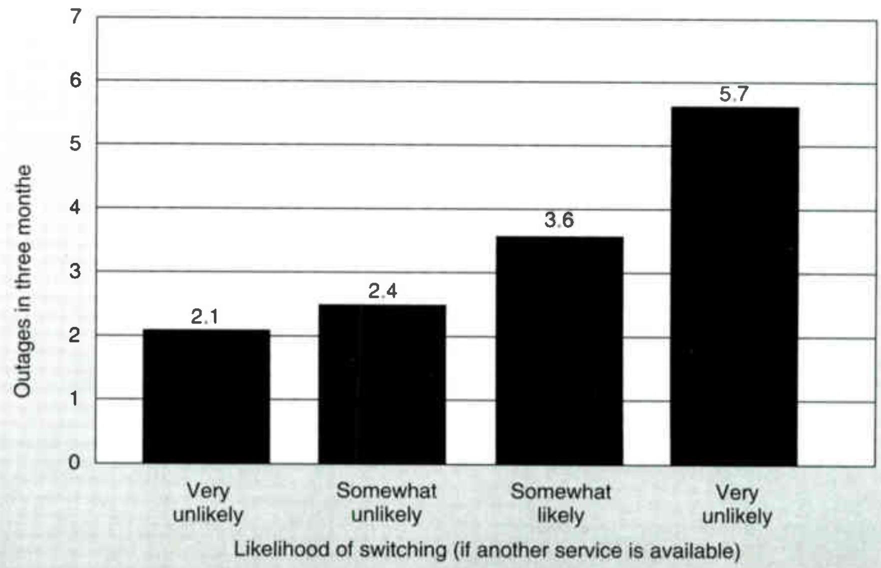
There is a reasonably narrow window of acceptance of outages by cable TV customers. This task force's findings illustrate in no uncertain terms that once outages exceed this customer-acceptable level, outages become the major customer issue. At that point, everything else is secondary.

Outages were an important factor in the results that came from *Consumer Reports*' 1990 annual questionnaire. Therein it was reported that satisfaction with cable TV was "the lowest the magazine has found in 16 years of rating services." (This information is from Rana Arons' "Consumer Reports Readers: Satisfaction with Cable TV Lowest in Survey History," which ran in *Consumers Union Newsletter* on Aug. 21,1991.)

More specific to the topic at hand, the report went on to say: "Some 60 percent of the respondents had suffered service outages — typically four in the past year — that affected all channels and usually lasted less than half a day. One-tenth of those who had such problems said that the most recent blackout had gone on for two days or longer."

Obviously, service interruptions are probably not the sole reason the *Consumer Reports* questionnaire found satisfaction with cable service so low. But again, since most cable customers list outages so high on the negative list, it would be prudent for cable operators to consider the outage problem to be a major factor contributing to subscriber dissatisfaction.

Figure 2: Outages and changing companies



"Outages are a major (if not the major) customer satisfaction issue."

Definition of an outage

Philosophically, the definition of an outage should be derived from the customer's point of view. Customers are the ones affected by an outage. They are the ones angered by the outages. Writing an outage definition from anything but the customers' point of view is ignoring the fact that they are the ultimate drivers of revenue.

Traditional definitions often include only some of the causes of outages, legislating away others that affect the customer. For example, outages resulting from weather problems or equipment failure may be counted, but interruptions caused by preventive maintenance, sweep, signal leakage programs, construction or delays in repair might be excluded (even though all these are seen by the customer as interruptions).

Also, outages are sometimes defined as events affecting large numbers of cable users, thus omitting interruptions at the tap level. While an outage definition that facilitates leveraged solutions is desirable, problems that affect two to 10 customers at a time certainly represent leveraged opportunities. Also, it is common to omit single-channel outages from consideration. However, recent research (which will be discussed later in this article) conducted by Viacom demonstrates that losing one channel has the same basic impact as complete loss of reception.

The aforementioned subcommittee was charged with the duty of pinning down a definition for "outage." Different cable companies have not had a definitive consensus on a definition. For example, the Warner Cable corporate operating standard (dated September 1990) defines an outage as "a total loss of pictures on one or more channels to at least four customers that are fed by common cable plant." As of June 1, 1990, Adelphia Cable defined it in part as "any failure, excluding individual service drops, which results in the loss of one or more signals."

As is apparent, some definitions are narrower than others. Some pin down exactly how many subscribers must be affected in order for a service interruption to be considered an outage, while others do not. This subcommittee therefore took on the task of developing a definition of an outage that could be agreed upon among CableLabs members. This membership includes 22 of the top 25 MSOs and covers 85 percent of U.S. cable subscribers and 45 percent of cable subscribers in Canada.

With all the previous information in mind, the following outage definition is offered: *"An outage is defined as any event in which two or more customers experience loss of reception on one or more channels arising from a common cause, regardless of the cause. Loss is defined as an interruption rather than degradation of signal. Loss of a single channel at the headend or hub site is included."*

This definition focuses on loss rather than degradation of picture and adopts the customer's point of view, so that any event the viewer would see as an interruption is counted. Sin-

(Continued on page 80)

Video dialtone brings telcos into the video game

By George Lawton

On July 16, the Federal Communications Commission rewrote the rules of the video game by allowing the telephone companies a greater role in the delivery of video services to their customers. The FCC unanimously agreed to a "video dialtone" (VDT) policy that is intended to bring the local exchange carriers (LECs) into head-to-head competition with cable companies. Some portions of the policy go into effect immediately, while others are only recommendations to Congress, which may or may not be approved.

However, the telcos must still overcome tough legal and technological hurdles before offering VDT as a commercially viable service on any large scale. "Video dialtone services will not appear before the year 2000," predicted Peter Hampton, an industry analyst with Boston-based The Yankee Group.

Hampton pointed out that the real question is, "Where has the line between telephone and cable companies been redrawn?" Each one is trying to expand its market by opening up new services to the home, and video is seen as the foundation for a new generation of interactive information services.

Sensing the enormous profit potential, the LECs are hungry to get into the information services game. In a report released to Congress last June, the Regional Bell Operating Companies (RBOCs) asserted that if they are allowed into the information services business, they will lead a $110 billion eco-

(Continued on page 86)

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Reader Service Number 26

Designing with interdiction — Part 2

Part 1 of this article ran in the November 1992 issue of "Communications Technology."

By Mark Bowers
President, CableSoft Engineering Services

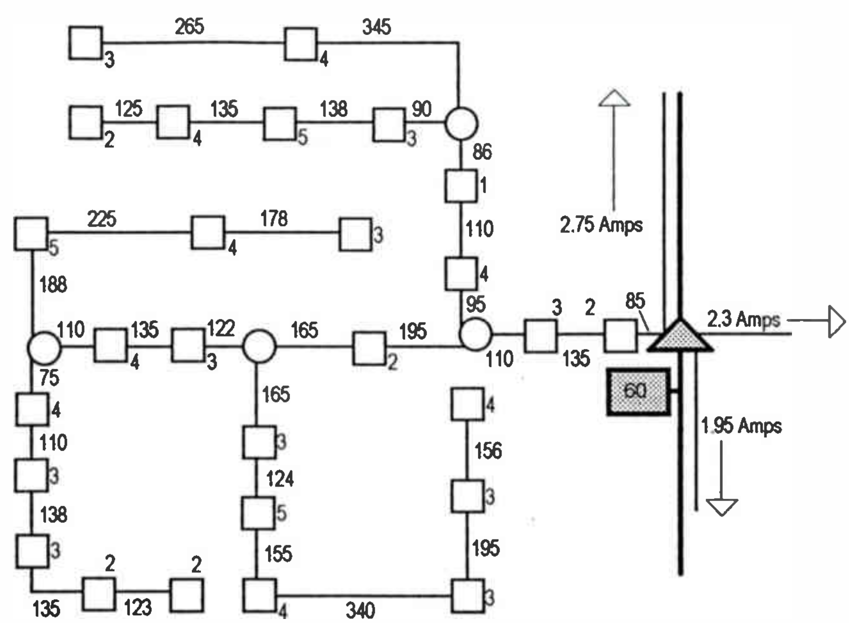
Let's begin the second part of this article by examining several rather simple designs and comparing interdiction design with the more conventional multitap layout. Figure 1 illustrates a potential area to be designed with either interdiction or multitap technology. It represents a subdivision that will be fed directly from a feeder leg at a bridger location. All feeder cables employed in this subdivision design are .625" size, third-generation type, with trunk at .875".

Figure 2 shows the same subdivision designed at 450 MHz with typical 4-port addressable interdiction units. Values shown on the tap are equivalent values as discussed earlier. (See Table 2 for associated *internal* directional coupler values.) The sample design involves 0.9 miles of feeder with five line extenders needed to feed the area, and 450 MHz cable and passive losses are used with levels appropriate for the bandwidth. Other items of note are:

- Four-port taps only were used in the interdiction design, because most manufacturers offer a fairly narrow window of choices in tap configuration. The subdivision contains 88 homes to be passed, and this design with 4-port only units created 120 total tap ports — yielding a tap port efficiency usage of 73 percent. One backfeed was necessary because of a lack of 2-port units. I assume this to have fairly minimal cost impact for the overall design (more on this later).
- Technically, the design in Figure 2 should have been accomplished by choosing appropriate directional coupler and equalizer values. For simplicity sake in this article, tap equivalent values were utilized. If you are gearing up for a large interdiction design, you'll want to ensure that your design software can accommodate the new calculations required in the interdiction process. The manufacturer's equations (or levels tables) for appropriate coupler/equalizer choice will need to be incorporated in the design processes.
- One particular manufacturer's units were chosen for this design. Obviously, designing with another brand would change our results — perhaps significantly. The gain (coupler leg through subscriber loop) incorporated in the interdiction unit(s) selected has a great deal to do with overall design efficiencies and results. Where more gain is employed, more efficient designs as compared to multitaps are realized.

Figure 1

Trunk cable is .875"; .625" feeder
Power supply loading does not include section to be designed



"Interdiction technology represents an exciting new choice in signal security and addressable control of the signals entering subscribers' homes."

Figure 3 now illustrates the same 450 MHz design with 450 MHz multitaps rather than interdiction units. As can be seen from comparing the number of actives required and tap values, the RF design does not deviate significantly between

(Continued on page 89)

Reader Service Number 27

FCC-required measurements: Coherent disturbances, terminal isolation and leakage

The following is the third in a four-part series of articles that began in October on Federal Communications Commission-required measurements for cable TV.

By Jeff Noah
Technical Writer, Tektronix Inc.

Coherent disturbances measurements — composite second order (CSO), composite triple beat (CTB) and intermodulation products or cross-modulation — cause as much grief for cable operators as any other kind of measurement. There's never a good time for taking a channel off the air, and that's exactly what the FCC requires for making coherent disturbance measurements. To minimize loss of program time, these measurements must be performed by a properly equipped, alert and well-coordinated crew at both the headend and subscriber tap. Fortunately, test equipment manufacturers anticipated cable operators' needs some months ago and already are providing automated solutions that simplify the tests now required by the FCC.

Which channels to measure?

Before running out with your tunable bandpass filter and spectrum analyzer to make measurements, you must first decide which channels you should measure. Several factors should influence your decision.

• *Channels with low carrier level.* Keeping in mind that the coherent disturbance measurements are made relative to the visual carrier, a low carrier level could produce a potential trouble spot. Since beat products result from combinations of other stronger carriers in the system, beat strengths near any given carrier are not affected by the amplitude of that carrier. Checking system response with a spectrum analyzer, sweep system or a signal level meter (SLM) can show you any areas where carrier amplitudes are lower. And if you perform the required visual signal level measurements first, you'll already have this information on hand. High-frequency roll-off is one example of a response degradation that could create problems.

• *Channels with known or suspected beat problems.* Another consideration — perhaps the most important when selecting channels — is to focus on channels you know or suspect to have beat problems. Subscriber complaints and earlier measurement data are two sources of information you can put to good use. If you don't have information from either source, take a good hard look at each of your channels. Channels with a grainy appearance might be suffering from CTB. CSO can cause a number of horizontal ripples across the screen. Cross-modulation superimposes a faint image from another channel onto the channel you're viewing.

• *High and low channels for CSO, middle channels for CTB.* The natures of CTB and CSO give some indication as to where they might be at their worst. CSO tends to be more pronounced at the upper and lower frequencies, while CTB is typically stronger in middle frequencies. (See accompanying table.)

To keep all this in perspective, remember that even though the FCC regulations specify that operators are responsible for ensuring all channels meet performance requirements, you need to provide proof-of-performance on only four channels (plus one additional channel for every 100 MHz upper frequency limit above 100 MHz). If you can get the most likely offenders to pass the test, you can have reasonable — though not total — assurance that all channels will pass an audit.

Signal connections

To clarify the techniques for greatly simplifying these measurements, this column focuses on the use of one currently available spectrum analyzer, the Tektronix 2714.

Before using any piece of test equipment as sophisticated as a spectrum analyzer, be sure to run it through its internal calibration procedure. This will help you get the best accuracy possible from your test gear.

Another factor that greatly affects measurement accuracy is the RF power level of your system. Most analyzers produce their own internal beat products if driven with too much power. To prevent this, simply connect a bandpass filter for the channel you wish to measure between the subscriber terminal and the spectrum analyzer.

The bandpass filter reduces the overall power level to the analyzer and eliminates this problem. Figures 2-3 and 2-4 in the 2714 operator's manual can help you decide if you need to use a bandpass filter. Since most cable systems are 75 Ω, and the 2714 has a 75 Ω input impedance, you can connect the cable TV signal directly to the analyzer. If a bandpass filter is needed, connect it between the subscriber terminal and the analyzer. If an impedance matching pad is necessary, insert it between the connections with the impedance mismatch. The coherent disturbance measurement is relative to the visual carrier level, so there is no need to make power conversion calculations to compensate for the pad.

Measuring CTB/CSO

CTB and CSO beats typically fall into five frequency bands. Beats from CTB occur at or near the carrier frequency for non-coherent cable systems. For coherent systems, they occur at the carrier frequency. For non-coherent and IRC coherent systems, CSO beats are typically found near or at ±0.75 MHz and ±1.25 MHz from the visual carrier. CSO is coincident with the visual carrier on HRC coherent systems.

The 2714 has a setup table with five user-definable entries for beat frequencies. Entries can be made as absolute frequencies or as frequencies relative to the visual carrier. For measuring coherent disturbances on multiple channels, you'll typically want to set these values to 0 Hz, +.75 MHz, +1.25 MHz, -.750 MHz and -1.25 MHz.

Select the first channel to be measured by using the 2714's front panel keypad. Then press the CATV/APPL key and select Item 5 (CTB/CSO) from page 2 of the menu. The CTB/CSO Setup menu (Item 6 of the CTB/CSO menu) presents the four modes in which the measurement can be run. CTB/CSO Setup also is the point where you enter the beat frequencies already discussed.

Of the four modes available, Interactive and Automatic with Pause are the best suited for making coherent disturbance measurements for FCC regulation purposes. Starting the measurement in Interactive mode configures the instrument as necessary, measures the visual carrier, prompts you to move the marker to the first beat to be measured, and then pauses the instrument.

When the instrument pauses, you can let the headend know you're ready for them to shut down the carrier for the channel being measured. Once the carrier is down, you can use the marker to search for distortions at any point in the channel. This mode is very helpful if you know (or suspect) a spurious, coherent signal from within the headend is somehow making it out to the field. The Interactive mode also lets you switch to an analog display to make it easier to find beats. Since switching is a popular option, it's included in the CTB/CSO Setup menu. Pressing "W" on the keypad causes the analyzer to measure the beat at the cursor position.

While measuring the beats, the 2714 uses the National Cable Television Association default settings of 50 kHz/div. span, 30 kHz resolution bandwidth and a 10 Hz video filter. In non-coherent systems the beats are spread out around the nominal beat frequency. The 30 kHz resolution bandwidth is adequate to measure nearly all the individual beats in the vicinity. Also, the 2714 searches ±50 kHz around the beat frequencies entered in the beat table for the maximum amplitude beat and makes the measurement at that frequency. Since interaction between beats causes changes in beat amplitude over time, the automatic selection of a 10 Hz video filter provides 100 milliseconds of averaging to reduce the effect of instantaneous variations in beat amplitude. (Remember the time-averaged requirement in §76.605(a)(8)(i) and (ii) of the regulations?)

Channels with maximum number of beats

	System size (No. of channels)				
	12	21	35	52	60
Channels	10	18-22	11	28,29	32,33
No. of triple beats	19	85	350	866	1,184

On a 77-channel system, there are 60 double beats at 54 MHz and 29 at 548.5 MHz. Those at 54 MHz are larger, but those at 548.5 MHz are visually more important.

Automatic with Pause mode measures the visual carrier and then prompts you to turn off the carrier. After the carrier is shut off, pressing "W" signals the analyzer to measure beats at the frequencies you entered in the CTB/CSO Setup menu. Each beat measured is recorded in the analyzer's non-volatile memory and can be recalled if needed. After the last beat is measured, the 2714 displays a readout of the largest distortion it encountered.

The last distortion type you must measure to satisfy the coherent disturbances requirement is intermodulation products, also known as cross-modulation. While cross-modulation testing doesn't require you to turn off the carrier while making the measurement, you must turn off the modulation for that channel after measuring the modulated visual carrier.

The 2714's Cross-Modulation measurement routine, like the CTB/CSO measurement, first measures the amplitude of the modulated visual carrier for the channel of interest. It then prompts you to shut off only the modulation, not the carrier, for that channel. Once modulation is shut off, pressing "W" continues the measurement. The 2714 then centers the carrier, enables zero span, adjusts the position of the carrier, and acquires the digital data with a 100 µs/division sweep. The raw digital data undergoes some processing prior to the application of a Fast Fourier transform (FFT). From the FFT, the 2714 extracts the 15.75 kHz component of the carrier. Using the 15.75 kHz component amplitude and modulated visual carrier amplitude, the analyzer calculates and displays intermodulation distortion in decibels.

Coherent disturbances in non-coherent cable systems must be kept at least 51 dB down from the visual carrier. Since frequency-coincident coherent disturbances have less effect on the picture in coherent systems, the FCC allows a more lenient margin of 47 dB for coherent systems (e.g., HRC).

Once you've repeated the CTB/CSO and cross-modulation measurements for a particular channel, record the worst disturbance and move on to the next channel. The 2714 can help in this process, too. Its interface lets you build a custom measurement sequence where you can store the channels to measure, the measurement(s) to make on particular channels, and the measurement mode (Interactive or Auto with Pause, for example). The analyzer's measurement sequence can store all data for easy report-generation at the end of your testing.

Terminal Isolation

The FCC's requirements on terminal isolation fall at the opposite end of the test difficulty spectrum from the coherent disturbance measurements. In most cases, fulfilling the requirements for terminal isolation will be as simple as tucking a data sheet from the manufacturer of your subscriber taps into a file along with your other proof-of-performance records — if the manufacturer has verified the spec (18 dB isolation) on a sample of 300 or more taps. If not, you can satisfy the regs by performing the test yourself on a sample of 300 units or by hiring an independent lab to do the testing for you. The desired effect of the 18 dB isolation spec is to ensure that a short or open circuit at the subscriber terminal causes no visible reflections at any other subscriber terminal.

Leakage

The subject of cumulative leakage index (CLI) has been well-covered by

(Continued on page 92)

A comparison of HDTV (left) and NTSC pictures.

HDTV Today

(Continued from page 21)

vanced Television Evaluation Laboratories in Canada will follow very soon. The full test report on the first digital system tested (GI's DigiCipher) has been published. The last report from the tests centers is expected to be published before Christmas. Richard Wiley, chairman of the advisory committee, appointed a special panel to deliberate the findings of the tests and determine a recommendation to be presented to the full advisory committee for approval. The special panel is scheduled to meet the week of Feb. 8-12, 1993. The full advisory committee is scheduled to meet on Feb. 24, 1993.

There are still some unresolved issues, however. Systems that were tested early may have incorporated revisions to their systems that would improve performance in one area or another. They might be considered as disadvantaged when compared to systems tested later unless these changes are considered. A group was formed to evaluate proponent claims. Proponents had to submit a written description of those changes by Nov. 2, 1992. Proper evaluation might require supplementary tests.

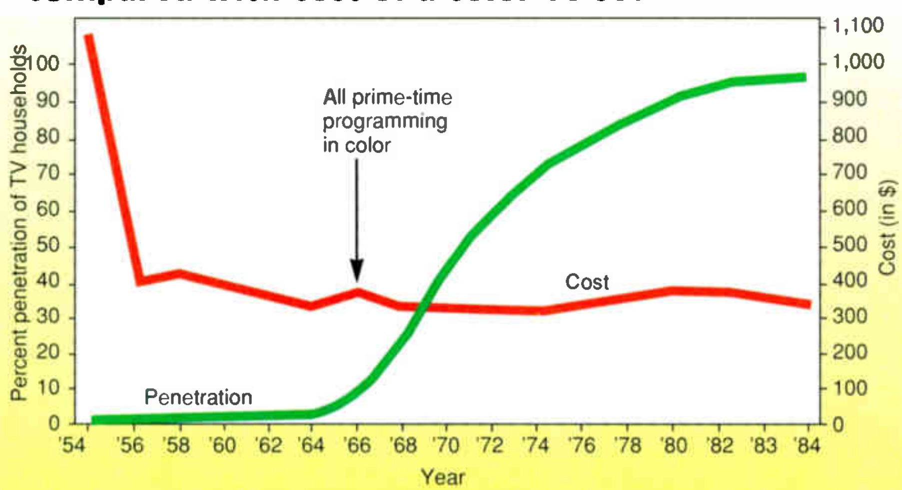
Will the proposed systems work in the terrestrial broadcast application? Some suggest even today that they will not. In a recent *HD World Review* article[1] Wiley said, "From a technical standpoint, the question of whether any of the systems being tested will prove to be sufficiently developed to serve as the basis for a new broadcast standard can only be determined when all the tests and evaluations are completed." This would include field testing that follows the system selection.

The computer industry has been anxious to have its concerns addressed in the specifics of the system implementation. It wants square pixels and data formats that include headers and descriptors embedded in the data stream to identify services, etc. Will these issues require some additional work?

The introduction of HDTV

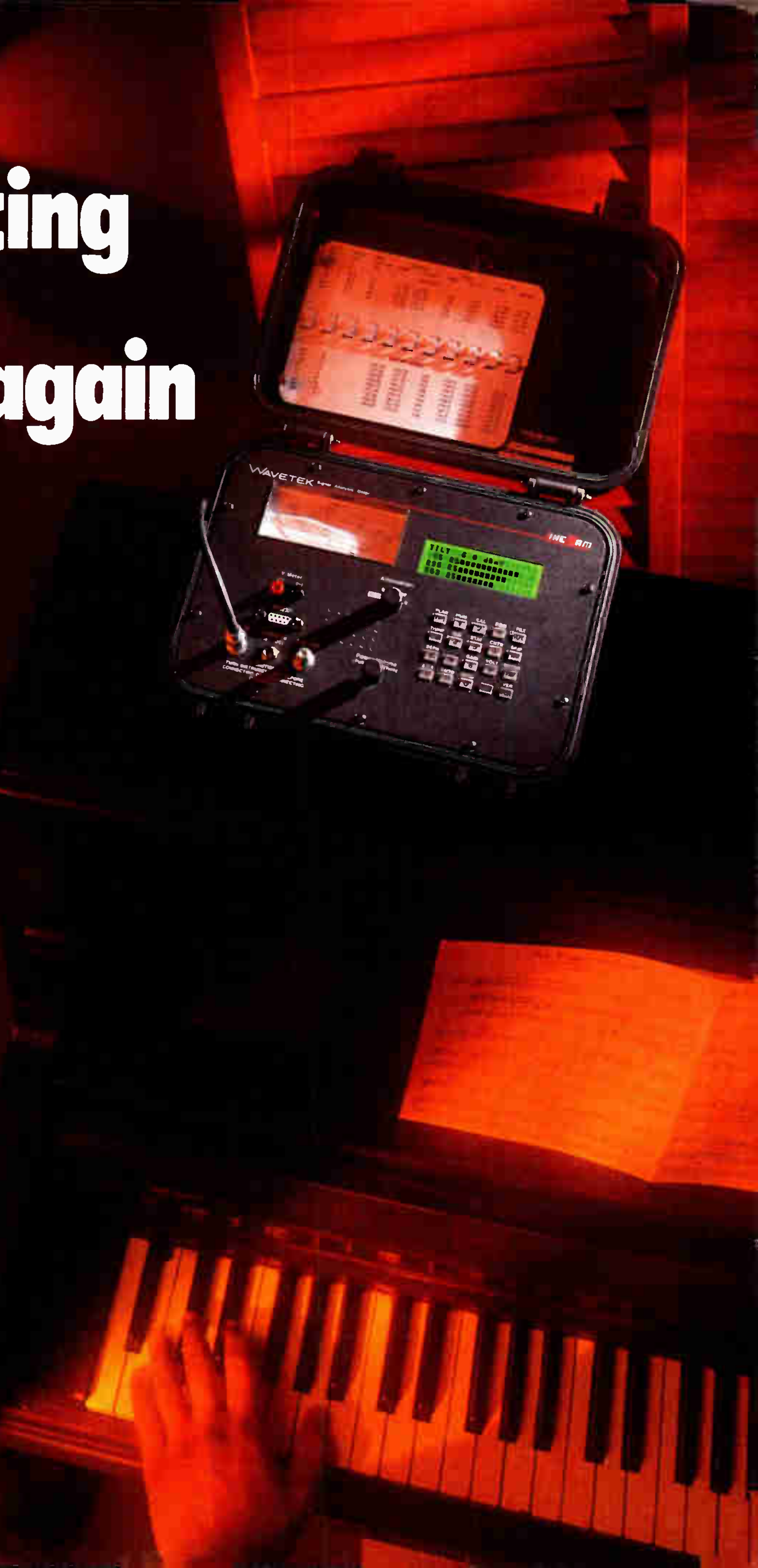
All of these issues will be resolved soon. The question is: "Then what?" How will HDTV be introduced? Will it indeed succeed? What groups will bear the cost and what groups will reap some profit? How rapidly will this happen? Some insight may be gained by reviewing history. The graph in the accompanying figure is based on one presented by Joseph Flaherty, senior vice president of CBS.[2] The penetration of color TV sets did not occur when the price of sets dropped. Penetration started its increase when all prime-time programming was in color. We can reasonably expect the same to be true of HDTV sets. Consumers will not buy new HDTV sets in any great number until they have a significant amount of programming available.

Color TV set penetration compared with cost of a color TV set



A lot of material suitable for HDTV exists today in the form of film. A large investment is required by networks and broadcast stations to bring this to broadcast TV. We cannot predict how rapidly the broadcasters will convert stations, but it will require several years at least. Broadcasters have requested more flexibility in the use of any new channel granted for HDTV. In fact, they have suggested using the channel for multichannel digital TV. This raises several issues. Will broadcast TV be permitted to launch a totally new service unrelated to HDTV using the additional spectrum allocation proposed? Land mobile would presumably take a dim view of that. It also is not clear how this serves the public interest. It is not efficient use of

Introducing the first play-it-again SAM.



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the limited broadcast spectrum. Multiplexing four local broadcast stations onto one channel would be efficient use. Bringing HDTV to the consumer without additional spectrum also would seem to be efficient use.

The cable operator also will have to deal with HDTV. Right now the focus is on multichannel digital. This will fit well with HDTV however. In fact, the broadcasters' request to use multichannel highlights that point. Once a digitally modulated channel and control system is established, it is no great leap to carry one HDTV channel or several NTSC-type channels. The infrastructure will be established in cable as multichannel digital is deployed. HDTV carriage will require digital deployment all the way through the system to the home, of course. Investments will be significant but should be spread over time as the market evolves. There also is reason to expect some commonality between the compression algorithms used for both applications.

"How will HDTV be introduced? Will it indeed succeed? What groups will bear the cost and what groups will reap some profit?"

Today's technology

Several video compression terms mentioned earlier are briefly described here. Predictive coding exploits the fact that one picture is pretty much like the next in television. That is, most things don't move far in 1/60th of a second. Almost everything in one picture is in the next.

Motion compensation then addresses those movements that do occur. The image of a thrown ball in one picture can be found in the next at a slightly different location. Motion compensated prediction matches up the pieces of one picture with another by moving around the pieces. Of course, one picture cannot be used to create another perfectly. If the predicted image is subtracted from the actual image, a difference or residual is left. This residual image is then transformed using DCT. This transforms the residual from the spatial domain to the frequency domain. The DCT process collects information from different parts of the image into frequency elements. Many of these elements may be zero or nearly so and can be thrown away with little loss of important information. It would be much more difficult to find actual spatial elements that could be eliminated.

It needs to be recognized that prediction need not be forward in time but can be backwards. In any picture, objects may be revealed as another object moves while other objects can be occluded by the same moving object. An object that suddenly appears in an image in this way can be predicted from a successive picture in which the image exists. One also can imagine interpolating between images as well. All of these techniques are used in the various HDTV systems (and the multichannel systems).

Standards

Standards for compression have been developing as HDTV and multichannel systems have been worked on. Motion-compensated predictive coding of images has been around for about two decades and DCT for five to 10 years. They are mature techniques suitable for standardization. This process is well-underway in the joint International Standards Organization/Motion Picture Experts Group (ISO/MPEG) standards activity. All the techniques discussed are a part of the MPEG standard. In fact, this standard is specifically employed by ATRC's (the Advanced Television Research Consortium) HDTV system.

The MPEG activity addresses both video and audio coding and includes testing of techniques proposed. The standard is for movies and full-motion video. A syntax that allows efficient and flexible transmission of the coded information also is a part of the standard. Low cost, flexibility to accommodate different applications, and future growth to handle technological advances are key considerations. The schedule for the Video Coding Committee of MPEG was to have a first draft of frozen (changes permitted only to correct technical error) specification by November 1992 and final draft by March 1993. This offers a unique opportunity to achieve a digital video standard that will eliminate the technical, operational and cost problems that have resulted from multiple analog TV standards such as PAL, NTSC and SECAM. A standard that provides interoperability with recorded media also is of great importance.

The MPEG standard is likely to become a subject of increasing discussion in HDTV (and in multichannel digital) in the next several months. In fact, it would seem foolish and risky for anyone launching a digital video compression service not to consider the MPEG standard.

There is a consensus on QPSK modulation for the satellite signal, both in HDTV and multichannel. As was mentioned before, several techniques have been proposed for the terrestrial broadcast signal. The FCC HDTV process will undoubtedly select a modulation format for the terrestrial signal. CableLabs also is evaluating modulation alternatives for cable. This work should establish the modulation interoperability guidelines for cable.

Conclusion

The HDTV landscape has changed dramatically over the last five years. The proposals expanded from a single analog system from NHK (MUSE) to 14 or so systems and then later shifted to five systems. These five include a modified Narrow-MUSE analog system and four digital systems. There is much commonality between the current proposals. The same fundamental coding techniques underlie all of them. These same techniques form the base of the ISO/MPEG international standard that is near completion. A recommendation from the FCC's ACATS is expected early in 1993, which will be followed by field trials.

The road to implement broadcast HDTV is not clear. We know that significant HDTV program availability is required for successful penetration of consumer electronics. Cable is preparing the way for HDTV as it deploys multichannel digital. Clearly, HDTV and multichannel digital TV are closely related in many ways. It is expected that emerging standards cannot be ignored in either application. **CT**

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[1]Richard E. Wiley, "HDTV: The FCC's Advisory Committee Perspective," *HD World Review*, Volume 3, Numbers 1 and 2, pages 5-7, 1992.

[2]Joseph A. Flaherty, "HDTV Service in the United States: Commonalities and Contrasts," *HD World Review*, Volume 3, Numbers 1 and 2, pages 8-15, 1992.

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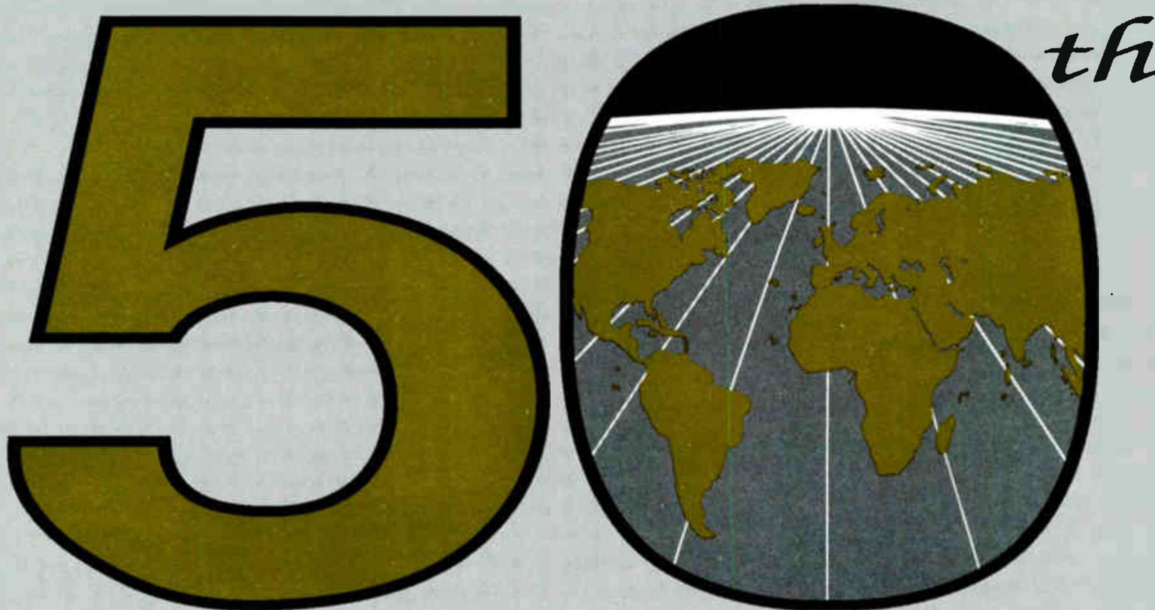

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Reader Service Number 29

Digital HDTV

(Continued from page 22)

the SP 32-QAM carrier.

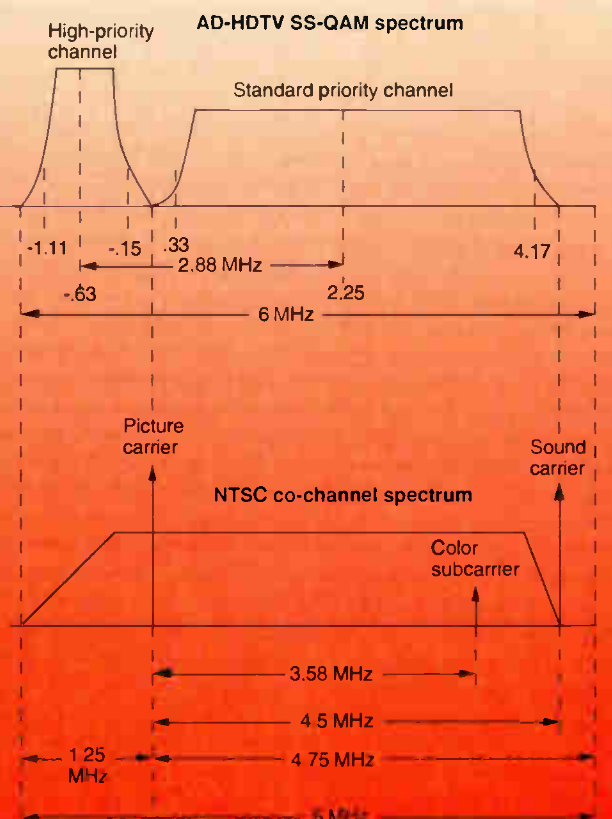
In video encoding, a priority encoding scheme is employed for generating the HP and SP data. The overall goal of the priority encoder is to maintain a "viewable" picture from the HP data only. The MPEG video compression is based on the discrete cosine transform (DCT) motion-compensated predictive coding algorithms. In general, the video bit stream is assigned to the HP and SP data carriers in an adaptive manner using the buffer rate control information. However, to aid the receiver in case of a transmission errors, important video information is always assigned to the HP data.

In addition to video data, two stereo pairs of audio channels of 256 kb/s each are provided. The audio compression is based on the MPEG MUSICAM (Masking-pattern-adapted Universal Subband Integrated Coding And Multiplexing) algorithm. An additional auxiliary data channel of 256 kb/s also is provided. Audio always is transported on the HP carrier and auxiliary data is assigned to the SP carrier.

The video, audio and auxiliary data are arranged in a cell-like packet structure where each packet or cell is 148 bytes long. One byte is used for the block sync, 20 bytes are used for error protection, and the remaining 127 bytes are protected data.

Concatenated Reed-Solomon block code (148,127) and set-partitioned modulation coding add channel error

Figure 8: AD-HDTV SS-QAM spectrum and its relationship to an NTSC co-channel spectrum



correction capability to the system where video, audio and data are protected. Reed-Solomon block coding is applied on a cell-by-cell basis. After Reed-Solomon coding, a byte-interleaver is used over multiple cells to protect against long burst errors. More error protection is provided by a rate 0.9 set-partitioned block code at the modulation level. The effect of the set-partitioned encoder is to reduce the carrier-to-noise ratio threshold by increasing the effective minimum distance of the decoded constellation points.

Baseband adaptive channel equalization (±4 µs range) is provided by the AD-HDTV system using a complex 64-tap finite impulse response (FIR) filter at the receiver. Filter coefficients are dynamically adjusted using the least-mean squares (LMS) algorithm. To ensure fast equalization, equalizer coefficients are stored and reloaded during channel changes.

The AD-HDTV system modulated frequency spectrum is shown in Figure 8. A null is shown in the spectrum that separates the HP and SP channels. The null falls at the NTSC picture carrier and therefore provides protection against a strong co-channel NTSC interfering signal. In addition, the frequency spectrum of the HP channel is situated to the left of the NTSC picture carrier and thereby reduces co-channel interference at the receiver, since this region of the NTSC spectrum falls within the Nyquist slope of the receiver's vestigial sideband (VSB) filter.

An optional 16-QAM SS-QAM mode has been added to the AD-HDTV system and the receiver will automatically adapt to this mode. 16-QAM is more robust to transmission impairments and hence has larger coverage area. However, the total data rate that can be achieved for this mode is reduced to 19.2 Mb/s. This lowers the overall video quality compared with the 32-QAM mode of operation with a 24 Mb/s rate.

AT&T/Zenith DSC-HDTV system

The AT&T/Zenith DSC-HDTV system is a 787.5-line progressive system that uses motion-compensated DCT and leaky predictive coding for video compression, Dolby AC-2 for audio compression and 2/4 level VSB modulation for the digital modulation. A total of 21 Mb/s data are transmitted using a 6 MHz TV channel.

The bi-rate transmission scheme automatically assigns important data to the two-level (i.e., W1 data) 2-VSB and less important data to the four-level (i.e., W2 data) 4-VSB scheme. The choice is based on the fact that the 2-VSB transmission is more robust than the 4-VSB and hence it carries the most important data. In general, video data is adaptively assigned as W1 or W2 data depending on the state of the forward buffer analyzer in the video compression encoder. The main stereo audio channels and the first ancillary data (i.e., 30.21 kb/s) channel are assigned as W1 data. Video control, data segment sync and data field sync are always assigned to W1 data to ensure proper receiver function at all areas of the transmission. The second stereo audio pair and the second ancillary data channel are carried by the W2 data.

An adaptive time domain channel equalizer consisting of an 80-tap feedforward and a 200-tap feedback section is provided. The equalizer uses the LMS algorithm for adjusting its coefficients and is aided by a training sequence for fast convergence. →

Reed-Solomon block code (167,147) for isolated errors and data interleaving for burst errors are provided. Data interleaving is done within each data segment (intrasegment interleaving) as well as between successive data segments (intersegment interleaving). Intrasegment interleaving is arranged such that every 12th symbol is always of the same data type (W1 or W2). The intersegment interleaver covers one-half of a data field (i.e., 130 data segments).

The DSC-HDTV system employs a comb filter (12-symbol delay, Class IV partial response) at the receiver to reject a strong co-channel NTSC interference signal by blocking its visual carrier, color subcarrier and audio subcarrier. This filter has seven nulls across the 6 MHz channel. In this arrangement, the visual carrier falls 7.86 kHz above the second null, the color subcarrier falls exactly at the sixth null and the audio carrier falls 23.6 kHz above the seventh null. The DSC-HDTV system spectrum fits in a 6 MHz TV channel as is shown in Figure 9 where it is compared with an NTSC spectrum. In addition, a small pilot carrier is used at the lower edge of the frequency spectrum to aid in the VSB demodulation at the receiver. Note that this carrier is placed at a frequency that is further away from the NTSC carrier and its interference into the NTSC receiver is minimized by the NTSC VSB filter.

GI DC-HDTV system

The GI DC-HDTV system is a two-field 1,050-line interlaced system using motion-compensated DCT and predictive coding for video compression, Dolby AC-2 audio compression and 32-QAM for digital modulation. The combined multiplexed data stream rate for 32-QAM is 24.39 Mb/s, which is well-contained within a 6 MHz channel bandwidth.

Figure 9: DSC-HDTV spectrum and its relationship to an NTSC co-channel spectrum

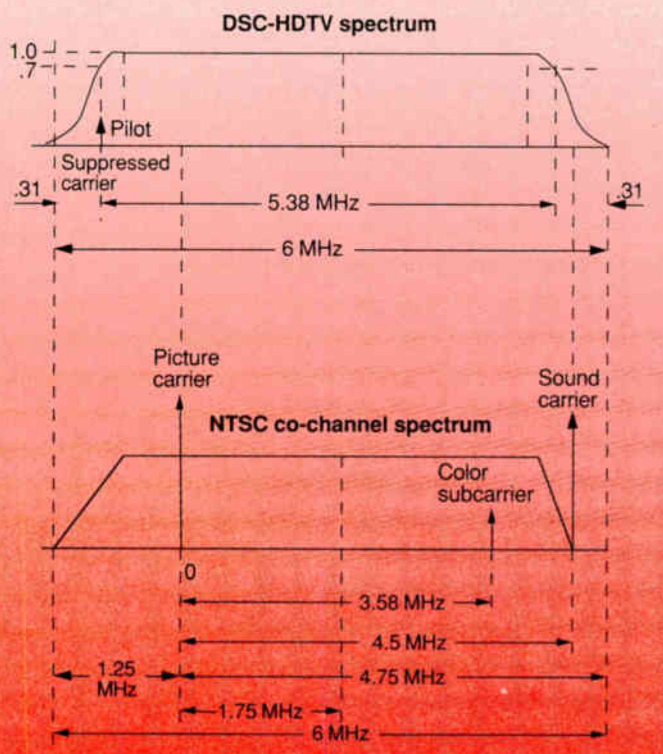
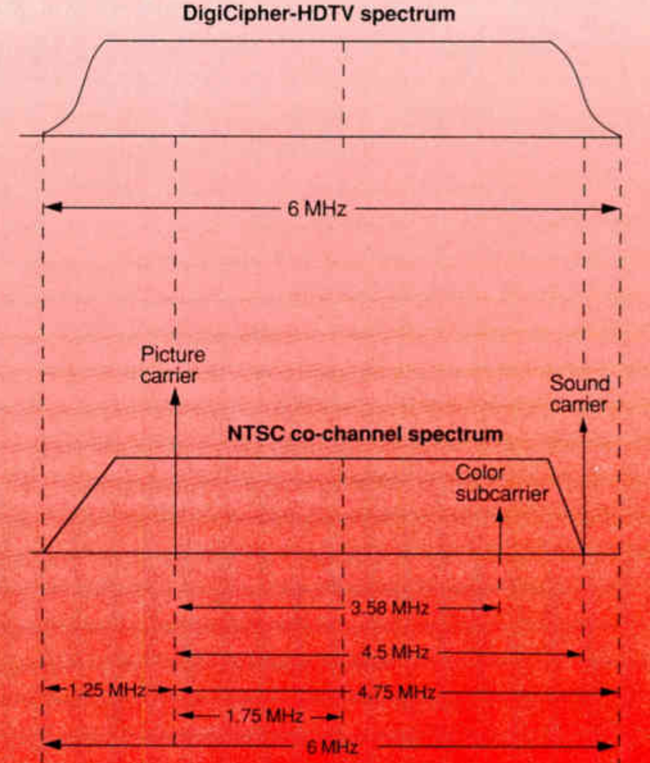


Figure 10: DigiCipher-HDTV spectrum and its relationship to an NTSC co-channel spectrum



The DC-HDTV system provides error detection and error correction using a concatenated trellis (4/5 rate) and Reed-Solomon block code (155,145) as well as data interleaving. The Reed-Solomon coding is followed by an interleaver that can handle burst errors and hence increases the depth of burst error correction.

Adaptive channel equalization is provided at input of the receiver by a complex 256-tap adaptive equalizer. The equalizer range is -2 to +24 µs for multiple echoes. This equalizer will provide overall flat frequency response and linear phase response required for zero ISI.

The GI DC-HDTV system does not explicitly address the problem of NTSC co-channel interference for two reasons. First, GI maintains that the NTSC co-channel interference problem will occur in a transitional period and eventually all NTSC stations will convert to HDTV program service. Also, since the HDTV signal's power requirement is considerably lower than the NTSC signal's for equivalent coverage, co-channel interference can be minimized by increasing the HDTV carrier power at the expense of increasing interference to NTSC receivers. Thus adding extra complexity to the encoder/decoder will not be justified. The overall spectrum of the system is contained in a 6 MHz channel bandwidth. Figure 10 shows the DigiCipher QAM spectrum and compares it with a typical NTSC co-channel spectrum. Notice that a strong NTSC co-channel interfering signal can be very destructive to the HDTV signal spectrum, especially around the picture carrier and color subcarrier.

A 16-QAM mode is provided as an option by the GI DC-HDTV system for more robust transmission. The total

Table 2: Performance of FCC proposed digital HDTV systems

HDTV systems	C/N (dB)	ATV C/I (dB)	NTSC C/I (dB)	Noise BW (MHz)	Visible thresholds
ATRC AD-HDTV	HP:	HP:	HP:		RS block error rates
	32-QAM = 11.1	32-QAM = 11.1	32-QAM = -6	0.96	10^{-3}
	or	or	or		
	16-QAM = 8.6	16-QAM = 8.6	16-QAM = -8	0.96	10^{-3}
	SP:	SP:	SP:		
	32-QAM = 16.1	32-QAM = 16.1	32-QAM = -2	3.84	10^{-3}
	or	or	or		
	16-QAM = 13.6	16-QAM = 13.6	16-QAM = -4	3.84	10^{-3}
AT&T/ Zenith DSC-HDTV					RS symbol error rates
	4-VSB = 16	4-VSB = 15	4-VSB = 0	6	5×10^{-3}
	2-VSB = 10	2-VSB = 10	2-VSB = -6	6	5×10^{-3}
GI DigiCipher					RS block error rates
	32-QAM = 16.5	32-QAM = 16.0	32-QAM = 7.0	5	10^{-6}
	16-QAM = 12.5	16-QAM = 12.0	16-QAM = 2.0	5	10^{-6}
MIT/GI DigiCipher					RS block error rates
	32-QAM = 15.7	32-QAM = 15.2	32-QAM = 6.0	6	10^{-6}
	16-QAM = 11.7	16-QAM = 11.2	16-QAM = 0.0	6	10^{-6}

data rate achieved by this mode is 19.51 Mb/s occupying 6 MHz of channel bandwidth. The decision to choose this mode is made at the transmitter side and the receiver will adapt to this mode automatically. A concatenated trellis (rate 4/3) with a (116,106) Reed-Solomon block code as well as data interleaving are also used for error protection.

MIT/GI CCDC-HDTV system

The MIT/GI CCDC-HDTV system is a 787.5-line progressive video format system. Aside from progressive mode and audio encoding, the CCDC-HDTV system is nearly identical to the original GI DC-HDTV system. However, there are some differences that must be noted. These include: a flexible input video specification for selecting variable image sizes, as well as 24-frame/second film mode, an overall higher data rate of 26.43 Mb/s for the 32-QAM primary mode and 21.15 Mb/s for an optional 16-QAM mode, and an extension to six audio channels of 755 kb/s.

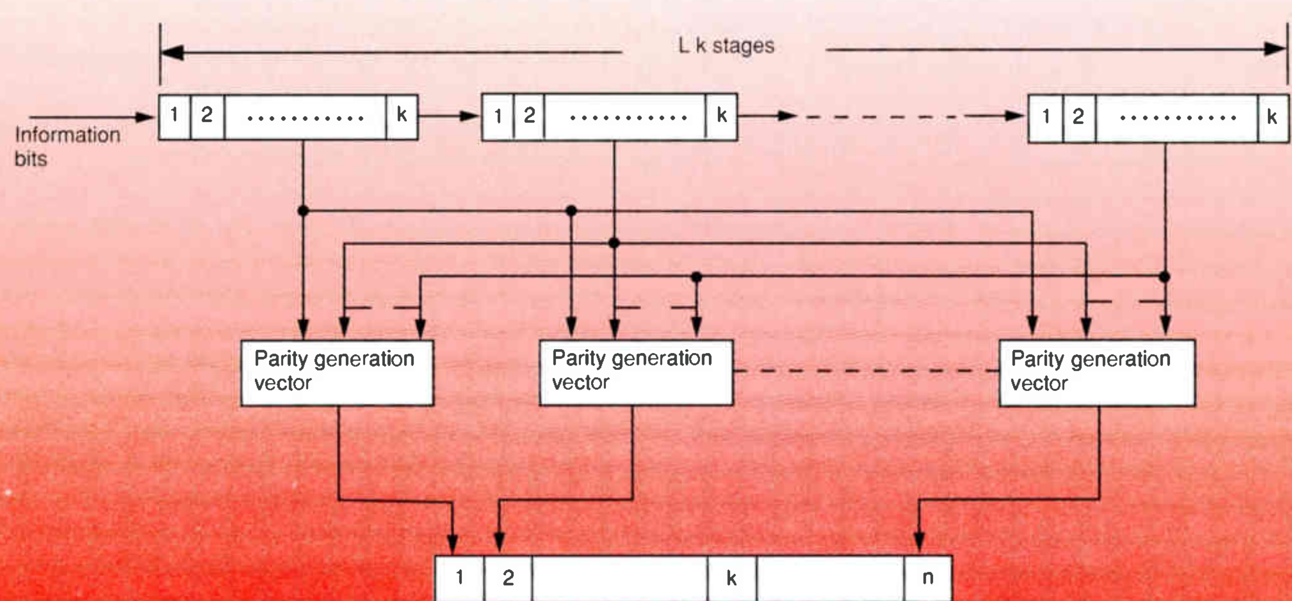
The CCDC-HDTV system employs the MIT Audio Coder (MIT-AC), which is based on adaptive transform coding and bit allocation techniques. The encoding process involves transform analysis, spectral envelope encoding and transform coefficients encoding. The spectral envelope information is used to dynamically allocate bits for encoding transform coefficients.

Conclusions

This article covered the important aspects of the proposed digital HDTV systems. Using these systems, digital transmission of HDTV signals is achieved in the standard 6 MHz of channel bandwidth. In particular, 16/32 QAM and 2/4-VSB are capable of transmitting up to 26 Mb/s of data through this channel. An additional feature of some digital HDTV systems is the provision for graceful signal degradation. Some HDTV systems provide some degree of graceful signal degradation by protecting the most important information from transmission errors at the expense of lower priority information. Table 1 on page 22 gives a summary of major capabilities of digital HDTV systems. In Table 2, a comparison of performance of these systems are noted. In this table, the threshold BER refers to visible video impairment thresholds claimed by each system proponent. **CT**

The author would like to thank C.K. Tanner and R.S. Prodan whose reviews and suggestions have significantly increased the value of this article.

In Part 1 (October '92) "Figure 3: Linear convolutional coding" was incorrect, it should have looked as it appears here.



Reader Service Number 33

Compression systems

(Continued from page 24)

racy as practical 10-bit A/D components become available. Minimum sampling frequencies are determined by the bandwidth of the sources and by practical implementation considerations. Complex waveforms such as composite NTSC and PAL are typically sampled at a rate locked to the color subcarrier (f_{sc}) at rates 3*f_{sc} or 4*f_{sc} to simplify composite signal reconstruction in the D/A. Both frequencies exceed the theoretical minimum sampling frequency of twice the highest frequency in the sampled system and represent an implementation compromise.

Component video sampling frequencies need not be concerned with subcarriers and can be more closely optimized for the application bandwidth. CCIR 601 specifies a basic sampling frequency of 13.5 MHz, permitting luminance (Y) signal bandwidths of approximately 6.75 MHz. The 13.5 MHz sampling rate also was chosen to permit 525-line and 625-line systems to have the same number of samples per video line, which is important for studio equipment commonality and ease of conversion. The accompanying table on the opposite page summarizes some of these parameters for comparison.

Some additional benefits of component coding are apparent from the table. Composite signals, which are combinations of the components luminance and chrominance (Y, U, V, etc.), exhibit a higher peak-to-average value because of the random statistics of combining the three waveforms. In order to accommodate this variation, the dynamic range of the A/D converter is typically restricted to 200 of the 255 available digital code words (assuming 8-bit coding). This results in a poorer signal-to-noise performance for the process, when compared to individual digitization of the component signals. This gain is of course not cost-free. Three conversions must be performed in parallel by dedicated or higher speed shared hardware.

An implication of the higher luminance bandwidth used in CCIR 601 is increased resolution in the overall picture. The digital active line of 720 pels (or pixels) in the CCIR 601 structure compares to an NTSC horizontal line of approximately 430 pels for a full 4.2 MHz luminance signal. This 71 percent improvement in visual resolution results in sharper pictures and larger practical screen sizes before lack of resolution becomes objectionable to the viewer. For comparison, also consider that many low-cost TV sets roll off the luminance at 3.3 MHz to avoid cross-color effects, limiting their horizontal resolution to approximately 352 pels. Further, popular home media formats — VHS at 2.2 MHz and 232 pels or S-VHS at 4.2 MHz and 430 pels — compete for the attention of the home video consumer. Of course, source and display resolution must improve to utilize this higher performance. Today's top-end TV monitors for the consumer market, capable of 600 lines or better horizontal resolution, are heading in that direction.

Color sampling structures

Analog standards such as NTSC, PAL and VHS provide lower bandwidth for the color information channels because of broadcast channel constraints and in recognition of the fact that human vision is far less sensitive to color differences than to luminance variation. Chrominance channels in these analog systems are typically 25 to 50 percent as wide as the luminance.

CCIR 601 also recognizes the reduced sensitivity to color information and adopted a high performance sampling structure know as 4:2:2. This nomenclature refers to the ratio of samples on each active line between the luminance channel (Y) and each of the chrominance channels (U and V). The sampling rate for the U and V channels is 6.75 MHz, resulting in 360 active color samples per active line for each. This results in one chrominance sample pair for two adjacent luminance samples on the active line. For completeness, the CCIR standard includes definitions for higher resolution, 4:4:4 sampling within its basic framework. Such a system may have application in computer-generated graphic images where each pixel is fully defined.

Compression of the digital image

Once it is in digital form, the image stream may be transmitted to a receiver and decoder or further processed. The bit rates listed in the table are feasible for transmission over today's real-world transmission systems but are not cost-competitive with 6 MHz AM-VSB in most applications. The bit streams must be reduced in bandwidth or compressed if the service is to be cost-effective. Data compression techniques applicable to random data sources can be applied to either the digitized composite signal or the digitized component signal. Such compression techniques typically replace long repeating patterns of like bits with digital code words that result in bit rate reduction, but typically on the order of a factor of 2 to 8. The target for a competitive technique is in the range of 2 to 6 Mbps for high quality video material, a compression range of 30 to 100:1.

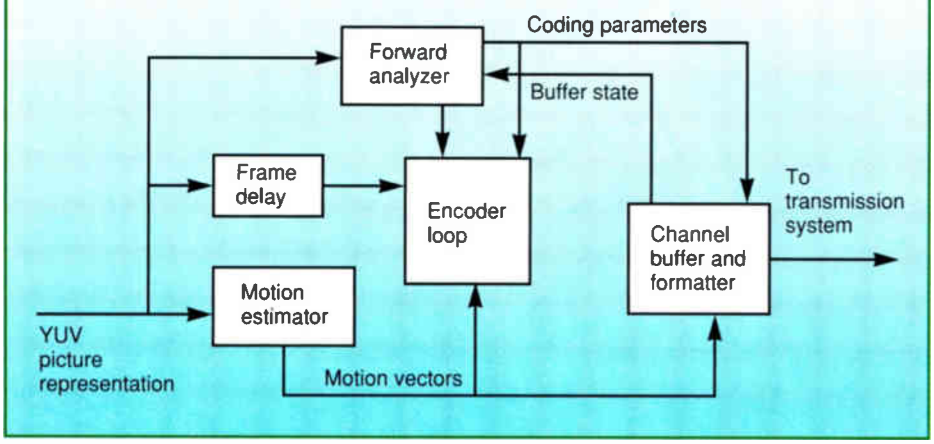
Compression systems capable of this level of bit rate reduction depend on several mathematical and video signal processing techniques. The algorithms require that a complete digital representation of each field or frame of the signal be available in the encoder memory. In order to build such a digital image, the pixels comprising the picture must be assembled in an ordered manner, both luminance and chrominance. Such an ordered representation is obtained from the component representation of the signal. Therefore, compression systems inherently require digital compo-

Candidate sampling structures for digital TV*

Signal source	Sampling rate	Luminance S/N	Luminance bandwidth	Horizontal resolution (max)	Uncompressed bit rate
Composite NTSC	$3{\cdot}f_{sc}$	53.5 dB	4.2 MHz	430 pels	86 Mbps
Composite NTSC	$4{\cdot}f_{sc}$	54.7 dB	4.2 MHz	430 pels	115 Mbps
Component	13.5 MHz (Y)	58 dB	6.75 MHz	720 pels	216 Mbps
CCIR 601	6.75 MHz (U,V)				

*Assumes 8-bit A/D precision

Typical video compression encoder



nent sampling structures, such as the CCIR 601 standard discussed previously.

A block diagram of a typical video compression encoder is found in the accompanying figure above. (The figure is taken from Arun Netravali's "A Comparison of Leading-Edge Compression Techniques," which appeared in the *1992 NCTA Technical Papers*.) The system uses discrete cosine transform (DCT) and motion-compensation/prediction techniques to minimize the amount of information (bits) that must be transmitted to the decoder. The encoder in the figure is a closed-loop signal processing system with internal feedback that adaptively codes images with their best possible representation within the available bit budget, as defined by the relative fill in the channel buffer. Short-term buffer fill variation is permitted to allow scenes requiring an above average bit allocation. However, the long-term average output rate must match the channel capacity allocated to the encoder.

While complex in implementation, the basic techniques used in the compression encoder are straightforward in concept. The digital picture is divided into blocks of pels called macroblocks (typically 16x16 pels in size). The DCT applied to each macroblock generates a mathematical representation of the image in a form similar to the Fourier transform used to describe complex time domain signals as a combination of sine waves of various frequencies and relative amplitudes. Algorithms are then used to determine which components of the transformed signal best represent the image based on the available transmission capacity or bit budget. The analogy to the Fourier transform world says that only the most significant frequency components of the complex waveform are transmitted. In general, the larger the bit budget, the more complete description of the image in the transform domain can be transmitted and the received, decoded image improved. The performance of the compression system is dominated by the encoder and specifically the algorithms (rules) used to determine which transform coefficients most accurately represent the transformed macroblock.

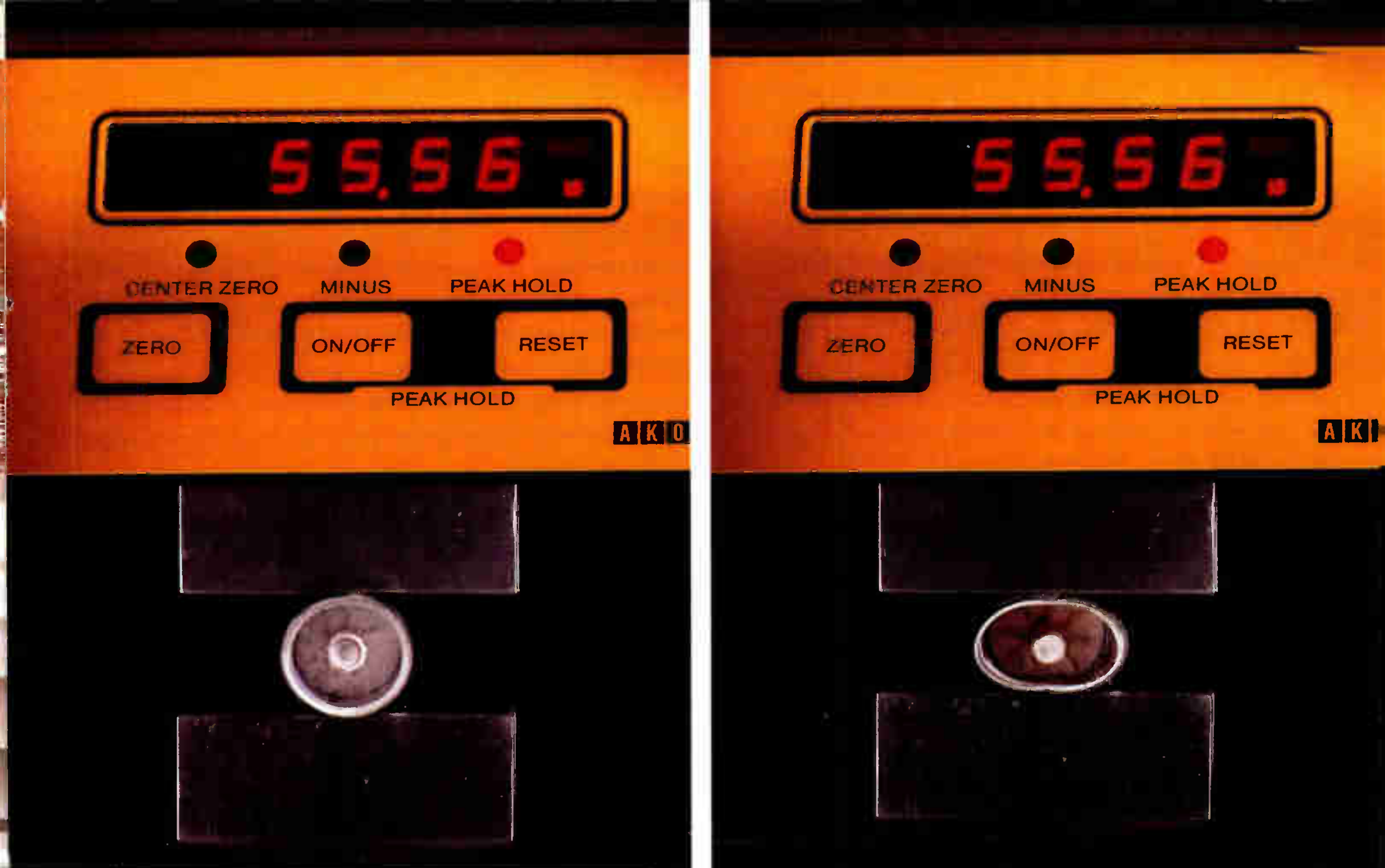
The performance of the encoder is maximized by reducing to a minimum the amount of new image information that must be coded with each new frame. Motion-compensation techniques are used to track objects as they move across the active picture area. Areas of the picture that do not change need not be exhaustively described with each new field or frame. Instead, stationary and moving macroblocks are described in terms of what they looked like last in the last picture, with only changes in exact location and relative detail change coded for transmission. Estimation errors and coding inaccuracies are multiplied in such a predictive system over several frames. To control such accumulation of error, the encoder keeps track of its coding decisions and compares the original image to a decoded version of the coded image. Regions of the image where differences in the actual and coded signal become relatively large are given more attention by the encoder.

Other techniques can be used to reduce the amount of data input to the encoder. Film source material, for example, changes at only a 24 frames per second rate, compared to 30 fps rate for video. Encoders can be designed to detect this reduced information content and more accurately code the 24 fps material. Video is restored at the decoder using 3:2 pull-down techniques. If bit budgets are extremely tight or source material is known to be of relatively low resolution, the encoder can subsample the digital signal before encoding. In terms of the CCIR 601 representation, a 2:1 subsampling (decimation) of the 720-pixel by 480-line frame will cut in half the volume of new picture information that must be coded each frame. Even further data reduction can be achieved with some loss in picture fidelity by subsampling the chrominance over vertical lines (vertical as well as horizontal subsampling). Such sampling structures are referred to as 4:2:0 structures, where color information is updated only every other line in the active picture.

The overall performance of the compression encoding process is largely subjective and must be evaluated with a wide variety of source material and on a wide variety of display monitors. Flexibility in the encoder implementation, largely through software-programmable subsampling and decision algorithms, and flexibility in the output data rate of the encoder makes it possible for the encoder operator (program provider) to tune the encoder for specific types of video under various channel constraints. This flexibility makes it possible to tune systems for specific types of service based on time of day, content or other service type constraints.

Summary

We have looked briefly at the representation of video signals in digital form. While several options exist, only component systems are ultimately practical for compression systems. Sampling structures based on CCIR 601, a production and transport standard well-documented and utilized in the industry, have been reviewed. Compression systems utilizing this basic framework will soon be deployed in CATV applications. Depending on allocated delivery channel capacities and source material quality, CATV systems will soon be capable of delivering significantly improved picture quality on multiple digital channels within each 6 MHz AM-VSB channel. **CT**



A simple compression test dramatically demonstrates Times Fiber TX cable's (left) superiority over a leading competitor

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Audio for HDTV

(Continued from page 27)

ATSC research

The ATSC (together with other organizations, including the FCC Advisory Committee on Advanced Television Service, the Electronic Industries Association, and the National Cable Television Association) recognized that much of the focus on ATV development and standardization has been in the development of vision signal encoding schemes and it is important that appropriate emphasis should be placed on defining the accompanying sound channels, the features of the ancillary data and control services, and the way in which they may best be included in the ATV transmission format.

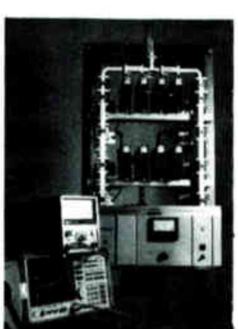
ATSC Specialist Group on Digital Services (T3/S3) conducted industry surveys and technical studies and has developed technical information and recommendations in relation to sound and ancillary data services. The specialist group set out to identify the range of ATV sound channel requirements and how they might be satisfied with recent rapid advances in the state-of-the art of digital audio coding. The group also sought to identify the range of desirable ancillary data services and to estimate the data capacity required for each.

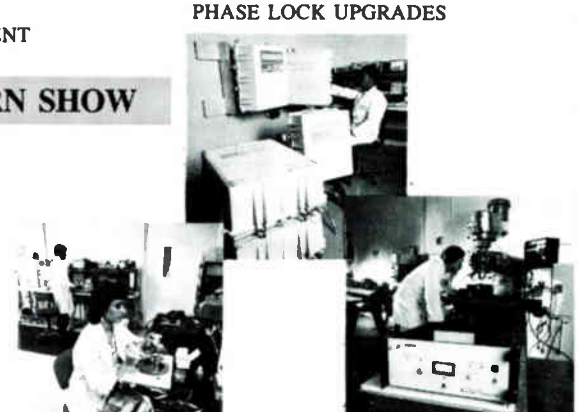
The goal of this work was to influence the characteristics of the digital services (other than video) that are to be provided by the ATV emission system selected for use for terrestrial broadcasting in the United States. (However, it was not ATSC's intention to affect the ATV testing program already in progress as part of the FCC selection process.) Specifically, it has been suggested that the final ATV system selected for terrestrial broadcasting, cable and other media follow the guidance provided by ATSC.

As a discussion vehicle, the ATSC specialist group prepared a "straw man" proposal for TV audio and data services for simulcast ATV systems. The straw man proposal suggested desirable program audio attributes and listed possible ancillary digital services, including some of those already in use with NTSC such as closed-captioning, and suggested that advantage should be taken of the opportunity to design a new generation of ancillary data services into the system from the beginning. Starting in April 1991, the straw man proposal was circulated for comments and suggestions to a wide range of parties with interest in ATV development and introduction, including the proponents of systems to be tested in the selection process. By an iterative process, the document was refined to reflect as much industry consensus as possible, with particular emphasis on flexible allocation of data capacity to audio and ancillary data services. ATSC issued the final document in February 1992.

ATSC's suggestions

What follows is a summary of some of the principal ATSC suggestions as to the characteristics of the audio and digital services that should be provided by an ATV emission system adopted for use in the United States (both for terrestrial broadcast and by alternate media). Certain services are identified that the final distributor of programming (e.g., the cable operator) may provide in a standardized manner. Standardization of services is necessary so that receiver manufacturers may produce units that can re-



ceive these services, and a number of capabilities are identified that every receiver should be required to provide.[3] They are as follows:

• *Flexible allocation.* The number and type of audio and data services that an ATV system should deliver will vary significantly depending on what services are available to accompany the picture, and the needs of the particular service area for the distribution medium (e.g., broadcast, cable, etc.). In order to provide a maximum level of utility, many audio channels and data services might be needed. A fixed provision for many audio channels and data services would require, however, that a significant portion of the available transmission capacity be reserved for these services. This would unnecessarily constrain the video quality, which would suffer if its available data rate were restricted.

Since some of the programming may not require as many audio channels or data services, a fixed allocation of transmission capacity to these services would be inefficient. Therefore, the ATV transmission system should be capable of a flexible allocation of data to audio and data services on an as-needed basis, with the remaining data available to the video system. At the point of emission or final distribution, a choice may be made based on the available services and the needs of the intended audience as to which services are to be delivered via the final distribution medium.

• *Extensibility.* It is not possible to envision and provide for all potential audio and data services that might be useful components of the ATV service in all media. It is feasible to allow new digital services to be added in a compatible manner by means of the flexible allocation of data capacity. The key is to provide a way to identify new types of allocated data services, so that new or upgraded receivers may make use of the new data types, while older (or less costly) receivers simply ignore them. The new data types could offer new kinds of audio services (perhaps with more audio channels) and new kinds of information services. Some of the additional data types could be intended for private or commercial reception, with the data capacity being sold by the final program distributor to provide a supplemental revenue source.

• *Multichannel audio.* The ATV system should be capable of delivering multichannel sound appropriate to the wider, higher definition picture. Consistent with demonstrated psychoacoustic principles, the preferred channel assignment is: left, center, right, left surround and right surround. A significant advantage of three front channels (rather than two as in present TV stereo) is stabilization of the audio dialogue image in the vicinity of the TV screen. An optional low bandwidth channel for low-frequency enhancement (subwoofer channel) also may be provided. Monophonic and two-channel stereophonic transmission modes of operation also should be provided and will offer the most efficient method of delivery for mono or two-channel stereo programming.

With composite coding, all of the audio channels that have been coded into the composite data stream must be reproduced together (similar to the way the R,G,B colors must be reproduced together to form the viewed picture), although not necessarily out of independent loudspeakers. The channels may be mixed together to

reduce the number of loudspeakers required for reproduction.

It is preferable that audio programs not be simultaneously provided by a monophonic or two-channel stereophonic service intended for low-cost receivers, in addition to separate multichannel service intended for high-end receivers. Simultaneous delivery would be wasteful in data capacity and would inhibit the use and growth of multichannel audio. It would be necessary, though, that all receivers be capable of decoding a multichannel service into the desired number of reproduction channels. Lower cost receivers would not need to completely decode all five channels but could decode the five-channel service into a conventional monophonic or two-channel stereophonic program with attendant cost savings.

• *Uniform loudness*. The ATV audio system should provide the means to control loudness in a uniform manner among various programs and delivery channels. The viewer should perceive the same subjective dialogue loudness when a program ends and a new program begins or when channels are changed. The ATV audio data should inform the receiver of a dialog reference level so the receiver can reproduce the normal spoken dialogue at an acoustic level chosen by the viewer.

• *Dynamic range control*. There is a conflict between the needs of many viewers for program audio to have a narrow dynamic range and the desires of some viewers to reproduce the audio in the full dynamic range intended by the program producer. The ATV audio coding system should incorporate an integrated dynamic range compression method that delivers data to the receiver representing the compression characteristic employed.

Receivers may include circuitry that gives the viewer the ability to control the reproduced dynamic range. Using the data representing the compression characteristic employed, the receiver may partially or completely reverse the dynamic range compression intentionally introduced by the program provider.

• *Error correction and concealment for audio services*. It is recognized that error correction and concealment is a more critical issue for an audio service than for the video service. This is because reproduced audio errors may be more annoying than reproduced video errors. In addition, some types of delivery — terrestrial, direct broadcast satellite (DBS), etc. — will be used by some viewers at the threshold of the service area. Therefore, the ATV audio system should include effective concealment methods to minimize audible disturbances caused by uncorrectable errors.

"It probably is widely expected that digital audio for HDTV will be at least as good as the audio compact disc (CD). But much more is possible."

• *Audio services to the visually and hearing impaired*. The ATV audio system should allow programmers to deliver special audio services to the visually impaired (VI) and hearing impaired (HI) using the flexibly allocable channels. The VI audio service would typically contain a narration describing the picture content and would be reproduced along with the main audio program in the receiver. The HI audio service would typically contain only dialogue and would be processed for improved intelligibility.

• *Service identification data (SVID)*. SVID should be incorporated into the ATV data stream. The SVID would supply descriptors for all digital services including digital audio delivered by the ATV signal. The descriptors should identify the digital services and indicate their locations within the overall data multiplex. Several methods may be used to deliver this information (such as packets with headers) providing they meet the requirements for this function.

The SVID must be very reliable, since errors could cause total loss of ATV service. The SVID should be recognizable by the receiver as soon as possible after a channel change. The information carried by the SVID should be repeated frequently, so that a receiver can quickly recognize the available services after a channel change and so that the redundancy can be used to improve reliability of the data. The format that is adopted for the SVID must be very flexible and allow new digital services to be defined and delivered in a manner that is compatible with all ATV receivers.

What happens next?

The data capacity estimated to be required for the suggested multichannel audio system is reasonably consistent with audio data capacity that most of the proponent ATV systems have allowed for. Following selection of an ATV system, it is conceivable that refinement of the accompanying audio technology may occur consistent with these recommendations.

Conclusion

When HDTV is introduced in the United States, it is likely to include the ability to deliver audio comparable in quality to that available from any audio-only source in the home. The HDTV audio system will likely be extensible, allowing a variety of receivers to be manufactured providing audio services ranging from monaural to multichannel surround sound — all from the same transmitted digital format. The FCC has been stimulated by ATSC's recommendation for a five-channel audio into directing the ATV selection Advisory Committee to address new audio developments such as those discussed by ATSC.

Acknowledgments

This article is based in part on a paper presented at the 1992 NCTA convention.[4] The author wishes to express his thanks to the members of the ATSC specialist group, in particular to Craig Todd and Tom Keller who helped draft much of the report language. **CT**

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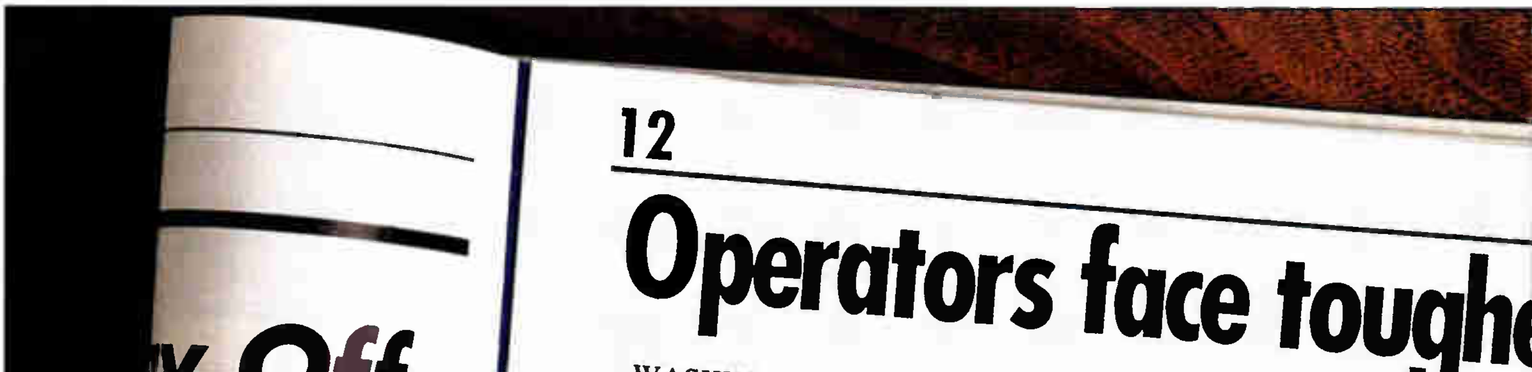

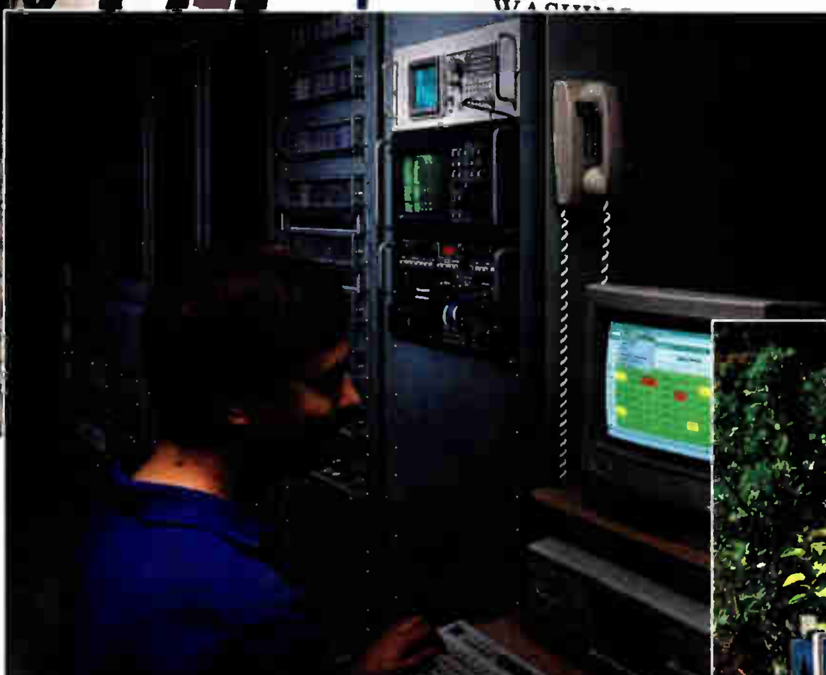

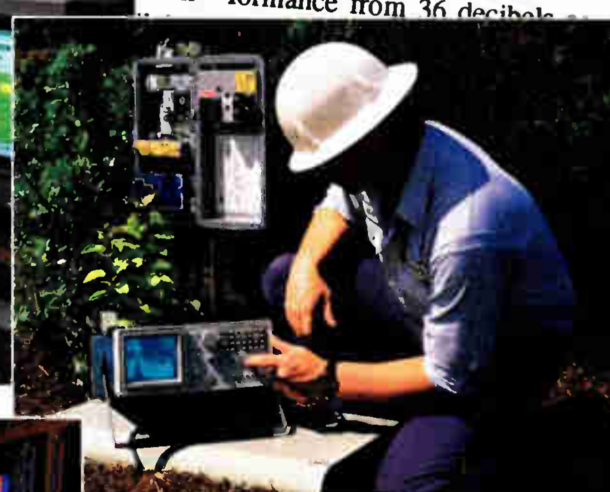

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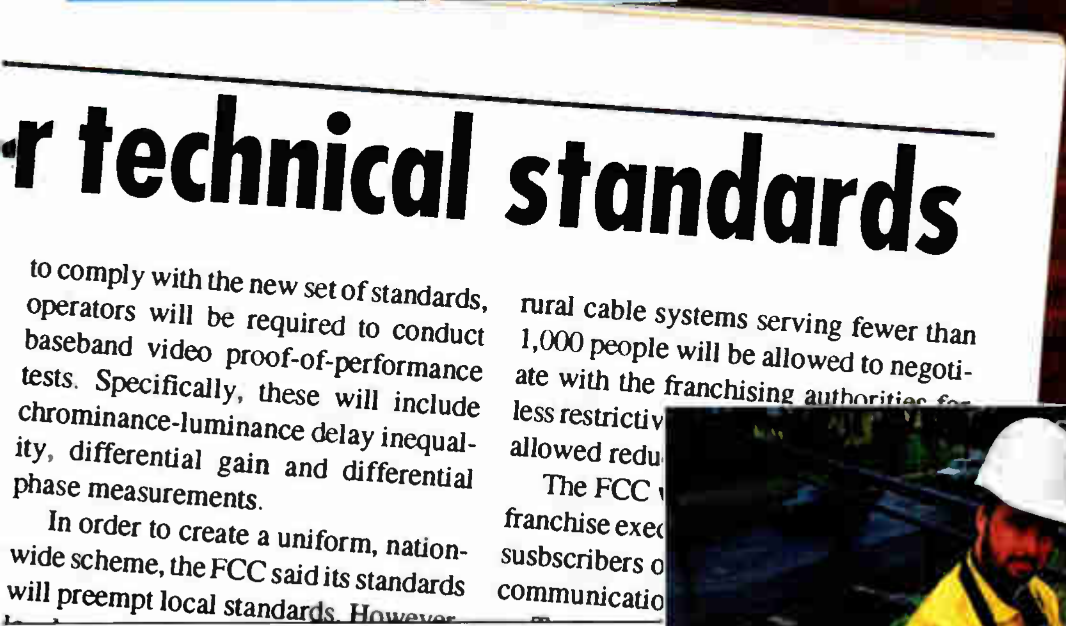

r technical standards

to comply with the new set of standards, operators will be required to conduct baseband video proof-of-performance tests. Specifically, these will include chrominance-luminance delay inequality, differential gain and differential phase measurements.

In order to create a uniform, nationwide scheme, the FCC said its standards will preempt local standards. However

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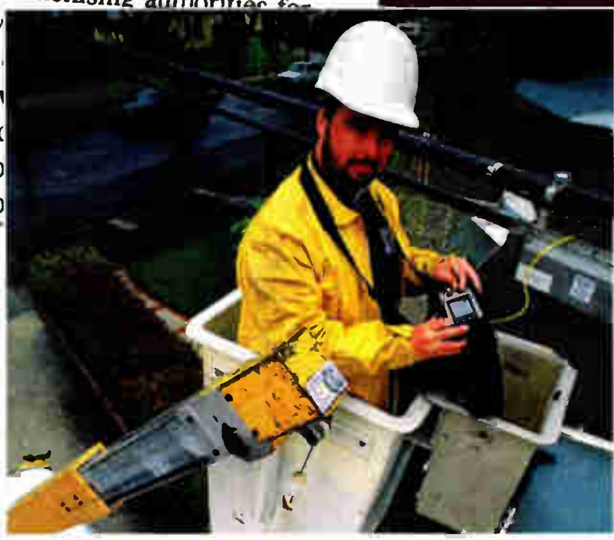

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Digital audio

(Continued from page 30)

method delivered one audio source per subcarrier. Digital audio currently provides 28 per transponder. Compression technologies will inevitably increase this number.

Looking at the effect of this signal at the TVRO level vs. the effect interference has on video, we find some interesting differences. For instance, when we experience interference with a video service, it is normally either overmodulation from the satellite tuner or signal "sweeping" through the bandwidth.

While both will cause some picture degradation, the video can still be watched. This, of course, generates irate phone calls, but at least the service is still on the air. A digital service (and this will be true for compression) can deliver its product through some pretty bad signal environments. Still, when it falls prey to ingress or interference, it will go from perfect to off air. There is no in-between with digital. Digital audio has a basic carrier-to-noise specification of greater than 10 dB. If you drop below the spec you drop off the air.

Let's look at the end effect. If you did pass uncorrected audio to the subscriber, the audio drops or hits would be objectionable because they are audio rather than a few video hits. As we know, subscribers live with the occasional hits to a few lines of their picture caused by sweeps. This reaction would be very different with an audio signal.

As for depth of modulation, there is nothing to set in a digital audio signal (no washed out pictures with which to contend). Digital signals need only be processed, not demodulated and remodulated.

How about transporting this received satellite signal from the TVRO to the headend? What about fiber, supertrunk or other forms of signal transportation?

The answer is easy, if you can verify that the transportation up- and downconversion is somewhat stable in frequency. No problem exists because when you start going off center frequency, you start picking up more errors in the transmission for which error correction algorithms can no longer compensate and the receiver will cut off or mute.

"The implementation of this new technology is easy when the installer, tech and subscriber are kept in mind."

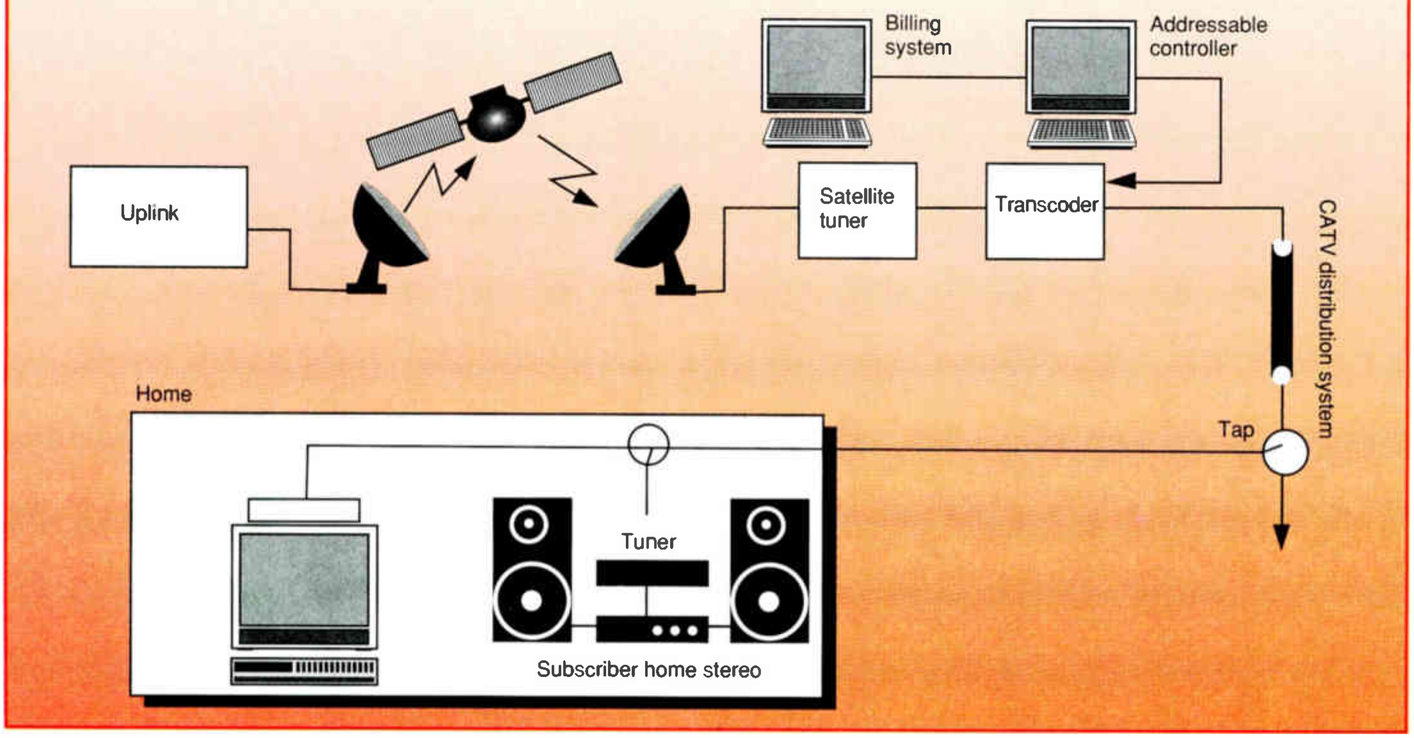
After receiving this signal, we must demultiplex and remodulate into separate carriers on the system. The headend equipment handles this. The only thing needed is to determine the location of these signals on the spectrum. (See Figure 1 on page 30.) If we look how digital audio signals are processed, we have 600 kHz carriers to find places for on the spectrum. With the bandwidth of these signals in mind there are only three rules by which to live:

1) 1.55 MHz away from a video,
2) 0.55 MHz away from an audio and
3) 0.6 MHz away from another digital carrier or data carrier.

You must keep one thing in mind: no matter how "tight" your system is, you will still need to run trouble calls for ingress. These calls can come from routine maintenance or just loose fittings. We must consider this when positioning digital audio signals. For example, you would not position a digital audio carrier on the same frequency as an over-the-air radio station. It might work great in the headend, but out in the plant you would find a very intermittent channel. Mostly because ingress is a form of noise and even digital audio has a point of no return.

Since a digital signal is a coded form of an analog waveform, it can be transmitted and received in some very trashy

Figure 2: Digital audio technical overview

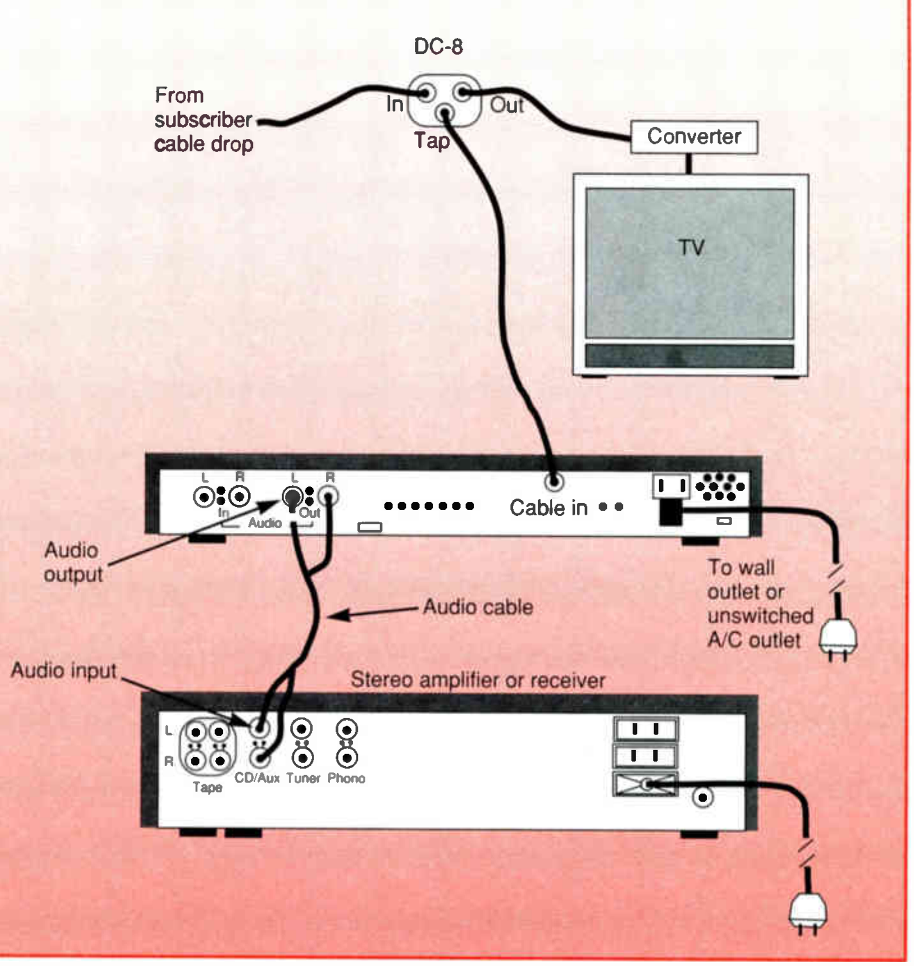


signal environments and levels that video would not survive (-30 dBmV) if you maintain a C/N of 15 dB. Normally this is easy to do if you don't have to contend with ingress.

The best place to start is by doing your homework. Find out and map all your over-the-air FM stations and make sure you don't place any signal on those frequencies. Find out what areas look clean and are cost-efficient to transmit, meaning AML or fiber impact. For help, contact the service's applications engineering group.

Now that we have placed all the new signals in their new homes and balanced their RF levels to 15 dB below video, we have to tell the tuners where to look for the signals.

Figure 3: Installation of tuner with typical stereo amplifier/receiver



Addressability

This is a fully addressable system and works pretty much like any addressable converter. Each tuner has a factory-supplied serial number. You simply use the billing computer to give the tuner its authorizations and frequency allocations, hook up the stereo and you're listening to music. (See Figure 2 on page 66.)

Training

Speaking of hooking up the stereo, it, too, presents an interesting dilemma. Just when you have trained everyone at your system on TV sets, VCRs and stereo TV sets, along comes digital audio, saying, "We hook up to the subscriber's stereo." It's one thing to come into a subscriber's home and install a converter on a $500 TV set, quite another to touch a $5,000 stereo.

But it's no big deal. It's even easier than doing a VCR hookup. (See Figure 3.) If the stereo has an "AUX" or CD input, it's ready for digital audio. Though this is simply stated, it is hard to convince most installers and techs how easy it is to install and troubleshoot. The best way to reassure your staff is through training, training and training. The more hands-on education before the launch, the smoother the launch.

By the way, let's not forget the first people to take the calls, the customer service reps. They, too, need training. In fact I don't know of any person in a system who is not affected by any new program in some manner.

Subscriber

In the home the impact is like adding an additional outlet. The incoming cable is split with a directional coupler rather than a two-way splitter. This way the tap leg can go to the digital audio tuner. It can receive its digital signal down to -30 dBmV, way below video.

Most tuners are very close to the existing cable converter, but subscriber education cannot be overlooked. The implementation of this new technology is easy when the installer, tech and subscriber are kept in mind from the built-in diagnostics to the flexible architecture.

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Reader Service Number 5

Cable audio services

(Continued from page 32)

hear the ball bouncing back and forth from the TV set to the radio. Today, of course, stereo-enhancement of video channels has become standard fare.

In the '80s, cable audio services like Tempo Sound and Galactic Radio were born with the discovery that audio could, in certain cases, be piggy-backed on the discrete subcarriers of a video channel to satellites without requiring additional transponder space. When the new digital technology was added to the mix, the result was the emergence of the dynamic audio category as we know it today. The puzzle pieces include the retransmission of off-air radio stations, basic audio services, premium digital music services and audio simulcasts for video channels.

The fully matured audio package will eventually include all four components. An example is at the Jones Spacelink system in Kenosha, Wis., where the engineering duties are handled by Shane Wagner, engineering manager, and Ed Jackowski, technical supervisor. The accompanying figure on page 32 illustrates the setup.

Putting the mix together

This 22,000-subscriber system began carrying Galactic Radio (now known as Superaudio) in January 1989, shortly after its inception. The service's six stereo music formats are uplinked unscrambled out of Denver, on Mind Extension University's video feed to Galaxy V. The three information and entertainment formats arrive on subcarriers of Home Shopping Network on Galaxy III.

They are placed on the FM spectrum in positions not occupied by off-air FM radio stations. In all, the Kenosha system carries 26 off-air FMs, which includes ones from Chicago and Milwaukee in addition to the locals. By running an FM spectrum analysis, based on the geographical coordinates of the headend, all the broadcast signals within a 100-mile radius can be identified and the open positions shown where Superaudio formats can be inserted. All that's needed in the way of in-home equipment for subscribers to receive the service is a TV/FM splitter and their own FM tuner.

The three audio simulcasts the system offers are for Disney (off of Galaxy V, Transponder 1) The Movie Channel (Galaxy I, Transponder 10) and MTV (Galaxy III, Transponder 17).

A premium audio service, Digital Music Express (DMX), downlinked via Satcom F4R, was launched in Kenosha on Feb. 1, 1992. "What's needed for DMX," explained Jackowski, "is 18 MHz of bandwidth. We use six modulators, each capable of five stereo channels. Each modulator takes up 3 MHz of bandwidth so we use three open channels: A-1 (Ch. 99) upper and lower, along with the upper and lower of Chs. 55 and 56. A system doesn't have to set it up exactly like we did. There's a lot of different ways you can arrange it because the groupings don't have to be adjacent."

Finally, each audio component is fed through its rack combiner and routed to the main combiner, which is a "backwards" 6-way splitter. There, the audio signals are put on to one cable with video TV signals and then output to a 4-way splitter that feeds four separate trunk runs.

An ear to the future

A decision an operator makes to carry a particular audio service generally has more to do with demographics and equipment payback than technical considerations. Nonetheless, the once stepchild of the cable industry — cable audio — has grown and prospered over the last decade and predictions are that it holds even greater promise in the future. **CT**

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Addressable technology

(Continued from page 34)

standard guest amenity at larger hotels, and most pay-per-stay TV services such as provided in hospitals are mostly sold by competitors of the franchised cable industry. These competitors find it difficult, however, to deliver services at reasonable cost to smaller properties because of inherent fixed costs per installation for satellite reception or local tape origination, plus control and billing hardware.

For cable to be effective in marketing to the transient-room market, some or all of the following features are required:

• The property should be able to subscribe to a tier of programming to be provided free-to-guest in each room and bulk-billed monthly to the property. This tier may not be identical to the basic tier provided to cable residential subscribers and probably will not be the same in different types of properties.

• Guest-paid PPV services are nearly essential and a variety of other services could be provided with payment on a pay-per-stay or pay-per-day basis.

• Methods of payment for guest-paid services must be consistent with the often short duration of occupancy of a guest room and cannot be part of a monthly residential billing cycle.

To date, the cable industry has provided mostly free-to-guest TV, and has found it very difficult to provide guest-paid movies or premium programming to the lodging and other transient-room commercial subscribers.

Benefits of the shared-services approach

Advances in addressable technology in the form of shared data services for order-entry authorization and billing make possible a whole new approach to both business and economics of the commercial transient-room market niche.

System benefits of this new approach include:

• The marginal cost of installing any room is low and is nearly constant from the smallest to the largest properties. Alternative systems have required significant investments in on-premises equipment, economical only in properties large enough to average down the cost-per-room.

• Programming lineups can fully integrate all separate viewing formats, free-to-guest, pay-per-stay and PPV.

• A sole cable provider can deliver all the desired channels of programming to any and all rooms, including quality over-the-air channels, subscription pay service programming, and PPV movies and events. The only previous alternative has been a mix of multiple vendors including cable, private SMATV and/or stand-alone PPV providers.

• Sale of a fully integrated service, particularly integrating free-to-guest and guest-paid services, frees the provider from financial dependence on any single service. In the past, adult programming has frequently been essential to the viability of existing stand-alone PPV hotel systems.

The growth opportunity for cable

Fewer than 25 percent of the transient rooms in the country are presently served with any PPV movies.

• Cable systems pass more than 5 million hotel/motels, resorts, campus and hospital rooms.

• The cable industry presently serves only about one-third of hotel rooms (and generally only with free-to-guest services) and virtually none of the hospital rooms.

Shared data services

Recent developments in the provision and integration of shared data services on a regional or national basis make it possible to provide addressable functions tailored to a particular cable system without the need for dedicated hardware or personnel. For example, shared voice response services are available both from telephone carriers (e.g., Sprint) and from specialized service providers and integrators.

To deal with order-entry, authorization and billing functions for the commercial market, a combination of shared services is integrated for the cable operator. These include:

• Similar to the audio response unit (ARU) function used in many cable systems, a shared interactive voice response (IVR) service accepts orders at one location from anywhere in the country using an "800" number. Automatic number identification (ANI) is used to identify the commercial property from which the call is made and a central data base further identifies the cable system to which the property is subscribed.

• A centralized billing system provides credit authorization and billing, with immediate or overnight effect (which is the key to guest-paid billing in the transient-room market).

• A centralized fax transmission service generates and sends hard copy "front desk" reports.

The advantages of using the integrated package of shared services are:

• No additional bank of inbound telephone lines is required at the cable system to accept orders from hotels and other commercial properties.

• Guest billing is off-loaded from the cable system. Tiering and pricing can be made independent of the residential subscribers.

• The variable burden of staffing and report-generation is shifted to the supplier of the shared services.

• These same advantages can be applicable to any shared network service. They become particularly economical when they are applied to only a small universe of subscribers such as the transient-room niche.

The StarTech system

StarTech Corp., a company located in Wellesley, Mass., has introduced a system based on the shared-service principles, which greatly simplifies provision of services to transient-room commercial customers. The technology combines into a single integrated system interactive processing for multiple users using shared data services, use of existing established facilities for telephone and cable networking and existing credit card billing services. The system is uniquely designed to enable the cable operator to enter the transient-room market niche with a minimum of complication or investment and without disrupting residential services.

The "front end" of the system uses an interactive voice response function that combines ARU, ANI and dialed number identification system (DNIS) telecommunications technologies. The "back end" is a proprietary billing system dedicated to the unique and varying requirements of commercial subscribers with particular emphasis on guest-paid transactions. →

Reader Service Number 48

"The cable industry has intrinsic competitive advantages that could be used for growth in the transient-room market niche."

The heart of the StarTech system is the DEC VAX computer located at the company's transaction center facilities and proprietary software developed by the company on this VAX/VMS platform. The computer communicates authorization information to standard cable addressable controllers and provides reports to an interactive terminal located at each cable affiliate headend over existing telephone networks. Individual guest orders are received over standard 800 number telephone lines from each of the hotels or other commercial properties where the TV services have been subscribed. The system also is capable of collecting guest orders over other return loops such as store-and-forward and can support impulse ordering in systems so equipped.

The StarTech system constitutes a supplement to an existing addressable installation, providing order-entry, authorization and billing functions in a form necessary for the commercial transient-room application. The system requires addressable converters in each guest room but because control of these converters resides in a separate billing system there is no disruption of residential addressable services.

Order-entry

Guest order-entry from a room in a subscribed commercial property is by means of a specific national 800 number. The transaction center computer recognizes the call as a guest order using the DNIS. Using an ANI, the computer identifies the commercial property from which the call has been made and starts a voice response interaction using a shared-service ARU system. The system prompts the guest to enter the room number, and with a sequence of prompts identifies the program or service desired and then the method of payment and credit card number if required by the property.

Thus the entire guest order-entry process is handled independently of the cable system's residential order-entry system. No new ordering equipment is required; there is no need for banks of inbound telephone lines.

When a guest order-entry is successfully completed, authorization information is communicated to the cable system's addressable controller.

Authorization

Authorization data for the commercial customers is sent from the shared-services transaction center to the addressable controller via modems and the public switched telephone network (PSTN). Typically the addressable controller is equipped with two or more serial data ports, one of which is normally connected to the billing computer used in residential services. Synchronous serial data is fed to a second port, using the same protocol as the billing computer. Should a second port not be available, a multiplexer is usually available from the supplier of the addressable controller. The controller thus creates outgoing authorization messages to all authorized converters, using information supplied separately by the system's own billing computer for residential subscribers and by the shared-services transaction center for commercial subscribers.

To date, the technical requirements, protocols, etc., have been satisfied for addressable controllers supplied by Jerrold, Tocom, Scientific-Atlanta, Zenith and Pioneer.

Addressable services can be provided to just commercial subscribers in systems that are not otherwise addressable by installation of one of the less expensive small-system controllers available from most addressable equipment suppliers. The small-system controller also can be used to serve just commercial subscribers where an existing addressable controller is already fully loaded or to enhance features over the residential controller.

Billing

A national, computerized billing service is provided that also uses shared-service data network architecture eliminating installation hurdles and the need for dedicated equipment or personnel either at the cable system or commercial subscriber property (e.g., hotel). Guest-paid programming can be charged either to the guest's room bill or major credit card or paid in cash at the property's front desk. In no case does the burden fall on the cable system.

Cable services to hotels

The accompanying network configuration diagram on page 34 shows the StarTech system as applied for provision of cable services to hotels and is illustrative of how the system may be more generally applied. The essential elements are:

- Cable addressable headend and distribution plant.
- Hotel supplied with cable service and equipped with addressable converters.
- The StarTech shared services transaction center.
- The PSTN interconnecting the hotel, the transaction center and the cable headend.

The addressable cable plant carries all the residential program services to the hotel. By addressing the converter, basic non-scrambled service may be authorized and scrambled channels may be authorized on a PPV or other basis. In addition, many addressable converters provide for channel mapping and addressable authorization by channel. This feature can permit retiering of basic services for hotel guests with a channel lineup different than that provided to residential subscribers or different from each other hotel.

The guest room is provided with an addressable converter, a "tent card" or other program guide, and a standard telephone. To request service, the guest — having consulted the program guide or on-screen barker channel — places a call. The guest is greeted with a message specific to both the system and the property with prompts to lead through a simple ordering sequence. If appropriate, the interaction concludes with entering of credit card information.

The outbound call passes through the telephone network and is carried to the transaction center via a T-1 multiplex, accompanied by caller number (ANI) and dialed number (DNIS) identification data.

The DNIS signaling, based on the specific number dialed, identifies to the transaction center that the incoming call is a guest-order call (as distinct from a request from a property front desk for an update of records). Using ANI,

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the specific hotel property is identified and the transaction center data base matches the property with the cable system provider. Thus it is able to initiate an ARU response with messages and prompts specific to both the hotel and the cable system. If the guest uses a credit card, the transaction center simultaneously communicates with the selected credit card network and obtains full credit authorization for the guest order. Once the order has been accepted, the transaction center communicates with the cable system's addressable controller to authorize the converter located in the guest's room to receive programming.

Program authorization can consist of authorization to descramble scrambled premium or PPV channels, and (in the hotel environment for example) access, or denial of access, to tiers of basic services using channel mapping of both scrambled and non-scrambled channels.

The transaction center provides activity reports to the hotel's front desk by automated fax service, which may be delivered on a regular daily schedule and upon telephone-dialed request from the property front desk using the IVR system similar to that used by guests to order service.

The cable system uses an interactive terminal to enter property installation data to obtain status reports and to provide updates of converter IDs and locations, etc.

Simple installation and start-up

At the cable headend, the only installation requirements are:

- A dedicated dial-up telephone line and modem for receiving authorization data from the transaction center. A standard dial-up line can be used until the number of rooms installed supports the cost of a dedicated data line.
- Connection of the authorization line to the controller.
- Provision of an interactive data terminal for addition of properties and converters to the transaction center's data base and for report inquiries.
- Any channel can be controlled for guest-paid programming. No change is required to scrambled or unscrambled channels on the residential channel lineup.

Within the cable distribution plant, no changes are required other than connection of service to the hotel. At the hotel, the installation requirements are:

- Verification that cable service is present in each guest room.
- In-room guides and promotional materials.
- In each guest room, installation of an addressable converter and correlation of the converter ID with the room number.

User-friendliness

A single 800 number is used for every order and in every property. Guest instructions are simple and uniform with a custom greeting provided for each cable system. Voice responses and menu selections are tailored to the system and to the programming subscribed to the specific property. Uniform instructions can be easily applied to any and all promotions (such as on-screen instructions), and force-tuned barker channels, previews, in-room guides, cross-channel promotion, etc., can be provided.

The hotel is provided with dial-up access from the front desk for guest billing status inquiries, up-to-date checkout

information and program ordering if requested. To support inquiries or guest folio payment, activity reports transmitted by the transaction center are faxed directly to the hotel front desk. The credit card payment option will be helpful to many smaller hotel and motel properties, seasonal resorts and hospitals. Credit card payment can be an important alternative to eliminate any significant level of guest denials at specific properties.

Reports

Comprehensive system reports are tailored to the needs of the systems and the subscribed properties. For properties that elect to bill and collect directly from their guests, the system produces reports that can either be mailed direct to the subscriber property or forwarded to the cable system for finalizing and mailing. Reports can accommodate different commission rates for each property, different commission rates for the different levels of service, and can be coordinated with a property surcharge on the guest-order call.

Bulk free-to-guest billing can be generated by the system as an option, thus freeing the residential billing system entirely with respect to subscribed commercial properties. The system includes the capability to generate monthly statements to support all programmer fees and royalties, and as a management tool, it provides prompt analyses of performance by property, program buy-rate, levels of service and pricing.

Benefits to the cable operator

The unique features to the system create the opportunity to penetrate the commercial hotel niche with an attractive package of services:

- PPV to every room in every property.
- Credit card, guest folio and cash payment options.
- Flexible tiering and pricing for free-to-guest services.
- Flexibility of PPV, pay-per-day, pay-per-stay or special seasonal and credit card rates.

Extension of the cable system's market is achieved with minimal capital investment without the burden of personnel for additional order-entry and billing functions, and without affecting the technical operation of the addressable system serving residential subscribers.

Additional applications

Other obvious examples of potential commercial customers that provide guest rooms on a transient basis include hospitals (which typically provide room TV service on a per-day charge basis) and resorts. Other properties may provide services on a semester-basis in the case of college campuses or on a monthly basis in the case of seasonal homes and condominiums. In addition to the more than 5 million hotel/motel, resort campus and hospital rooms, it is important to note that there are an uncounted number of intermediate-stay properties (such as apartments, nursing homes, military bases, marinas, etc.) passed by cable systems.

The technology also has application to small cable systems where the cost of order-entry and per-program billing systems may otherwise make unattractive the prospect of conversion to addressability. Coupled with use of the inexpensive small-system addressable controllers now provided by most addressable systems suppliers, use of a shared-services transaction center can make provision of PPV to small cable systems much more economically attractive.

Conclusions

The use of shared data services for order-entry and guest billing makes it possible to extend the capabilities of existing addressable cable systems to fit the requirements of the commercial transient-room markets. Addressable tiered and PPV services can be tailored to hotel and other specific needs without interfering with services provided to cable residential customers.

Technical implementation of addressable services to hotel and other commercial markets is simple. Once basic cable service is provided to guest rooms, the addition of tiered and PPV services requires only the provision of an addressable converter for each room, and a modem connection from the shared-services transaction to the cable system's addressable controller. Other than a monitoring terminal, no other capital equipment is required at the cable system.

With capability in place for handling order-entry and billing of hotel guests, cable systems are positioned to provide PPV movie services to the 75 percent of transient rooms not presently served by the existing hotel PPV providers and to compete economically with the established services. Additionally, cable systems can repackage basic and other services to best suit hotels, hospitals, campuses and all other transient-room properties. **CT**

The author is grateful for the help of Don MacIlvane Jr., director of system and customer support for StarTech, in the preparation of this article.

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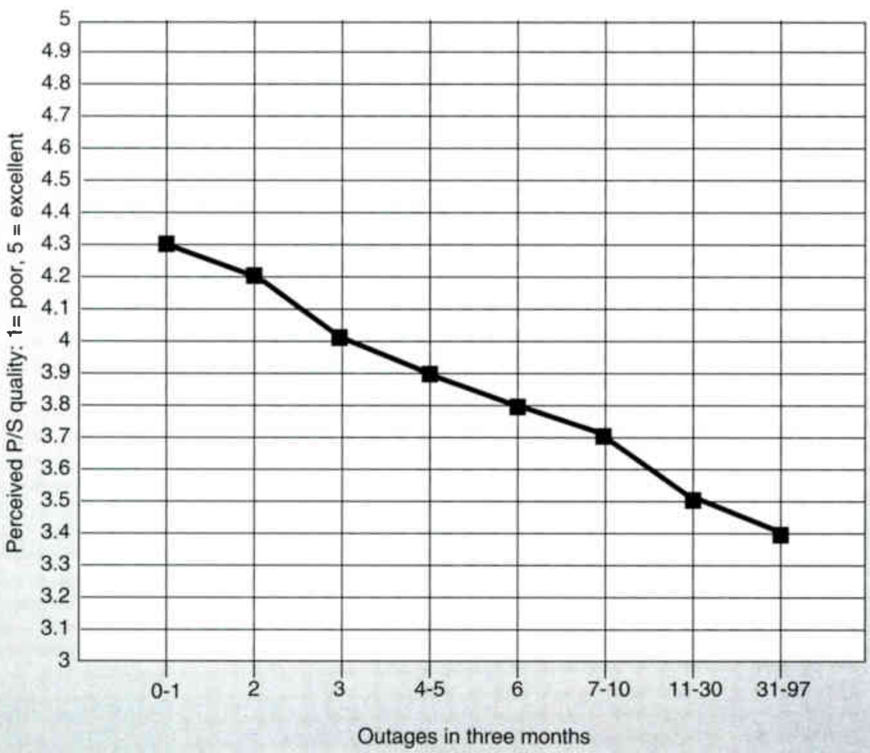
Figure 3: Outages and perceived picture/sound quality



Outage management

(Continued from page 37)

gle channels are included and situations amenable to leverage solutions above the drop level are counted. The provision for common cause protects against counting independent drop-to-TV set problems at several different homes as an outage.

Subscriber satisfaction

Based on available customer research, the following are general issues with customer satisfaction:

- Issues of high impact include outages, repair, phones and employee concerns for customer needs.
- Issues of medium impact include installation, telemarketing sales, picture/sound quality, cable store and employee courtesy.
- Issues of relatively low impact include billing, cable guide, and employee knowledge of cable services.

Note here that the most important customer satisfaction issue is outages, based on the available research.

As outages decrease, overall satisfaction improves dramatically. A similar dynamic exists when reliability is compared to cable value and customer interest in switching to a competitive service provider. (That is of course, if a competitive service is available.) Suffering fewer outages relates to greater value perceived by the customer and to less interest in switching. (See Figure 2 on page 37.)

Outages also drive perception of picture/sound quality, even though the two would seem to be separate issues. (Refer to Figure 3.)

Finally, the frequency with which reception is lost ties to actual downgrades or disconnects. Downgrade and disconnect rates are about 80 percent higher for customers who have frequent interruptions than for those with reliable reception as Figure 4 shows.

At the risk of being redundant, this subcommittee's findings stress that outages can be linked more clearly to overall satisfaction than other service components (like telephone access and convenience of service appointments). No other service component has such impact.

Critical outage threshold

If a business meets (or better yet, exceeds) customer expectations, customer loyalty is built and the perceived value of services improves. This relationship was clearly demonstrated in research conducted by the Strategic Planning Institute, which found that companies with higher perceived quality have greater growth rates, market shares and profit margins than do firms offering medium or low quality. What is important to remember is that the customer defines quality. Conformance to specification is meaningless if meeting the specification does not yield satisfied customers. So, it is relevant to ask how outages shape user perceptions. What elements of outages should be understood and controlled to maximize customer retention?

The Viacom research mentioned

Figure 4: Outages and downgrades or disconnects

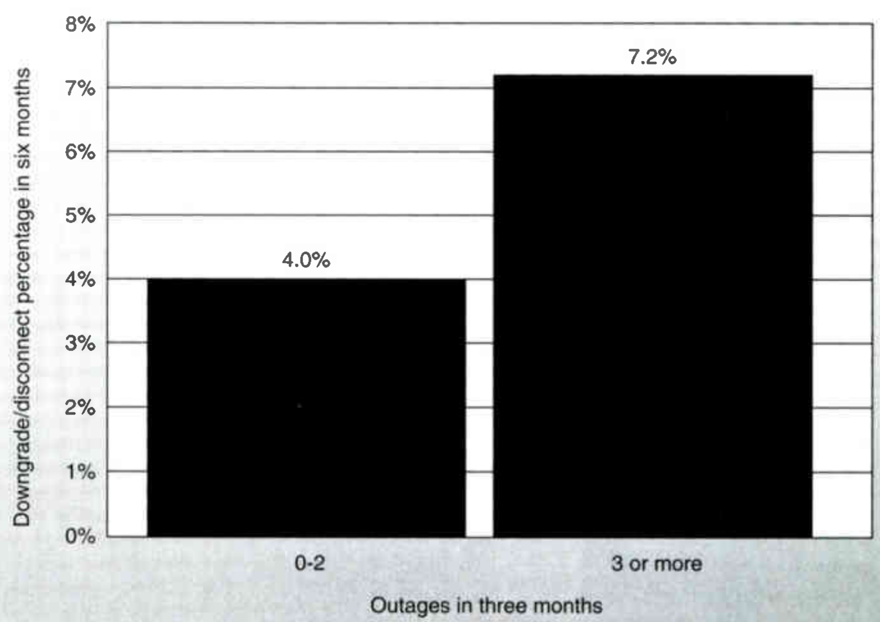


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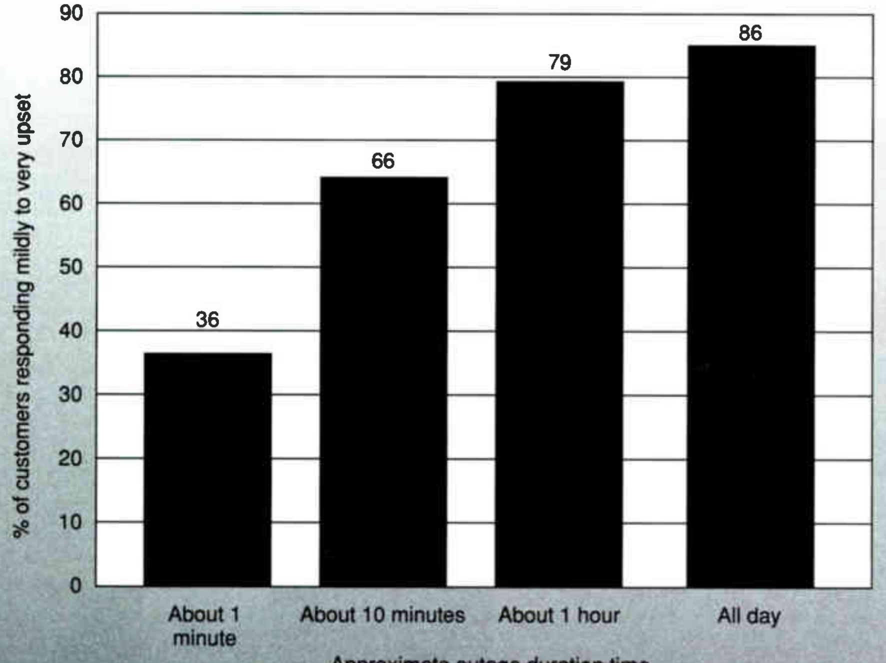
Figure 5: Outages duration and customer satisfaction (all channels out)



1991 Viacom customer service survey (OnTraq)

previously is helpful. It explored how outages affect customers and what the level of acceptable performance is. Outage questions were written jointly by Viacom and OnTraq, a cable customer research firm, and administered by OnTraq over a period of four years using a phone survey. The sample sizes were quite large (consisting of between 1,000 and 4,500 customers each year) so the results are considered statistically reliable for this article's purposes. One topic explored in the study was how customers react to different elements of the outage experience. This research was conducted specifically to develop an outage definition and to set parameters for tracking performance.

It was found that single-channel outages are almost as frustrating to customers as having lost all channels. In fact, for single-channel outages of a one-minute duration, the level of frustration is virtually identical to an all-channel outage. (See Figures 5 and 6.) This points strongly to including single-channel outages in definitions and measurement systems.

In terms of duration, the degree customers are upset increases very quickly as the outage extends beyond one minute. Almost as much customer goodwill is lost when the outage goes from one to 10 minutes as when it lengthens from 10 minutes to all day. The implication here is that, unless the outage is restored very quickly, customer satisfaction will be severely affected. So, while restoration within one hour is better, the customer has already been hurt. Any tracking mechanism should measure the time lapse from when the outage is detected and service restored.

It is necessary to note here that it usually is impractical to restore an outage in just a couple of minutes. However, many outages are a result of maintenance and it is sometimes possible to keep these outages very short. Therefore, impact on customers can be kept to a minimum by adopting some work-around procedures.

Customer reaction to outages varies during different times of day. Frustration is greatest when reception is lost during prime time. Customers are least sensitive to interruptions during the early morning or late evening hours.

Obtaining an acceptable outage level

The required level of reliability can be developed by correlating outage frequency (as reported by the customer) to various measures of satisfaction. This will identify trigger points where satisfaction begins to erode as reliability worsens.

Ratings of picture/sound quality begin deteriorating when the customer perceives more than one outage in three months. (Refer again to Figure 3 on page 80.) However, when correlated to global measures of satisfaction (such as overall service quality, perceived value of cable, and actual downgrades or disconnects) the trigger is more than two outages in three months.

In other words, if the customer sees no more than two outages in three months, service interruptions exert little influence on global attitudes or behavior. Several implications arise from these findings. First, the customer does not require perfect reliability. Reasonably good reliability, at least for now, is enough. It is even more important, however, that outages should be measured as a threshold phenomenon, not as an average.

The event that concerns the operator is when a customer experiences more than two outages in three months. An average outage frequency of 1.6 in three months is inadequate if 30 percent of the customer base is over the threshold. With this in mind, the following performance target can be established: *"No customer should experience more than two outages within a three-month period."* While less accurate, because the cumulative effect of outages over time is lost, a secondary standard could be set at no more than 0.6 outages per customer per month.

Whenever a performance target like this one is set, it is important to define how it was created and how performance will be measured against it in the future. This target was developed by asking customers via telephone interviews the following question: "In the last three months, about how many times have you been aware of loss of reception on some or all of your channels?"

Conducting interviews like this can be expensive and time-consuming, so performance data to compare against the target can only be gathered once or twice a year. Measuring more often is too costly. Unfortunately, gathering data every six or 12 months is not enough to keep an operation on track. What is needed is to tie the customer-driven standard and performance as measured by customer interviews to frequently gathered internal data, like that generated by a billing system. Once this is done, the customer-driven standard can be used to develop an internal operating standard against which performance can be routinely assessed. This lets the operator measure performance frequently and determine if it is good enough to keep customers satisfied.

How all this is done is somewhat tricky. The process contains the following five linked elements:

1) *A method of measuring how many outages customers think they experienced*. This is usually a telephone survey that asks a random sample of customers in a cable system how many outages they had in the prior three months, and will be referred to as "external measurement."

2) *Data gathered using external measurement that tells how many outages customers actually experienced*. This is defined as "external data."

3) *An outage standard developed from external data*. This is the "external standard." The recommended performance target of two outages in three months is suggested unless an operator experiences conditions that might invalidate this. In that case, the operator should replicate the research presented here and customize the standard for his own operation.

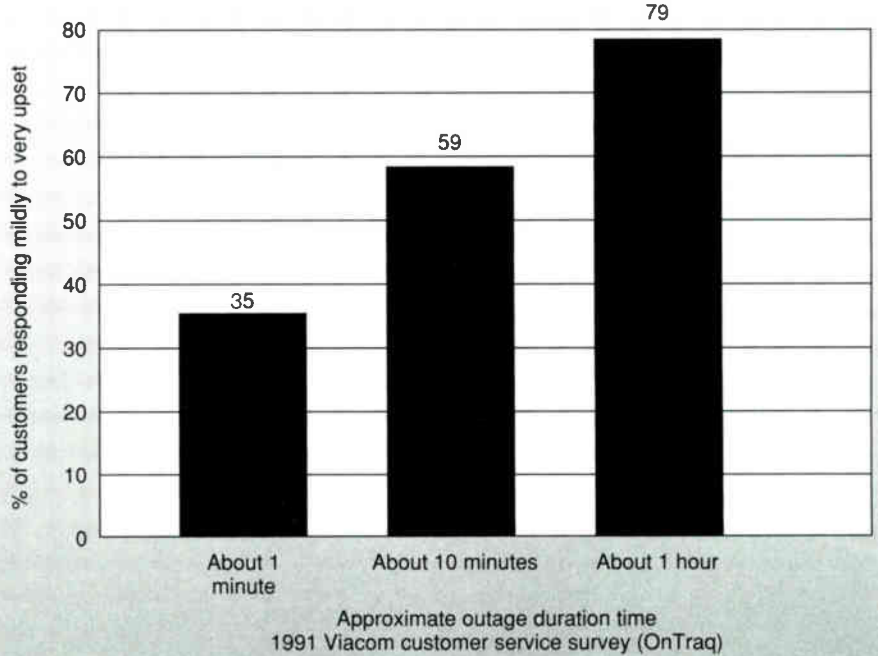
4) *An internal method for measuring outages*. This is the "internal measurement." The method proposed later in this article using customer phone calls to trigger an outage alert via the billing system should work. Any other method that delivers reliable data also is acceptable.

5) *An assessment of outages using internal measurement*. This will be referred to as "internal data."

Once the operator gathers reliable external and internal data and has an external standard, an internal customer-driven outage standard can be derived. This is done by simultaneously analyzing performance using external and internal measurement, determining the level of external performance needed to meet the external standard, then translating that level to the internal measurement system.

Once this rather complicated process is complete, the operator will have performance data available, perhaps daily, on system reliability. He also will have an internal outage standard that, if met, will by definition yield satisfied customers.

Figure 6: Outages duration and customer satisfaction (single channel out)



Detection and tracking

A customer-driven definition and standard for outages is of little value if performance cannot be measured reliably against them. The technology in other industries makes tracking easy but in cable TV (where most systems are one-way) accurate measurement has been problematic.

In developing a tracking method, it makes sense first to consider the elements of an effective system. In the absence of a perfect solution for tracking, the method ultimately deployed will be a compromise between what is ideal and what is technically feasible. The ideal outage detection/tracking system should contain the following elements:

- It should determine if and when an outage exists without relying on human judgment.
- Measurement should be reliable in that all outages are consistently identified and counted. Inherent in this is the ability to rely on accuracy over time. Changes in month-to-month data should indicate differences in real performance, not errors in the tracking system.
- The method should be as automatic and non-labor intensive as possible. The fewer hands on it, the better.
- The gathered data need to facilitate diagnostics so that, in addition to telling frequency and duration of outages, information also is provided to help determine cause as well as determining repeat outage areas.
- MSOs should be able to compare the performance of different cable systems. This way, corporate reliability standards can be established against which all systems are measured.
- The method should use resources already in place or ones that can be easily and cheaply obtained. It does little good to have the perfect detection/tracking method if it is too expensive or time-consuming to deploy.

It is recognized that outage detection, tracking and reporting have never been easy. The method most commonly used in the industry today is manual detection and tracking. Field technicians, customer service representatives (CSRs) and dispatch operators decide that an outage exists and when it started and log the event, either manually or on a PC. This method has been forced on the operator through lack of a better option. Unfortunately, it fails to pass the objectivity and reliability tests, and is therefore not the optimum solution.

Various techniques like status monitoring would provide the perfect answer. Unfortunately, for one-way cable plant, they are too expensive to deploy down to the customer level. Failure to reach to the tap would allow too many outages to go unreported.

The on-line billing solution

With the widespread use of on-line billing systems, a compromise between the inaccuracy of manual tracking and the cost of tap-level electronic monitoring is available. The concept is simple and already being offered by several billing vendors. Supporting components are being provided by several other companies.

The method relies on customers reporting loss of reception, primarily via phone calls. At the time of the customers's report, the CSR schedules a service call. When a certain number of outage service calls are scheduled within a specified geographic area, the billing system determines that an outage has probably occurred and triggers an alert. These geographic areas, called area designators, may be of several types.

Of the two most common types, one involves amplifier numbering. The amplifiers and power supplies in the cable system are numbered, and each house is assigned to an amplifier. When a predetermined number of customers fed off a given amplifier call with an outage, the alert is triggered.

The second method uses the ZIP code + four area codes, and again assigns customers to the area code in which they live. Historical reports could be run against the billing data base that would count the frequency and duration of the outages, give their locations, the number of customers affected and how the problems were fixed. The point to be made here is that systems can get reliable outage detection without spending considerable effort to create a customer amplifier data base.

While an outage detection/tracking method based on customer phone calls may seem unusual, even heretical, is meets the criteria for a good tracking system fairly well. It is objective in that human judgment is not normally involved. Basing the system on scheduled work orders, a task already required by the billing system, means that outage tracking requires no extra labor. As mentioned, several billing vendors now offer detection packages, and other companies are expected to follow, so the package should be available without unusual added expense. Assuming the number of households per area designator is the same across systems and the triggering thresholds are the same, reliable numbers should be obtainable for system-to-system comparisons. Finally (and this is very important), the method is driven by customer-reported outages, which brings the entire concept in line with consumer perceptions.

To support the developmental process of an outage detection and tracking system, a specification was created and presented to the relevant vendors serving the cable TV industry. The subcommittee developed its recommendation from information based on vendor responses as of Feb. 21, 1992.

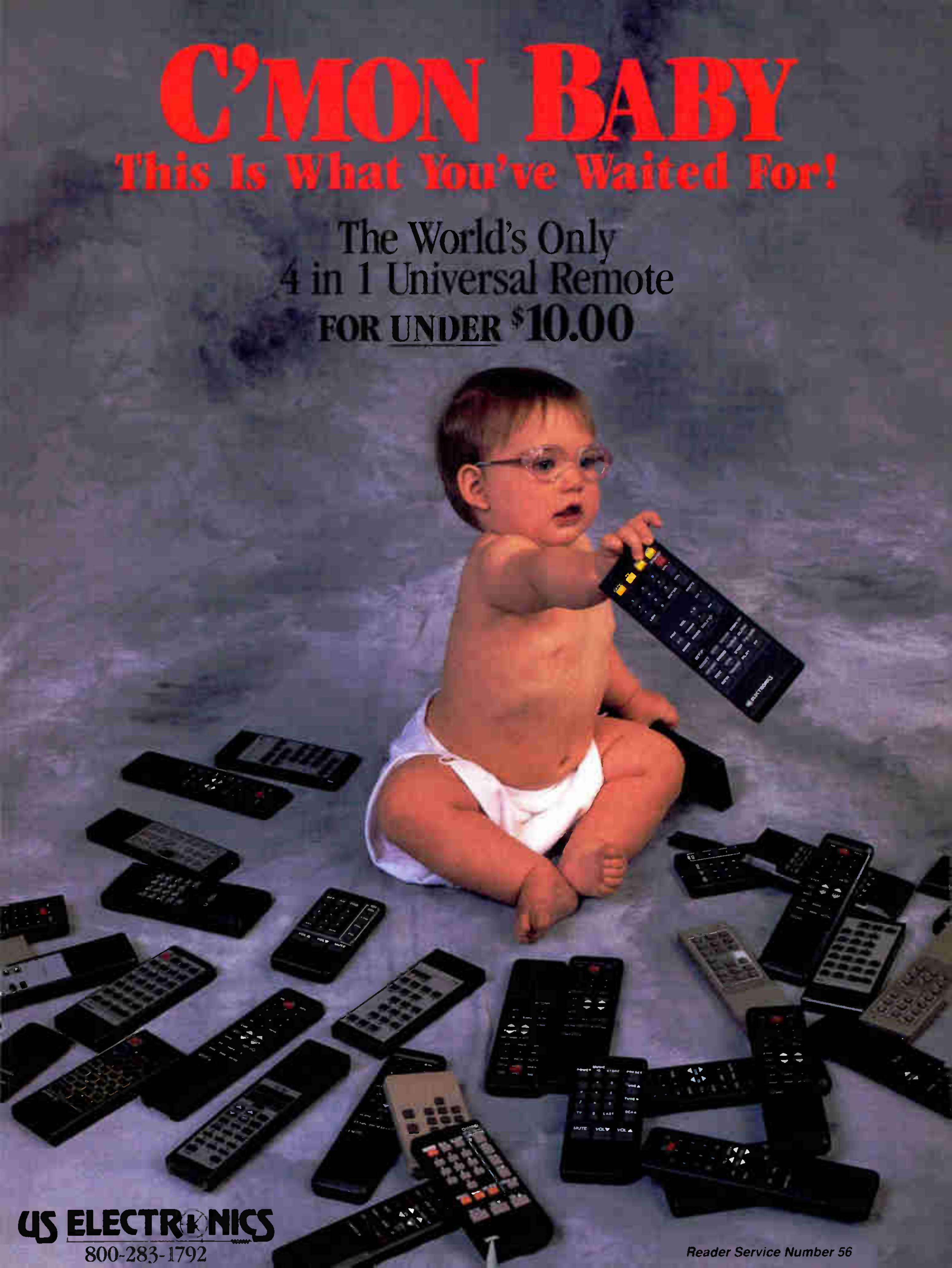
A key point to note here is that the solution developed has been successfully field-proven and does indeed meet all the requirements this task force deemed necessary. This tool is available and the task force recommends systems use it.

To reiterate this very important message, the majority of cable TV systems have outage detection and tracking available through billing systems. This can and should be implemented by all systems.

The specifics of the outage detection and tracking specification developed by the CableLabs Outage Reduction Task Force are not included in this article. These details are laid out in the CableLabs document, *Outage Reduction*.

Summary

Outages represent one of the major opportunities (if not *the major* opportunity) for service improvement in the cable TV industry. Adopting a customer-driven outage definition, since all interruptions affecting the customer are counted, is the first step. The next step is establishing an external performance standard that is based on what is expected and what is acceptable to the customer. Finally, an accurate internal method for detecting and tracking outages is needed. Once deployed, it can be tied to external customer data and a customer-driven internal operating standard for service reliability can be developed. **CT**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Video dialtone

(Continued from page 38)

nomic boom and create 1.46 million new jobs.

Hampton said that after a long shakeout, the losers will be the non-MSOs and video stores. The non-MSOs because "it will be harder to offer these new systems with minimal investment, which is something only the larger cable players and telephone companies can do." The video stores will lose, unless they can find a new on-line channel for distributing their services.

Ramifications of the VDT policy

Under the new policy, the LECs will be allowed to transmit video signals on a common carrier basis, without having to obtain a municipal cable license and incur the costs that go with licensing. As part of the service, LECs will be permitted to set up electronic menus that will allow consumers to navigate through video services.

The LECs can place a small stake in the services they carry by investing up to 5 percent of the equity interest in program services and providing financial backing for these ventures. Previously they could only acquire up to a 1 percent equity interest in information services they carry. However, they are prohibited from pricing, owning or maintaining editorial control over video programming on their networks.

The FCC also recommended expanding the number of areas in which service providers are exempted from the cable/telco cross-ownership ban. Currently LECs are permitted to offer cable TV services in non-metropolitan areas with less than 2,500 residents. The FCC's recommendation, to expand this limit to 10,000 residents, must first go through Congress to become reality.

Beyond just expanding this exemption, the FCC recommended that Congress completely repeal the cross-ownership ban, mandated by the Cable Act of 1984, that prohibits the LECs from owning programming services. The FCC set up a two-tier structure through which the LECs can provide video services, which adheres to its existing distinction between basic and enhanced services. The major difference between these tiers is the degree to which a company utilizes the carrier's resources. Basic services only provide programmers with a channel for sending their signal to consumers — the programmer must bill, collect and maintain equipment for the customers on its own. Enhanced services will make the LECs' administrative/technical resources available for billing, collecting and maintaining customer-premise equipment.

New centrex-based services are allowed to take advantage of the video infrastructure to support digital media in any format. Users will be able to send video messages or store-and-forward movies. Video gateways could enable consumers to explore millions of different channels. A baseball game could have multiple cameras connected to the telephone network, enabling viewers to choose a camera angle. Video rental companies could provide real-time video-on-demand. Unfranchised competitive cable operators could jump into the cable market on a moment's notice.

The VDT provisions were crafted by FCC Chairman Alfred Sikes, who said they were intended to speed the "development of a universal, feature-rich communications network across America — a network of networks — which has great potential to create new jobs and to foster economic development, while at the same time expanding people's choices and advancing the goal of individual empowerment."

The FCC is hoping that VDT will open up the arena for increased competition in the video services marketplace and accelerate the modernization of telecommunications networks. The long-term impact of this push for an open video market will be profound if it continues.

Legal barriers

Although the VDT provisions open the door for telcos to find new uses for their networks, the telephone industry still believes the door is not open wide enough to make the video business profitable. Furthermore, pending legislation threatens to slam the door shut, making any LEC investment in video services a risky proposition.

The government is searching for a way to take information services to the home and business at a price that spurs the economy without creating a dollar-hungry monopoly over any one sector. Different entities — such as Congress, the FCC and Judge Green — are pushing policies that seem to be at odds with one another.

Telco regulation began in 1982 when federal Judge Green created a number of restrictions to keep Ma Bell from ruling the market. He observed that although market power is often a function of a company's size and sheer strength, the RBOCs' power is in their almost complete domination of the last mile of the telephone network. He observed, "In fact almost 99 percent of all traffic must pass in the end through the regional companies' local loop."

However, now that competition has begun to emerge in the video arena, the FCC has been taking the stance that it is time to begin letting the RBOCs into the ring. The FCC has been looking for ways to push the development of a high-speed network of networks that will support a new generation of services. This will require a major investment, which no one is prepared to make. By raising the stakes high enough, it hopes to entice deep-pocketed RBOCs to begin construction.

Still, certain members of Congress such as Rep. Jack Brooks, chairman of the House Judiciary Committee, fear that it is still too soon for the LECs to get into other services. Last May, Brooks introduced a bill, H.R. 5096, that, if passed, will delay all LEC entry into information services — broadly defined as all wire-based audio, video and data services — for three years with a stringent antitrust entry test to follow.

Congress' fervor for regulation may at the same time aid the LECs in finding programming for their video services when they emerge. In July, the House voted 340-73 to pass a cable regulation bill (H.R. 4850) that would require cable company affiliates that produce programs to sell their programming at competitive rates to direct competitors such as the telcos.

Perhaps in their drive for fairness, Congress has forgotten that competition is the greatest regulator of all. Hampton said, "Video dialtone will be more effective than the cable regulation bill in promoting competition to ensure reasonable rates in a pro-competitive environment."

The FCC concurs entirely and seems to be driving for the fully open marketplace. Its petition that Congress repeal portions of the Cable Act would, if successful, allow the LECs to own the programming services that they are clamoring for. However, Hampton believes this "would not help to foster head-to-head competition.

"If one is allowed to acquire the other, one only replaces one monopoly with another. In addition, such a change alters the LEC's common carrier role, and could create incentives for the LEC to discriminate against the service providers in which it does not have an investment."

The telcos sense that the VDT ruling is a step in the right direction, but falls far off the mark of what would entice them into the video services business. A 5 percent stake in video programmers is not enough. They want full control over what they can provide over their network.

Betsy Ricci, a spokesperson for NYNEX, said, "Full programming relief would provide the incentives for the telephone companies to accelerate the deployment of broadband technologies. Without the right to offer programming services, the public telephone network is unlikely to supply meaningful competition to today's cable TV monopolies."

Technical barriers

For VDT to become a reality, a completely new infrastructure needs development. For starters, new connections will have to be made, not just to homes, but between LEC central offices as well.

Bill Murphy, group product manager of HDSL technologies at Tellabs Inc. in Lisle, Ill., said, "The big issue is not getting the connection to the home, that only requires a box at the central office and the home. The big issue is the network infrastructure between central offices."

Video will increase the traffic to the home by several orders of magnitude. A typical POTS (plain old telephone service) connection can operate in the kb/s range while a consumer-quality video signal requires Mb/s capacity. Unless all video communication is isolated to within each central office, this will create a 50-fold-plus increase in interoffice traffic.

New technologies on the horizon such as asynchronous transfer mode (see *Communications Technology*, October 1992, page 20) and SONET promise connections at higher speeds than ever before — 2.8 Gb/s links are now being commercially deployed. These high-speed links will have to become more ubiquitous before massive deployment of wide area VDT services are a reality.

At the local loop level, the existing copper network will eventually support higher bandwidth using emerging new technologies. But, as it stands today, there is no low-cost commercially available technology for bringing high-quality video to the home. ISDN (integrated services digital network) has begun a phase of large-scale deployment, but its 64 kb/s transmission rate is too slow for anything but low-resolution video conferencing.

Two emerging technologies could beef up these copper links to the point where they could carry compressed video with VCR-like quality — HDSL and ADSL. High-bit rate data service link (HDSL) is available today for providing 1.544 Mb/s up to 2.5 miles without repeaters over existing copper facilities. Using compression technology, a fully digital NTSC signal could be squeezed down to fit on these links.

HDSL is just beginning to come into wide use, but the price will have to drop significantly below its current $2,000/circuit cost before it starts rolling into homes. The standard was only defined last year and products began rolling off the production line this past year.

Work is underway to increase the speed of HDSL technology. AT&T Paradyne is reputed to have begun testing 3 Mb/s technology. Murphy said that this was not likely to go very far because it does not adhere to any existing standards. Normal HDSL can support links at T1 rates of 1.544 Mb/s, a telephone industry standard.

Murphy explained that telcos are more likely to go with a technology that is compatible with their existing equipment, even if there is some loss in capacity. Researchers are beginning to develop 45 Mb/s links that are compliant with the T3 industry standard. Although these links can only run a few hundred feet, they could act as the final link in a fiber-to-the-curb architecture.

Asynchronous digital subscriber link (ADSL) is being developed with VDT applications in mind. While HDSL requires two wire pairs to offer duplex service at T1 speeds, ADSL only needs one. It splits the line into different transmission rates in opposite directions — T1 rates to the home and 16 kb/s from the home.

ADSL is still in the research phase and has not been standardized. Bellcore is planning to begin testing prototypes this month. Murphy said that ADSL is in the same place that HDSL was two years ago, implying that it will be another year and a half before ADSL products become commercially available.

Both of these copper-based technologies will only support the first generation of services. When HDTV becomes a standard, it will require considerably more bandwidth than HDSL or ADSL can provide. When virtual reality communication systems emerge, their bandwidth requirements will pale even HDTV's. Fiber to either the home or the curb will become a necessity for these higher speed services. However, completely replacing the installed base of copper will cost enormous sums. Estimates run from $100 billion to $400 billion.

Fiber is not all that much more expensive than cable to install, according to Ricci. The problem is that the RBOCs are only allowed to depreciate and replace cable after a 15-year period. NYNEX has petitioned the FCC to quicken the depreciation period so that it can begin a more rapid deployment of fiber-optic technology.

One possibility that would benefit both large cable companies and LECs would be what Hampton calls a "condominium strategy." Instead of competing to build independent networks, Hampton believes cable and telephone companies could cooperate on a single high-capacity network that they could share by offering noncompetitive services.

One example of this strategy is the Viewer Controlled TV (VCTV) test bed in Denver. VCTV is a joint venture between AT&T and US West on the telco side, and TCI from the cable side. The network takes advantage of all three companies' resources to deliver video-on-demand services to consumer homes.

Entertainment barriers

If VDT is ever to get off the ground, it will require a steady stream of popular entertainment. Murphy said, "Some RBOCs are talking to Hollywood for first-run distribution, but are running into conflict with the existing pecking order." Murphy explained that this pecking order constrains movies to follow a hierarchy of distribution, one that Hollywood is not likely to sacrifice until it can be assured of considerable profits.

Conclusion

The FCC's recent VDT provisions are a first step for bringing the telcos into the video business. However, major barriers, requiring several years to overcome, still remain before the average American will be able to dial up a movie via the telephone network.

Congress has been pushing for increased regulation, which could stop all progress in its tracks. No low-cost, high-speed technologies exist today for leveraging the existing installed base of copper. Fiber-optic cable, capable of supporting high speeds in the local loop, will only be deployed gradually as copper is depreciated out.

These barriers could form the basis of innovative new partnerships between cable and telephone companies, if they can adapt and position themselves for the evolution of video dialtone. **CT**

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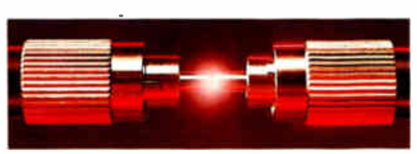

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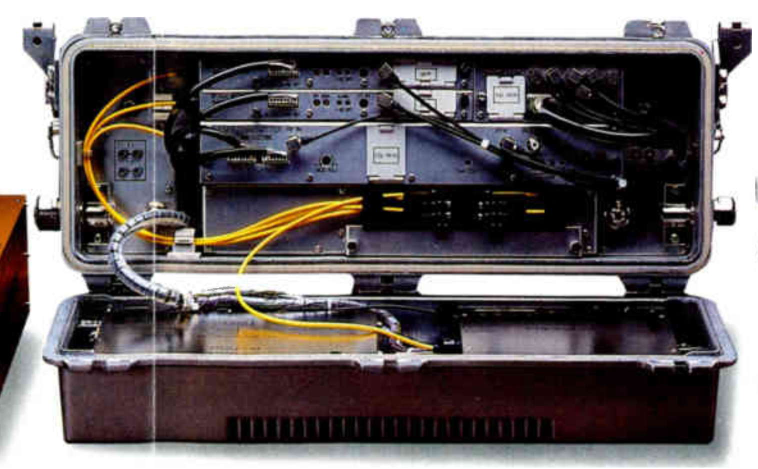

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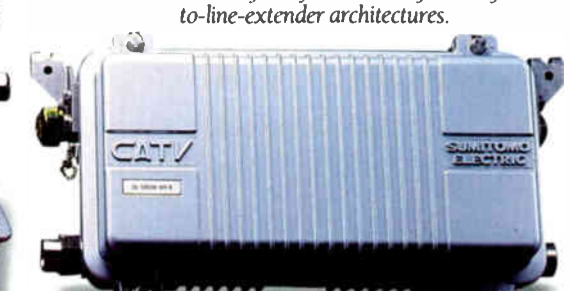

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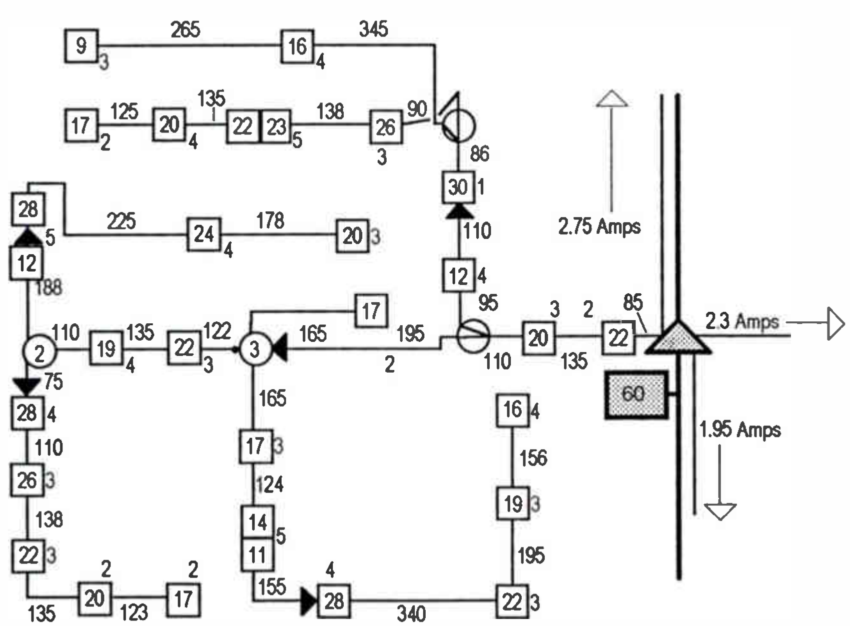
Figure 2

Trunk cable is .875"; .625" feeder
Power supply loading does not include section to be designed



Designing with interdiction

(Continued from page 40)

the two — assuming the same minimum tap output requirements are kept (minimum tap output requirement was +15 dBmV in both designs). Interdiction tap design generally does not cause significant variations in design efficiency as compared to multitap unless, for some reason, you could make do with less tap output level in the multitap run as compared to those chosen by the interdiction manufacturer. Then the interdiction design would require more electronics because its tap output levels are fixed by internal electronic requirements and design. Instances where lower output levels than those chosen by interdiction manufacturers would be acceptable are few in my opinion. As already mentioned, if more internal gain were incorporated in the interdiction unit, designs would actually be more efficient than with multitap use; and at least one manufacturer has indeed taken that approach.

This multitap design also allowed for the use of 2- and 8-port taps. Actually, four ports were left in locations where 2-ports could have been used — unless moving to the 2-port gained some advantage in the design process. It must again be pointed out, however, that there is a big difference in tap port cost between passive multitap and interdiction technologies, so the concern exists in either a design or financial analysis. In this example, designed tap ports totaled (if 2-ports had been used in all appropriate locations) 108, which yields an improved tap port efficiency of 81 percent. If locations requiring an 8-port housing were built with a 4-port and 2-port, tap port efficiency increases to 86 percent.

Points to our RF examination are as follows:

- RF layouts with interdiction are not significantly different than multitap design, given the caveats mentioned. Although designs can be performed using equivalent tap values, the more appropriate and accurate method requires calculation of directional coupler and equalizer values. A good design program not only needs to be able to correctly calculate the pads and equalizers, but also should include a totaling of same in the BOM section of the program.
- Noise and distortion accumulation at the interdiction tap, an active device, must be analyzed carefully. Once understood, noise and distortions can be kept at manageable levels — as we do in any properly designed system. Doing so will have an impact on appropriate system operational levels.
- Lack of 2-port, and in some cases 8-port, tap combinations escalates the number of unused tap ports, which has some financial impact on total interdiction system cost. Past estimates in interdiction designs are that increases in required feeder electronics could be as much as 5 percent, depending on minimum tap output requirements and lack of 2-/8-port units. The designer must take great additional care in proper placement of taps, particularly in underground areas. Use of RG-6 (perhaps even RG-11 in some instances) coupled with careful drop routing is key to a financially as well as technically acceptable design.
- Because the input/output levels of the interdiction device are strictly controlled for jamming carrier insertion, further limitations are placed on the designer with hot-tap use not available.

All in all, once basic concepts are understood, and assuming your design methodology can handle new calculation requirements, the RF design process is not a whole lot different than multitap layouts except for a required eye toward the previous caveats.

AC design considerations

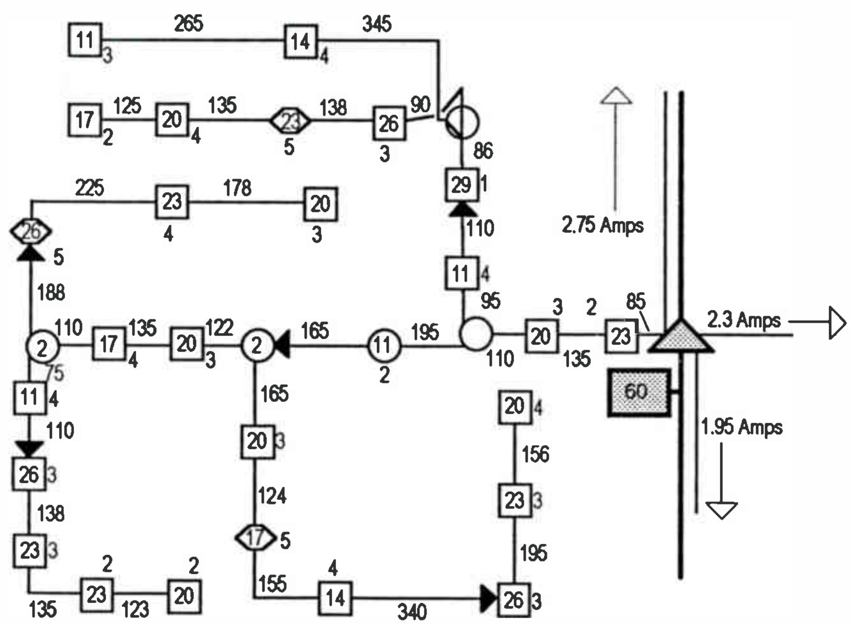
Finally, an examination of the impact of interdiction taps on system AC powering is in order because many operators feel this is perhaps *the* primary stumbling block toward full-scale deployment of this technology. Powering can be either drop- or system-implemented — with system powering the more common approach at this juncture. If single-port units become the accepted future approach, drop powering will likely take hold as well.

When addressing the AC layout, one is faced with several up-front decisions that must be made. Dramatically increased power consumption in the feeder system necessitates a more careful design approach in an area frankly overlooked or given scant attention in many designs. An analogy of design requirements in this area is actually a better match in the AC power distribution system (electric utility) area. Does one design for 100 percent loading at all locations even though you suspect 100 percent basic penetration would never be realized? Do you design for 100 percent tap port use — assuming increased homes passed over time?

Let's re-examine our earlier interdiction design and calculate the system AC powering requirements if interdiction were implemented as shown — and with both present load-

Figure 3

Trunk cable is .875"; .625" feeder
Power supply loading does not include section to be designed



ing vs. 100 percent homes passed loading. We'll also compare this with current requirements for the addition if we had employed multitaps only.

For AC design purposes, I've assumed: 15.8 watts per loaded 4-port interdiction unit; 13 watts for three ports used; 10.75 watts for two ports used; 8 watts for a single port used; and 35 watts per line extender.

Examining Figure 4, you'll note that the interdiction equipment plus line extenders draw an *additional 10.6 amperes* of current. This amount represents interdiction equipment to feed all existing homes passed in the design area — assuming 100 percent subscriber loading. If the area were designed with multitaps, total current flow into the subdivision (additional load) would only be *3.03 amperes*. The interdiction design in this particular area therefore represents a powering load current increase of 249 percent over a standard multitap design. Further points on this sample design are as follows:

- The total additional current draw for the subdivision was 10.6 amperes — easily enough to dedicate an entire power supply for just this subdivision! This presents one of the biggest challenges in interdiction design and operation. I've personally reviewed or performed designs in the past that typically require one power supply per trunk station, and sometimes require multiple supplies per trunk! The prudent approach is to design the area for 100 percent loading at each equipment location, even though one could rationally assume that 100 percent will never be reached. You could project some average loading per section — perhaps 75-80 percent — which would result in some reduced power requirements but will not entirely avoid the issue.
- In this particular example, the addition of 10.6 amperes to the supply loading that already existed (2.75 A + 2.3 A + 1.95 A) takes total supply loading to 17.6 amperes, beyond the capacity or advised loading of most supplies. Thus, in this admittedly fictitious example, a second supply would be required anyway.
- Current draw through the first several interdiction units is greater than 10 amperes, which exceeds the current passing capability of most if not all brands presently on the market. Thus the supply would likely have to be located farther into the subdivision at a point where injection better balances current flow in various directions, or a cable would have to be overlashed from the trunk location for injection further into the system. The second alternative has some drawbacks that I won't go into at this point; suffice it to say that it's not the best solution to the problem.
- Voltages at the various system components are OK. In the interdiction run, the lowest voltage at any point including end-of-line locations was 51.2 VAC. In the multitap run, the lowest voltage at any line extender was 57.3 VAC.

The conclusion to all this is that powering is probably the more difficult of the two design issues when tackling interdiction. The old method of "placing supplies every once in a while where it looks like they should work" — won't! You need an accurate AC design program and a lot of patience.

As a final note on powering, recent work performed by the Outage Reduction Task Force of Cable Television Laboratories (of which I was a member) accurately points out that, from a system reliability perspective, power supply cascades are quite crucial. Interdiction powering poses an additional problem: If a power supply is needed roughly every trunk station, a cascade of 20 trunks will yield an equivalent cascade of power supplies — a number totally unacceptable for reliable overall system performance. That leaves two alternatives to effectively reduce the power supply cascade (or its effects):

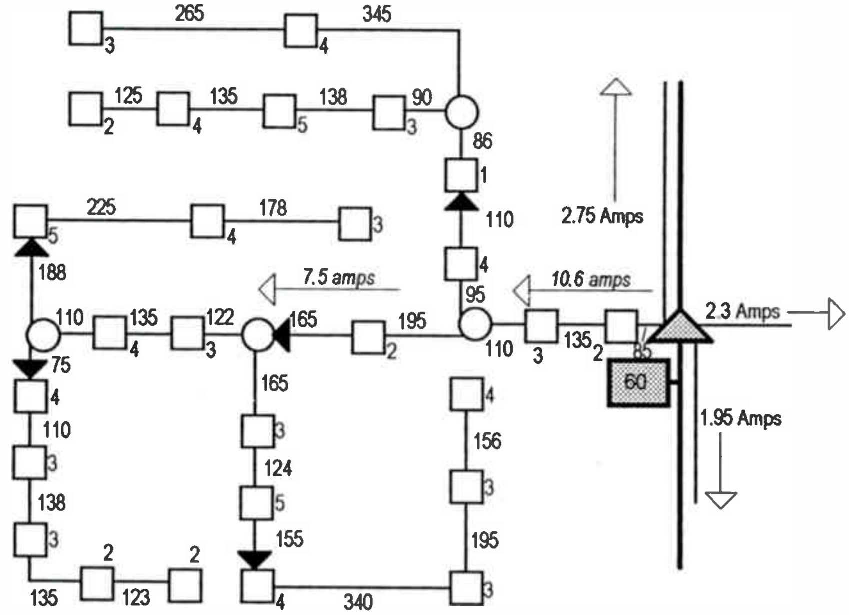
1) Employ hardened trunk techniques — powering trunk and feeder separately. This is really an ideal solution in many ways: trunk power supply cascading is kept to very minimal numbers, with a single (or sometimes multiple) supply for each feeder area to power line extenders plus interdiction devices. Power supply cascades with this approach are typically at five or less, with 60-75 percent power supply cascade reductions easily attained as compared with normal *trunk + feeder* AC layouts.

2) Employ standby powering at all or crucial locations to reduce the effect of lengthy power supply cascades.

Based on many sample designs accomplished, I believe typical overall powering load requirements increase around 200 percent or more with interdiction as compared to multitap design. The example shown earlier with an increase of 249 percent is therefore not atypical. While this presents some challenges for the designer and operator, they are manageable ones. I also feel that system powering issues are preferable to the different and more difficult-to-manage problems introduced with home powering via the drop cable. Very careful placement of each main AC supply is necessary in optimizing the AC design, and this location is

Figure 4

Trunk cable is .875"; .625" feeder



not always at the trunk station as has already been noted. AC design placement efficiencies are therefore possible in interdiction but must be considered carefully by the designer due to the increased powering requirements. Finally, hardened trunk powering techniques are recommended to keep supply cascades at acceptable levels of around seven or less.

Conclusion

Interdiction technology represents an exciting new choice in signal security and addressable control of the signals entering subscribers' homes. While somewhat increasing the cost of plant design compared to one-way addressability, cost savings are incurred in the use of converters and traps, and even offer the cable operator the opportunity to entirely vacate the converter business if desired. It offers a broadband non-scrambled signal to the subscriber with fully resolved consumer-interface issues and increased consumer acceptance of cable products.

In terms of RF and AC design considerations, new issues exist here that were not of serious concern in multitap designs. Some limitations in overall design flexibility occur given strict unit input/output levels, inability to use hot-taps and lack of 2-port units. These problems are manageable, however, and I believe the overall advantages offered by interdiction far outweigh the concerns. **CT**

FCC-required measurements

(Continued from page 43)

this and other cable industry publications in the past few years. In fact, prior to the new technical standards, the codification of CLI was the last major technical challenge presented to the industry. The paragraphs of §76.605 concerning leakage, for all practical purposes, did not change. Since the topic of CLI has been so well-covered in the recent past, and it is already among the most familiar technical exercises for cable operators, the January 1990 and July, August and December 1991 issues of *Communications Technology* should provide all the in-depth information you need.

Coherent disturbance, terminal isolation and leakage measurements, like the ones discussed in the two previous FCC measurements articles, should be manageable for any system. Most systems already own the bulk of the equipment needed for these measurements. If not, the new regulations should give you all the financial justification your manager needs. **CT**

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SCTE STATUS:

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Chapter or Meeting Group Name: ______________________________

Nat'l Member ____Yes ____No

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Address: ______________________________

Title/Position: ______________________________

Employment period: from ____________ to ____________

Telephone Number: (_____)____________

Present Supervisor: ____________

Duties: ______________________________

EMPLOYMENT HISTORY:

Employer: ______________________________
Address: ______________________________
Phone Number (_____)____________
Title/Position: ______________________________
Duties: ______________________________
Immediate Supervisor: ______________________________
Employed from: ____________ to ____________

Employer: ______________________________
Address: ______________________________
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Duties: ______________________________
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Employed from: ____________ to ____________

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Activity or membership: ______________________________
Your most significant contribution: ______________________________

Current SCTE BCT/E or Installer Certifications: ______________________________

EDUCATIONAL HISTORY: (Attach all appropriate transcripts)

High School Level Completed: ☐ 9 ☐ 10 ☐ 11 ☐ 12

College Level Completed: ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6

Names & Locations of Schools: (Attach additional page if necessary.)

______________________________ ______________________________

Degree Granted: ____________ Date: ________

Major: ____________ GPA: ____

Dates of Attendance: ________ to ________

Degree Granted: ____________ Date: ________

Major: ____________ GPA: ____

Dates of Attendance ________ to ________

Vocational/Military School:

Names & Location of School:

____

Graduated: ______ Yes ______ No ________ date

Course of Study: ______________

Dates of Attendance: ________ to ________

Grade Point Average (4.0 scale) ________

Correspondence or Self-Study Courses:

Name & Location of Institution:

____

Diploma Granted: _____ Yes _____ No ________ Date

Course of Study ______________

Dates of Attendance ________ to ________

Grade Point Average (4.0) scale): ________

REFERENCES: (Two industry related references required)

Name: ______________

Title/Position: ______________

Company: ______________

Address: ______________

____

Telephone Number: (____) ______________

Name: ______________

Title/Position: ______________

Company: ______________

Address: ______________

____

Telephone Number: (____) ______________

CONFIDENTIAL FINANCIAL DATA:

Gross Annual Income:*$ ________ Net Taxable Income:*$ ________ Number of Dependents: ________

** As reported in the IRS in last tax year; for married couples filing separately, include both incomes.*

INTENDED USE OF TUITION :

NCTI Course Other Course Please specify school, course, amount required and reason for studies (use additional page if necessary):

____

____

____

____

Explain why you should receive an SCTE Technical Tuition Assistance Grant and how it will benefit you (use additional page if necessary): ______________

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____

____

Signature: ______________________ Date: ____________

Please Fax to (215) 363-5898 or return completed form to:

Society of Cable Television Engineers, 669 Exton Commons, Exton, PA 19341 • PLEASE ALLOW 90 DAYS FOR PROCESSING.

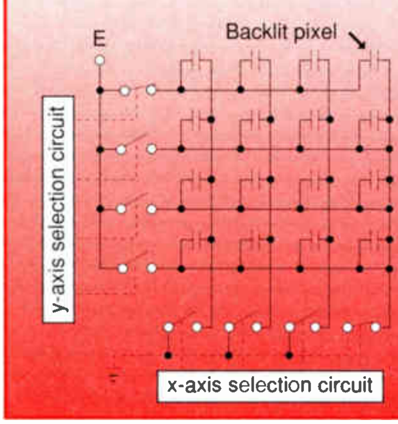
New developments in flat panel displays

By Lawrence W. Lockwood
President, TeleResources
East Coast Correspondent

As has been said often and by many, high definition TV (whether analog, digital or whatever transmission scheme is finally approved) will not become a large business (a consumer business) unless the home receivers produce a substantially larger picture than the current popular NTSC receivers — and at a price the consumer will pay, in volume.[1]

Table 1 shows the scanning relationships of the five HDTV systems under test along with their display diagonals (at a 9-foot viewing distance — taken as an average home viewing distance). The 16:9 display diagonals are determined in the same manner as that done for determining the viewing distance as three times the picture height for a 1,125 system or the viewing distance as seven times the picture height for NTSC; i.e., determined using the 1

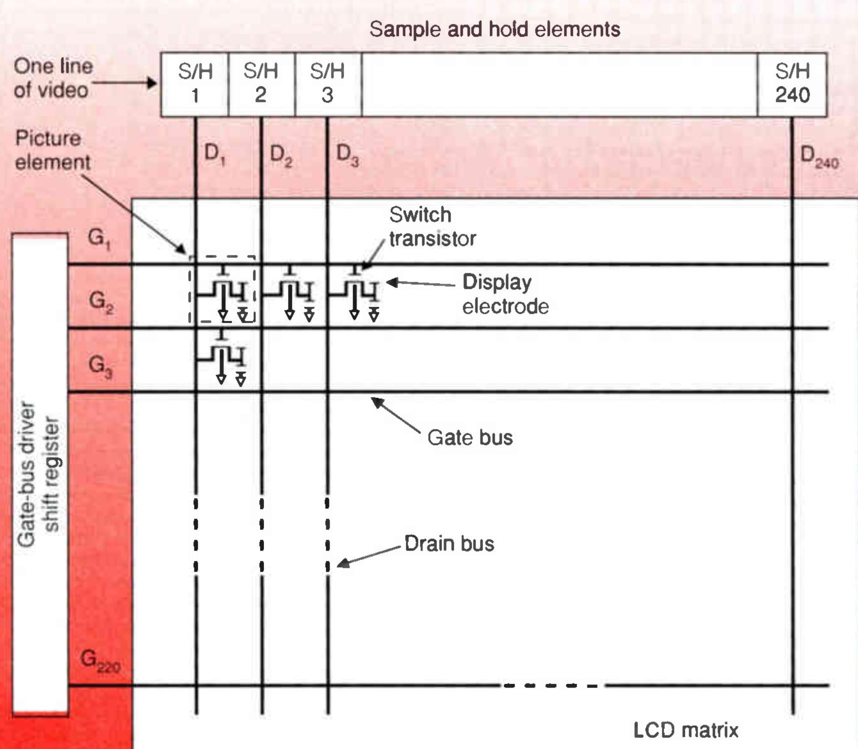
Figure 1: Passive matrix display



arc minute resolution of the human eye. Using the same calculations and at the same viewing distance, an NTSC display would be smaller. Any smaller 16:9 display diagonals than those shown in Table 1 will waste HDTV resolution and at a 30-inch diagonal, produce *no better resolution* to the viewer than NTSC.

The display diagonals pretty much rule out the use of CRTs because of weight and size. Sony currently sells a 38-inch diagonal HDTV CRT display (present price $59,500). The price in volume would likely come down but, for the home, totally unrealistic values of weight (over 400 pounds) and floor space required (41 inches and most important 3 feet deep) are unlikely to be reduced. These have been key factors behind the worldwide interest in flat panel displays.

Figure 2: Matrix addressed LCD



Flat panel LCDs

The principles of operation of any of the LCD (liquid crystal display) video flat panel approaches — passive matrix, matrix addressed and active-addressed passive matrix — are the same: Each pixel (picture element) of the LCD panel is presented with the video voltage of that pixel and that voltage regulates the LCD pixel's transmission (low video voltage = dark LCD pixel, higher video voltage = lighter LCD pixel). The most common LCD flat panel display is the passive matrix used in watches, calculators, etc. (See Figure 1.) All LCD displays used for video are illuminated from the rear.

The passive matrix STN (super twist nematic) LCD response times still remain relatively sluggish, just fast enough

"High definition TV ... will not become a large business (a consumer business) unless the home receivers produce a substantially larger picture than the current popular NTSC receivers."

to follow cursor movement, and much too slow for video. The cause of the speed problem isn't the STN display itself but the standard multiplexing addresssing method to drive passive matrix LCDs. The current row-at-a-time addressing method breaks down; after each select pulse, the liquid crystal significantly decays before the next one refreshes it, causing the display to fade.

Table 1: Scanning relationships used by the five HDTV systems under test and display scan size for each (at the average home viewing distance)

System	Scan ratio	Scan type	16:9 display diagonals at a 9-ft. viewing distance
Narrow Muse (NHK) Japan	1,125/60	Interlace	65 inches
DigiCipher (GI/MIT)	1,050/59.94	Interlace	60 inches
DSC-HDTV (Zenith/AT&T)	787.5/59.94	Progressive	46 inches
AD-HDTV (ATRC)	1,050/59.94	Interlace	60 inches
Channel Compatible DigiCipher (GI/MIT)	787.5/59.94	Progressive	46 inches

Matrix addressed displays

The matrix addressed LCD is one that has received massive developmental investments. Twenty-nine Japanese LCD companies will invest over $1 billion this year into development, improvements and mass production. The matrix addressed LCD display overcomes the fading problems of the passive matrix LCD display. (See Figure 2.) The matrix addressed LCD display has a thin film transistor (TFT) at each pixel. This transistor holds the video voltage on the LCD pixel until the next "sweep," thus overcoming the fading problem of the passive matrix LCD display.

However, the attendent problems of perfect deposition of thousands (up to a couple million in some HDTV) of TFTs over the height and width of the display has produced enormous yield problems. Yield in the normal manufacture of transistors refers to the number of good vs. bad transistors produced in a 6-inch silicon wafer. The problems with producing transistors (TFTs) on a display panel (aside from the fact that the size of the panel vs. that of the smaller wafer produces significant manufacturing difficulties) is that the yield must be perfect. The eye is *extremely sensitive* to any discontinuities.

Currently, even only 10-inch matrix addressd LCDs are achieving manufacturing yields of 10 to 20 percent or 80 to 90 percent rejects; and worse, the problem is aggravated as the displays get larger. One proposal for large displays under some consideration is to "tile" many of the smaller displays to make one large one. However, the problems here are apparent (aside from the fact that the high cost of the aggragate collection of the panels is obvious) and at present far from solved.

Active-addressd passive matrix displays

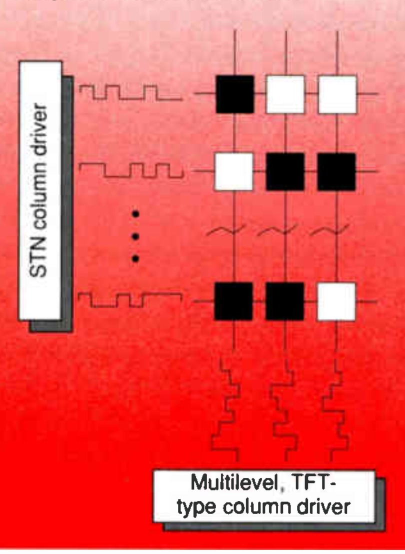
At the '92 meeting of the SID (Society For Information Display) in Boston, a small company (In Focus Systems Inc. of Tualatin, Ore.) presented a paper and a color demonstration of a very interesting new approach to a passive matrix LCD — the active-addressed passive matrix LCD.[2,3] Paul Gulick, vice president of technology for In Focus Systems, stated that though the demonstration unit was small (4-inch diagonal with a 240x240 pixel configuration) the performance was outstanding — especially since it was in color. In this scheme, instead of each row being sequentially pulsed, or selected, as in a passive matrix display, all of the rows are selected all of the time with special, low amplitude bi-level signals. Each row receives its own characteristic signal. The row signals are conveniently delivered with a standard LCD column driver used as a row driver for active addressing. Since every row is simultaneously "selected," the column signal depends upon the collective information state of all pixels in the column. Special algorithms are therefore required to generate the column signals to ensure that each pixel receives its proper RMS voltage. (See Figure 3 on page 98.) With active addressing, the pixel sees many small pulses and the liquid cyrstal never has time to decay before it is pulsed again, even in very fast STN cells.

Active addressing requires a sophisticated algorithm that allows the simultaneous driving of multiple rows and columns to provide exact control over any pixel without loss of contrast. →

Table 2: Comparison of 40-inch direct-view HDTV technologies

Feature	CRT	TFT-LCD	PDP
Peak area luminance (fL)	35	35	35
Typical head power consumption (W @ 40 percent APL)	180	230	100
Maxium head power consumption (W @ 40 percent APL)	200	230	160
Average luminous efficacy (lm/W @ 25 percent APL)	0.23	0.17	0.42
Gray scale (levels)	256	64	256
Monitor weight (lbs.)	400	50	60
Monitor depth (in.)	34	2	2
Viewing angle	Excellent	Restricted	Excellent
Relative cost	Medium	High	Low

Figure 3: Active addressing of passive matrix LCD



Full color is achieved through In Focus' proprietary triple supertwist technology TSTN where three STN panels are stacked together, each controlling a subtractive color primary, although additive color techniques are possible as well. Since each panel is capable of displaying 64 gray levels, a palette of 262,144 colors is possible. The response time of the system is 30 ms at operating temperature and the contrast ratio measured off the screen is over 30:1. The display resolution can easily be exteded to 640x480 with no impact on display performance.

In Focus claims that active addressing presents a pathway to obtaining TFT-like performance with existing low-cost STN manufacturing techniques. Besides the obvious advantages of cost and production volume STN has over TFTs, the aperature ratio of an STN pixel is inherently larger than that of a TFT pixel because bus lines and transistors are not present on the substrates. This allows for more light throughput, especially at finer resolutions. In Focus also claims that active addressed displays will achieve rapid commercialization because no new technologies or production methods need to be developed, and there are no critical yield issues.

In Focus is a 6-year-old spin-off of Planar Systems, in turn, a spin-off of Tektronix's display operations. Shortly after the SID show a new and interesting development was revealed when Motorola and In Focus made a statement. Motorola is going to make a $20.2 million investment for a 20 percent equity in In Focus and will form a 50-50 partnership to build an active-addressed passive matrix plant in the Portland area.

Plasma display panels (PDP)

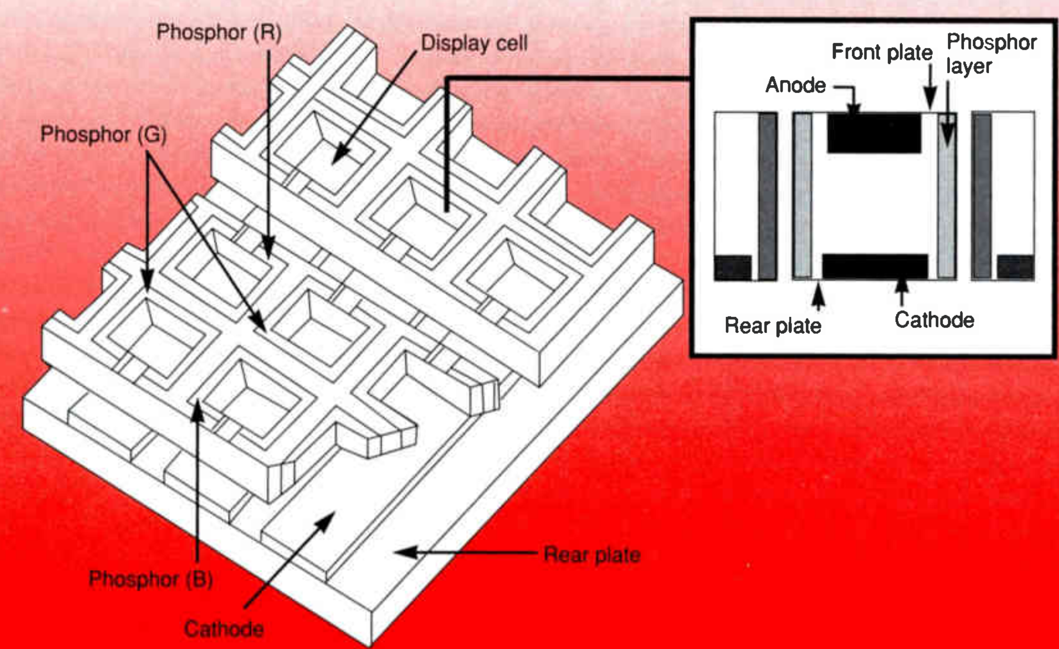
PDPs are another flat panel display area receiving a great deal of attention. At the SID show Texas Instruments-Japan showed a prototype of an NHK/OKI 25-inch color plasma HDTV with pulse memory. Peak white luminance is rated at 90 cd/m^2, but according to observers, the exhibited unit was probably producing about 75 cd/m^2, which the observers noted was subjectively bright enough and with natural and pleasing colors. Commercial introduction is targeted for late 1993 at $10,000, which is the target time and price for commercial CRT HDTV receivers.

In early October Fujitsu, at the Japan Display '92 conference in Hiroshima, demonstrated a 21-inch full-color ac plasma display that it is going to make commercially available initially at $7,000. The display is 1-1/4 inch thick, weighing 10-1/2 pounds, has an area luminance of 150 cd/meter^2 and has a viewing angle of more than 140°. Akira Otsuka, the project manager of design and engineering at Fujitsu's display division, predicted that a 40-inch HDTV wall-hanging ac plasma display can be commercialized within a year or two. He said "with no doubt, it's technically feasible — 50- to 60-inch displays will become ready within three to five years."

Standard monochrome plasma displays contain neon and emit the same red light as a neon tube; custom versions have reached sizes to 1.5 m (60 in.), while laptop computer-size monochrome panels sell for about $500 each in quantity.

Color plasma panels work like a fluorescent bulb, containing color phosphors that convert ultraviolet light from an internal gas discharge into visible light. Such a configuration is used by the TI/NHK/OKI unit as shown in Figure 4.

Figure 4: Color plasma display cells



Acording to Peter Friedman, president of Photonics Image (Northwood, Ohio) — another PDP manufacturer — manufacturing costs for color ac plasma will be well below those for TFT LCDs. His projections show a better than 90 percent yield for displays, even as they scale up to 55 inches and beyond. He believes (not unexpectedly) that PDPs will lead to the first practical, nonprojected large screen, picture-on-the-wall HDTV display.

A comparison of these technologies taken from the publication of SID[4] is shown in Table 2 on page 97. (In Table 2 the display head is the display itself with its associated drive and control electronics. The luminous efficacy of the display head is the total luminous flux emitted by the display head divided by the electrical power required to produce it — under typical operating conditions.)

Microtip flat panel display

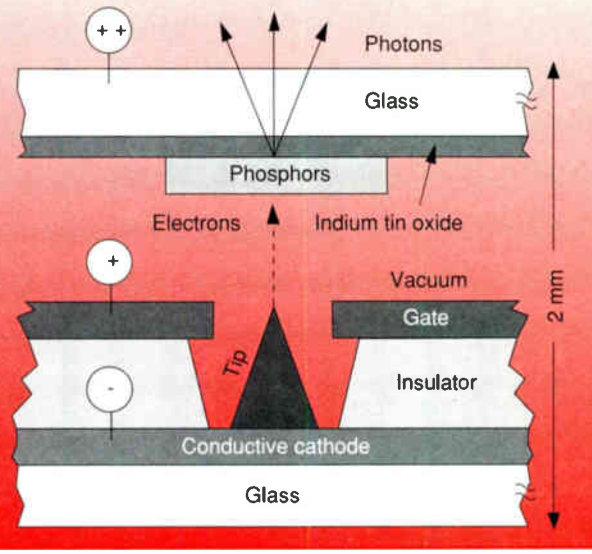
An intriguing — though far from fully developed — scheme is essentially a flat CRT. A feasibility demonstration of a color display using the microtip technology was recently shown at the Laboratoire d'Electronique et de Technolgie de l'Informatique (LETI) in Grenoble, France. The microtip field emission display (FED) technology was pioneered by SRI International (Menlo Park, Calif.) in the 1960s. The microtip fluorescent display is a thin CRT with two main features: it contains a large matrix of microscopic electron guns, called microtips, that emit cold electrons by field effect, and it has a low-voltage screen that produces light when struck by electrons. (See Figure 5.)

The microtip flat panel display uses a large array of microscopic tips that emit electrons. The electrons are accelerated toward phosphors across a vacuum. The principle is the same as that of conventional CRTs, but the electron-flight distance is greatly decreased, and the number of electron guns is greatly increased. The entire panel is only 2 or 3 mm thick, unlike displays of conventional CRTs. The configuration of these microtips to make a flat panel display is shown in Figure 6.

In this microtip display configuration, the anode is patterned in three sets of indium tin oxide (ITO) stripes, each covered by different phosphor, with stripes of the same color interconnected. In each pixel, the same cathode is used to excite all three colors by positively biasing one set of ITO bands after the other; at a given time, the electrons emitted by the cahode are attracted to the selected phosphor by the active anode. By switching anode voltage on each color, and by sequential addressing of the cathode, a full-color image can thus be displayed. This principle requires a faster line scan than a monochrome display because three frames must be addressed per picture; the fast response time of the field effect makes this possible.

This scheme needs *much* more development before it could be considered a candidate for consumer HDTV use. However, it has already attracted the attention of a number of military/aerospace contractors who have joined with Microelectronics Computer Technology Corp. (MCC) to form a consortium to develop these for military use — largely avionic displays (although Zenith is said to be negotiating to join the consortium). A French company, Pixel International, has licensed LETI's FED technology and according to Pixel's founder, Jean-Luc Grand Clement, it will start selling notebook computer-sized screens (8.5-10 inches) at a medium volume of 200-300 screens a day by mid-1994. Meanwhile, Pixel is seeking world-class partners — those that turn out 2,000 screens a day — to help penetrate a global market. Within five years, Pixel plans to attack the HDTV market with direct-view, 1/2-inch thick, 40-inch displays.

Figure 5: Microtip configuration



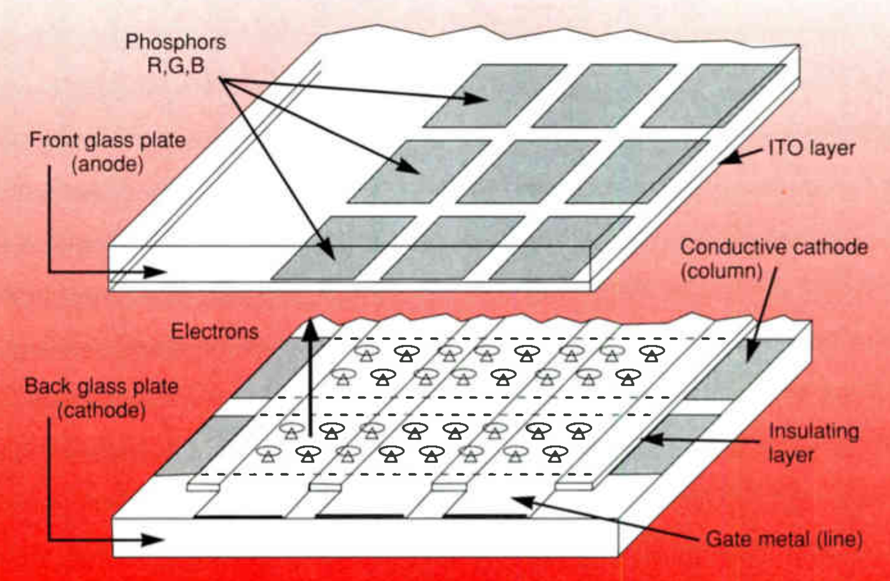
Conclusions

Since a large picture display is necessary for an HDTV consumer success, a review of the available display techologies reveals problems of a differing nature — depending upon the specific display technology.

CRTs produce bright pictures, which is important when in high ambient light conditions; e.g., viewing the soaps or a ball game in mid-day without having to draw the blinds. However, for HDTV the weight and furniture size rule agains CRTs. Although these negative factors work against CRTs for home HDTV display use they are being used in some business applications of HDTV where these drawbacks can be ignored; e.g., use in the auto industry for vehicle styling, etc. CRT projection sets — both front and rear — produce good sized pictures but suffer in high ambient light — and they also are heavy and are large furnitures. The

(Continued on page 100)

Figure 6: Microtip display configuration



FOR SAFETY'S SAKE

Part 2: Tools and personal protective equipment

By Michael H. Morris
President, Taylor, Morris & Associates

I recall vividly as a child building my first tree house. I had found the perfect tree, the right materials and the proper tools. I had at my disposal all of the tools a enterprising 8-year-old could ask for: a rusty saw and a single-edged hatchet, good for pounding nails or form fitting hard-to-use materials.

Being distracted for a moment, I picked up a 16 penny nail and with my first stroke realized that I had used the wrong edge of the hatchet. Looking down I could see the sharpened edge precisely intersecting the head of the nail. I remember thinking at the time that it was not luck that left me with my fingers, but my superior skills as an 8-year-old master craftsman. In retrospect — I'm slightly more mature now — I now recognize that I had used the wrong tool for the job.

The federal government, through the Occupational Safety and Health Administration and OSHAct, protects people like you and me through the various standards that require employers to provide training to the worker. This not only protects the worker from injury but those who work in and around the area where the tools, equipment and materials are used.

OSHA gives us the right, and more importantly the obligation, to work in a safe, healthy environment. As with any tool, we can choose to ignore this right, and use the tool in a manner that is not consistent with its intended use.

The Telecommunications Standard (Part 1910.268, Sections A to S), defines the specific procedures we are required to use when inspecting safety equipment and tools. It tells us about safety procedures that we should observe while performing various tasks, directing us in the specific procedures that we must use when we perform specific job functions.

OSHAct Standard 1910.268 is 31 pages long. It covers a broad range of information. Items such as battery handling, first-aid kits, pole climbers, lead soldering and insects are examples of information covered. To address every point in this standard would be very time-consuming. OSHA requires that every cable operator have a copy of the Telecommunications Standard. More importantly, you are required to be trained in all aspects of the 1910.268 as it relates to your job functions. If you have not read it, ask your supervisor for a copy.

Critical areas of 1910.268

To assist you in focusing on critical areas of 1910.268, here's a few examples of items you might want to refer to:

- Heading (D) deals with employees' protection in public work areas. Warning signs and/or flags shall be placed conspicuously to alert and channel approaching traffic ... The employer shall ensure that an employee finding any crossed or fallen wires that create or may create a hazardous situation at the work area (i) remain on guard or adopt other adequate means to warn other employees of the danger and (ii) has the proper authority notified at the earliest practical moment.
- Heading (F) covers tools and personal equipment. Generally ... before each day's use the employer shall ensure that these personal protective devices, tools and equipment are carefully inspected by a competent person to ascertain that they are in good condition.

So who is a competent person? You are! A worker who is considered qualified in the completion of his work duties is considered competent. Therefore, you are responsible to examine your tools and equipment *before each and every use.*

If your gaffes are worn to a length of less than and 1/4 inches, they must be replaced. If your ladder is missing rungs or if the rungs are loose, remove it from service. If your drill has a frayed cord (exposing electrical wires) repair it or replace it. If your rubber gloves have holes in them, discard them and get a new pair. Rubber goods (i.e., rubber gloves and blankets) should he tested no less than once every 12 months.

As cable TV technical personnel we work in and around dangerous situations on a daily basis — situations that may not allow us a second chance if we make a mistake around electrical lines, in closed spaces or at high elevations.

No rule or regulation can make you use tools and equipment correctly. It is your responsibility to use common sense as you perform your daily work assignments as well as follow safe work practices. Although you may say: "It's my life. Let me live it my way," or "I know it all, don't bother me with all the rules" — you may be setting a poor example for someone who looks up to you or worse, cause serious injury to or the death of someone else because of your poor work habits.

No job is more important than the safety of workers and those around them. **CT**

Clarification — In Part 1 (October) a reference was made regarding the testing of linemen's body belts. It should be noted that OSHA requires the tests to be done on production line samples by a nationally recognized testing lab, not the employer. As well, once a belt has been so tested, it cannot be used to provide fall protection. (Thanks to SCTE's Ralph Haimowitz for pointing this out.)

Flat panel displays

(Continued from page 99)

active matrix LCD flat panels have enormous problems in achieving any reasonable size for HDTV. When used in projection rather than direct-view they suffer from the same problems as CRT projection.

At this point in time, at least two flat panel methodologies seem worthy of continued close attention — the active-addressed passive matrix LCD and the plasma display technologies. **CT**

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[1] "An HDTV Flat Panel Display Contender?" L. Lockwood, *Comunications Technology*, January 1991.
[2] "Active Addressing Method for High Contrast Video Rate STN Displays," T. Scheffer, B. Clifton, In Focus Systems.
[3] "Active-Addressed Passive Matrix Opens Lower Cost LCDs to Video," P. Gulick, *Advanced Imaging*, May 1992.
[4] "HDTV Techologies: The Power and the Light," P. Friedman, K. Werner, *Information Display*, June 1992
[5] "Displays On Display: SID '92," K. Werner, *Information Display*, July/August 1992.
[6] "Japanese Flat-Panel Displays: What JTEC Saw," L. Tannas Jr., *Information Display*, July/August 1992.

December 1992

Spotlight on troubleshooting

BACK TO BASICS

The training and educational supplement to Communications Technology magazine.

Table of Contents

Calculations made simple — Part 1

This installment deals with carrier-to-noise ratio measurements. Part 2 will deal with composite triple beat measurements.

By Mark Harrigan
State Engineer
TCI Cablevision of California

The accompanying "calculations made simple" tables were put together to assist our field personnel who are required to perform these calculations monthly at random test point locations. I call them simple because even

Cascade (trunk only) carrier-to-noise

Cascade	10 x (log cascade)		Single station C/N		Cascade C/N
17	12.3	+	-59.5	=	-47.2
		+		=	
		+		=	
		+		=	
		+		=	

Single station carrier-to-noise

Thermal noise		Input level		Station noise figure		Equalizer loss		C/N
-59	-	10	+	8	+	1.5	=	-59.5
-59	-		+		+		=	

Combining different carrier-to-r

Trunk C/N	Divide by 10	Antilog		Bridger calculations	Divide by 10
-47.2	-47.2	1.9-05	+	-67	-6.7
			+		
			+		
			+		
			+		
			+		
			+		
			+		
			+		

oise numbers

Antilog		1st line extender (if applicable)	Divide by 10	Antilog	2nd line extender (if applicable)	Divide by 10	Antilog		AML noise (if applicable)	Divide by 10	Antilog	=	Log x 10
1.995	+	-62	-6.2	6.31-07	-62	-6.2	6.31-07	+	-54	-5.4	3.98-06	2.45-05	-46.1
	+							+					
	+							+					
	+							+					
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	+							+					
	+							+					

if you forget all the formulas, the example lines (highlighted in the table) will get you there (if you can get the same answer) as long as you have the amplifier single station specifications, which should be typed on the form before it's passed out. Beyond its primary purpose, these forms help provide a good "practice application" of the classroom training field techs receive, making what they are taught a little more relevant. **BTB**

I changed the converter: So what is it I do now?

By Les Read
Field Service Engineer
Sammons Communications

Is this familiar? You've just been promoted to technician after a distinguished career as installer. You have gone through a too-short period of on-the-job training with an experienced technician. Today is your first day working alone.

The customer has a problem picture and you have found that the problem is not the TV set nor the converter. And the levels into the converter are fine. Where do you go from here? What is the best way to solve the problem?

Getting ready

First, do you have the proper tools? You need a signal level meter (SLM), a digital voltmeter, and a TV set you can use in the field (either DC or one with a generator). What else? You need a knowledge of appropriate trunk and feeder levels and AC and DC voltages.

Second, listen to the customer and observe the picture and sound on the customer's TV set. Describe the picture to yourself as perhaps "snowy," "having horizontal lines," "having diagonal lines," "with two pictures superimposed," "with some snow and some pattern" or whatever other words come to your mind. Is the sound clean, "buzzy" or "muffled?" Don't try to figure out what could be causing the problem. Just remember your description.

Third, check signal levels across the band. Are they all reasonable or are some extra high or low? If some are high or low, are they clustered at one end of the band or are they sprinkled all across the spectrum? Remember if there is anything unusual about the levels.

Fourth, connect your test set in place of the customer's TV set. Can you see the problem there? If you can't see it there, you will find it difficult to see out in the field!

In search of good pictures

Your next step will be to find an upstream location where pictures are good. For troubleshooting purposes, it really doesn't matter whether you find pictures good at a trunk amplifier or a line extender or a tap. Remember we are not just looking for good levels, we also are looking for good pictures. Use your test set.

Now you are going to use the "Rule of Halfway." Roughly stated, this is if you know where pictures are bad (the customer's house) and where they are good, then if you split the possible locations of the defect in half and check at the middle, you will have optimally used your time in pinpointing the location.

This works most cleanly dealing with trunk amplifier cascades. For example, if the problem is present at the 16th trunk amplifier in a cascade and the headend is clean, the (theoretically) optimum amplifier to test would be the eighth, then the fourth or 12th, etc. This assumes you have no prior knowledge of the possible problem locations and all locations are equally accessible.

Applying this to a feeder run, you would choose taps by halves. Again you would choose the more accessible locations for testing.

You probably have some idea where the pictures are good. For instance, if there are only a few calls about a popular channel in a localized area, you may guess the trunk is OK.

What do we do now?

Assume now that you have found where the pictures are good and the first location in the system where the pictures are bad. They look much like those at the customer's house. This location could be a tap port if you are working feeder or a trunk station if there is a trunk problem.

Check the input and output levels, and AC and DC voltages. This is probably not news, and is probably your company's standard troubleshooting procedure on trunk amplifiers and line extenders and can give you much information. Be sure, in checking levels, to check the channel giving the problems in addition to the pilot channels. Check any others that appeared odd at the customer's house.

Checking input and output levels is easy on amplifiers, which always have test points. It is not so easy on taps but can be done with a housing-to-F adapter screwed into the port and touching the seizure screw. It is important to realize that this technique "loads" the signals so:

- The levels you read are approximately 3.5 dB down from the levels under normal operation, and
- At the time levels are being read in this manner, there is an impedance mismatch on the line.

There may be power on the line. Don't blow a fuse!

Also, the SPD-30 (otherwise known as the "Speedy 30") should be mentioned. This test probe is designed to bridge across the center conductor and at the meter end to present the signal exactly 30 dB down. There are two important facts about the SPD-30:

1) It does *not* load the line down. What you read is 30 dB below actual signals.

2) It is *not* a 30 dB pad. It is not a pad at all. You cannot use a pad in place of an SPD-30 and you cannot use an SPD-30 in place of a 30 dB pad!

Measure AC and DC voltages at a suspected problem location. DC voltages in trunk amplifiers and line extenders have narrow tolerances, often ± 0.5 volt, and your digital meter should read the specified value on a properly operating unit. AC voltages, on the other hand, can vary over a wide range and the ability of meters to read them accurately also varies widely, depending on the power supply waveform and the meter circuitry. It is a good idea to check your AC meter on properly operating amplifiers to get a feel for a satisfactory voltage reading. *(Editor's note: Unless you use a true RMS digital meter, your AC voltage reading will be about 10 percent high when measuring the quasi-square wave power on cable systems.)*

Meanwhile, back at the location of defective signals, you have some choices to make. You have narrowed down the location of the defect to that location or the previous one. (It could be the output connector at the previous one, couldn't it?) At this point signal level measurement and visual inspection may give you the answer. What if it doesn't?

Fuzzy logic

It would be great if, using deductive reasoning and a few well-chosen tests, we could go directly to the fault, identify it immediately and fix it quickly. And most of the time, with more experience, you will do just exactly that!

Sometimes you will be faced with a

problem that could be caused by one of the following several components: input connector, output connector, trunk module, AGC module, bridger module, tap plate, etc.

Make a guess at which component to change, but allow yourself to be mistaken. You may have to change several before the problem is fixed. After each component is changed, it is good practice to check pictures to see if the problem is cured. It often is cheaper overall to replace several components, even if only one is defective, than to spend a great amount of time pinpointing the failed component by analyzing the symptoms.

Engineers sometimes fall into the trap of excessive symptom analysis when dealing with field problems. If you have one working with you who is afflicted with this disease, and you are working on a problem, let him amuse himself by the analysis, but go ahead and change out a few things that might be the problem. When the problem is solved, he will probably say, "Yes, that's what I though it was." If he feels really good he may buy you lunch.

I remember vividly an incident involving an intermittent trunk outage occurring during a city council meeting where a new franchise was being discussed. The engineer was in the headend analyzing the whole power supply structure, while a technician found where a tree had rubbed the cable and caused a short!

Intermittents

The easiest problem to find is a complete outage. Constant picture defects are nearly as easy, depending on the symptom. But, listen to some technicians telling "war stories" and you will hear about really difficult problems.

The customer says: "It was really bad this morning, but it is OK now." Or, "It happens about every 30 minutes to two hours, sometimes in the morning and sometimes in the afternoon." Or maybe: "The man who was out here last week changed the box on the set and replaced some fittings, but it still comes and goes." Sound familiar?

There are three ways to handle intermittents:

1) Luck

2) Rebuild the entire system

3) Use two patient technicians with communications

Luck works sometimes. If you receive a complaint of intermittent problems, check the line for possible defects even

"Engineers sometimes fall into the trap of excessive symptom analysis when dealing with field problems."

if the symptom is not present. You may discover and fix the problem. Even if you don't, you have taken the first steps toward the solution.

What about waiting for the rebuild? Try to tell a customer: "We're waiting for a rebuild." He responds with: "Why can't you fix this problem?" What do you say? So, when your luck runs out and the rebuild is in the next century, what do you do?

You must see the symptom. Ideally you see it on the customer's TV set and on your test set at the same time. It also is good to monitor the channel with an SLM and notice what, if any, changes the problem causes. Then the other patient technician goes upstream and looks for the symptom, staying in contact with you by radio. You tell him when you see it. Also watching the same channel, he either does or doesn't see it and moves up or downstream depending on this. This can take hours. (I hope the problem channel is at least moderately entertaining. You *do* enjoy the shopping channels, don't you?)

Multiple problems

We've all had these. You go on a service call and you find and fix a problem. The customer says, "The pictures are better, but they still aren't good." And the customer is right. And you find and fix another problem. And, in some extreme cases, there is an additional third problem.

You have spent all morning on a service call, the schedule is disrupted, you are frustrated and you may long for the days of your distinguished career as an installer. You are not alone. It takes much longer to fix a symptom caused by multiple problems. For lack of a better name, I'll call this "Read's Law": The time spent on a service call varies as the square of the number of problems causing the call.

For example, if there are two separate problems it will take four times as long. If there are three separate problems, it will take nine times as long. Four problems take 16 times as long, etc.

There also is the weather/time/event corollary. The probability of beginning a multiple problem service call is minimum on a warm sunny Monday morning, and maximum on Friday at 4 p.m. in a cold rain, and with the existence of your sacred oath you will attend your daughter's dance recital at 6:30.

Just remember, when it happens to you, you aren't the first one.

After it's fixed

It's over. You have located the problem and fixed it and the customer has good pictures. There is still one bit of unfinished business. Remember the defective pictures and sound, how the levels behaved and the problem that caused this appearance. Add this to your personal, perhaps unwritten, file of experience. As time goes on, you will have a good history of defective pictures and possible causes. Then you are on your way to a distinguished career as a technician.

Don't forget to turn on your leakage monitor! **BTB**

The author would like to thank Mark Gearhart and Mike Radke of Sammons Communications for their valuable input, and he admits to his share of problem over-analysis.

Basic troubleshooting

By Robert E. Hagan II
Plant Manager
Longview Cable TV

When we start talking about service calls or troubleshooting a line problem, technicians start trying to analyze the problem by just looking at the picture. We walk in, look at the picture and say, "Yep, I know what that is. I had the same problem over on John Doe Street last week." But when we come in from "fixing" the problem, we still have a problem. So, let's go back to the basics of troubleshooting and set a format for line problem troubleshooting.

Before entering the house

When a technician drives up to a house for a service call he should do several things before he approaches the house. First, he should look at the tap to see if it is up to specs (i.e., shields on traps and drops tagged properly and tied off properly). Next he should inspect the drop and make sure it is following power. Then he should check to see if the drop is a messenger and if it looks damaged in any way. If possible, he should inspect the ground block. This may help the tech solve the problem by simply knowing that the equipment is old or damaged. This also will give him an idea of what type of maintenance he will have to do before he leaves this address to bring it up to the current installation specifications.

At the TV set

Once inside the subscriber's home, the technician should look at the picture on all channels, not just one! The most important thing he should do is take a signal reading behind the TV set and log this reading. This will let him know if the problem is right at the TV set or if it is still in front of this point.

Next, he should go back to the ground block and take a reading, which also should be logged. This will let the technician know if he should go to the tap or replace the line from the ground block to the TV set. Then, at the tap, he should repeat the same procedure, taking readings and logging them. He also should remember that if there are traps or decoders, a reading should be taken before and after them before he comes down the pole. If he follows these steps, there is no reason why he cannot solve any problem from the tap to the TV set.

"All problems have their own unique way of developing, but solving the problem is basically the same procedure in each case."

Trouble farther down the line

Now that we have gone over the basic steps in troubleshooting at the subscriber's home, let's move on. When tracing down a line problem, whether it is feeder or trunk, there is always a "Point A" and a "Point B." Point A is a good point and Point B is a bad point. Now, the technician can find the problem because it will be somewhere between these two points.

There are three basic pieces of equipment that will help him find most any type of problem. They are the field strength meter, the volt-ohm meter and a test set. Many times the technician will not be able to see a problem on his field strength meter or volt-ohm meter. This is when he must rely on his test set to check the picture quality.

There are many different checks the technician can do at each point that will help him isolate and fix the problem quickly. First we will look at a voltage problem. If there is no AC into an amplifier, he should find the power supply feeding that amplifier and check it completely. This includes making sure the ferro is putting out 60 VAC; making sure it is passing through the standby unit (if there is one); and checking the power inserter (in and out) on both legs. This will give him a Point A (good point) or put him at the source of the problem. If this does not locate the problem he can now start looking for it by checking all splitters or directional couplers and amplifiers between his established Point A and Point B. This procedure should be repeated until he locates the problem. However, this does not always hold true for a short. But, that is a different story.

Low signals

Now, we should look at a signal problem. If the technician has already determined that there is a low signal at the tap through the basic procedure check at the subscriber's home, the next step he should take would be to go to the nearest active device (i.e., line extender, bridger or trunk amplifier). At this time he can determine whether or not he is at the source of the problem or whether he needs to back up more and start narrowing it down. For example, if he is at a line extender and the signal is good in and out, he has located his Point A and he already knows his bad point, Point B, is the tap feeding the subscriber. He should then go halfway between these two locations and recheck the signal and AC if applicable. Then he would just repeat this same step until he is able to locate the source of the problem.

When a technician is at a line extender, bridger or trunk amplifier, he should always check the input signal first. If the input signal is bad, he knows that he has a problem at or before that point. After he has checked the input, he should check the AC and DC voltage. Here again, if there is no AC there will not be any DC, which of course does not allow any output. If there is AC, he can now check the output signal. He also should be careful to check all surge protection devices and make sure all seizure screws are snug. After he has checked all seizure screws and surge protection devices, and his input is good but output is still bad or nonexistent, he can start the process of elimination inside the amplifier.

Having already established good AC and DC and good input levels, the next step he should take would depend on what type of equipment is in his system. For example, the Texscan amplifier has basically four items that might cause this type of problem. They are the continuity module, the trunk module, the wiring harness (base plate) and the output bell inside the housing. By checking each of these items one at a time, the technician will be able to solve this problem at this amplifier.

All problems have their own unique way of developing, but solving the problem is basically the same procedure in each case. Following these basic steps will help the technician solve any problem he may encounter in the technical operations of a CATV system. Remember, there will always be a Point A and a Point B with the source of the problem in between. **BTB**

Southern fried signal surveys

By Rex Porter

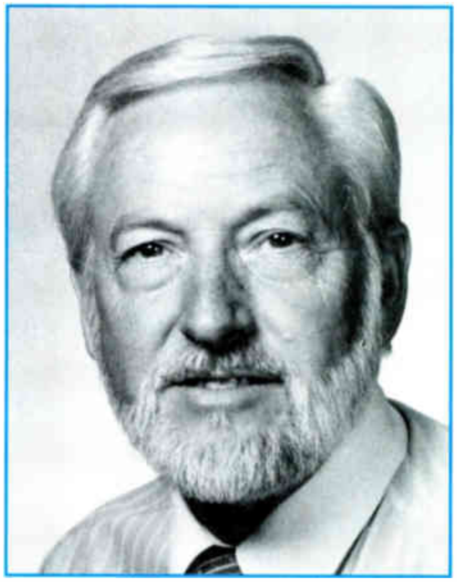
Did you ever wonder how we knew where to locate the thousands of CATV towers serving cable TV customers? In the old days, before we had computers to figure out the best locations, some of us spent weeks studying maps and reading signals before the city officials were ever approached about the possibility of building a system. Although some mistakes were made and towers located on the wrong hillside, most towers stand today where we originally built them 30 and 40 years ago.

In the early '60s, one of my jobs was to travel in Illinois, Indiana, Kentucky, Tennessee, Georgia and Florida to run signal surveys before a tower would be erected. Now, in many towns, I found that TV signals were either so weak or so few that people often didn't have TV sets in their homes and usually didn't have a TV dealer in the town.

During these years, the western division of our cable company was building microwave and cable systems across southern California, Arizona and Texas to bring the Los Angeles independent stations to the East Coast. The eastern division of our company, where I worked, was building microwave and cable systems southward to bring the Chicago independent and, hopefully, New York's independent station, to link up and basically cover the country with as much additional programming as possible. (You must remember that we didn't have satellites or HBO or any of the premium services back then.)

On the road again

Our eastern regional offices were in Decatur, Ala., and on this cold fall Thursday, my boss told me to get ready to run signal surveys in the Horse Cave, Ky., area over the next two or three weeks. On Sunday afternoon, I drove my van to



"By 5 o'clock, there must have been 60 or 70 people sitting about 10 feet from my van like a miniature drive-in theater."

Powderly, a small town in Kentucky where I would run my first test. But the second town to be checked stays in my memory. It was to the east of Paducah, set in a tiny valley surrounded by tall mountains.

I brought along a set of topographical maps (these maps to illustrate the highest and lowest elevations), a Sadelco meter, a larger 704 FSM, a TACO antenna (which is really a two piece low-band/high-band unit), a pad of 360° circular charts (which I drew up in my office in Decatur), a telescopic mast for my antennas, a lined notebook, an alarm clock, a sleeping bag, a supply of food, a rifle and a pistol. The firearms were necessary due to my often setting up on the back side of a mountain range, away from town and closer to some big wild animals.

However, at this little town, I found from the "topo" maps that the most likely spot for good signals from three directions should be on the side of a mountain next to a local sawmill. So, I drove up the winding dirt road to the sawmill and unpacked my equipment. First, I attached the TACO antenna to the mast on the van, raising it as high as possible and then locking it at that height but leaving it loose enough to turn. Attaching the 704 meter to the downlead, I started reading signals from about three different states. At this height above ground, coupled with lack of sophisticated equipment, anything from 30 microvolts and up becomes quite interesting.

On this trip, I had a real little jewel to work with. I had one of the first GE Porta-Color TV sets to check picture quality. So, I hooked up the color set and noticed sawmill workers were paying more attention to my work than their logs. Most of the programs were black and white but about every third or fourth one was color. I could see into town by looking back east over the trees. I began to see cars from town heading up the dirt road. But to run a good set of signal surveys, you have to really keep your mind on your job and I didn't think things too strange at the time.

Let the show begin and pass the vittles

I had the doors of the van wide open with the little GE color TV set blasting away and I had to change channels about every 15 minutes to check for fades, co-channel, power noise, hum and other picture disruptions. From time to time, I noticed that there were people watching the TV set but I just thought it was the workers from the sawmill taking a break. Busied with the pictures, drawing the angles of incoming signals and noting whether the picture had problems, I wasn't really paying any attention to anything else. But, when I got ready to change one channel after about 15 minutes, I felt someone tapping my shoulder and I turned around to find about a dozen people from town all sitting in lawn chairs or on the ground watching the color TV set in awe. Not only was this their first time to see any TV programming but they just couldn't believe the color. "Mister, them people never watched a whole program before. If you could, would you just wait 'til this show is over before you switch channels, please?"

I don't remember which programs were on back then but it was probably *Gomer Pyle* in the daytime and *Gunsmoke* in the evening. But, by 5 o'clock, there must have been 60 or 70 people sitting about 10 feet from my van like a miniature drive-in theater. Now, they started to bring food from town and by 6 or 7 p.m., they had tables set up with food like a church dinner on the grounds. There was ham, chicken, potatoes, cake, cookies and just about all you would expect at a country dinner. They also had sodas, tea and lemonade, just to make sure I wouldn't object to their watching television for the first time in their own little town.

For the next two days, I had free breakfasts, lunches and dinners. I got to know the mayor, the city councilmen and all the good people of that little town. And they got ready for cable TV to come to their homes. On the third day, a helicopter flew in and landed on the mountaintop. We removed the passenger door and I placed the Sadelco FSM, the color TV set and notepad on the floor of the copter. I had attached the TACO antenna to a bamboo pole, which I held below the helicopter as it rose in 100-foot increments up to 1,000 feet. I would have to read the signals, check the pictures on the TV set and write the information as we rose to 1,000 feet and then, again, as we descended each 100 feet back to the mountaintop. All the townspeople were on hand to see the helicopter go up and down as if they had now become a part of the work force. After we landed, I had to get my gear ready to go on to the next town.

No, I've never been back to that little town in the valley. I hope they have a good cable system there. I hope they remember the first day many of them ever saw television, the thrill of it being in living color and just maybe one of them will remember I was there when they tell about it. **CT**

Rex Porter entered the CATV industry with American Cable TV, the system operation arm of Ameco Inc. He was involved in the start of 27 microwave and cable TV systems in the midwest, southeast and western United States. He developed United Video Systems, which became the original six systems (purchased by Monroe Rifkin in 1968) known as ATC. He went into sales with Times Wire and Cable Co. in 1968 and left in 1988 after becoming vice president and part owner of the parent company, LPL Inc. Some of his accolades include: member of the CATV Pioneers since 1977; one of the founding members of the national Society of Cable Television Engineers; president of the Tower Club in 1990 and 1991; SCTE member of the year in 1986; member of the Arizona "Hall of Fame"; and member of the SCTE "Hall of Fame" in 1992.

Antennas outside of the laboratory

By Isaac S. Blonder
President, Blonder Broadcasting Corp.

An apology by the author of this article is transparently owed to the professional antenna designers and their clients. In commenting on antennas in the field, both from my design experience and observation of those emanating from other companies, I hope to be both tactual and accurate. However, since my theoretical skills were imparted before World War II, the basis of some of my remarks may be faulty. The slipstick is obviously no match for the computer, but one tries to use intuition to counteract the facile knowledge and accuracy available to the computer-aided engineer.

My background

The following is a rundown of my experience: M.S. in physics; 40 years as an antenna designer and manufacturer; holder of several key patents on antennas; veteran of a trip through the federal courts, including the Supreme Court on an antenna patent; salesman with field trips galore offering antennas; consultant and/or owner of eight high and low power TV stations; member of the Federal Communications Commission Committee for All Channel Broadcasting (CAB) and CTAC Committee, particularly oriented to TV antennas and reception technologies; and, the installer of a homemade double Yagi on my parent's house in 1947.

Some antenna basics

In my opinion, the entire field of antenna design and installation is as much an art as it is a science. Instead of existing in a known shielded environment and containing specific measurable components, the antenna often fails to attain the calculated electrical specifications and, when installed, varies unpredictably from the theoretical values.

An antenna is not a complacent electronics directory. Its elements must radiate energy to fulfill its mission. Every tuned element possesses an unknown resistive component as well as reactive, and the uncertainty of these values make the design and performance of the antenna more of a guessing game than a given. The physical dimensions of the antenna elements are another variable that requires trial and error to achieve the desired performance. Add the potential detuning effect of the support means and the feed means and the antenna departs even further from the required specifications. Unless there exists a vast body of previous working designs to fashion a new antenna, the result is still likely to be off the target, with or without the computer.

Next, the antenna is modified by its location on earth on a typical tower, not isolated as it would be in outer space. There is a so-called "near-field" in which the adjacent metal objects are close enough to the antenna that, for all practical purposes, they are reradiating energy and interacting with the RF source as an integral part of the antenna. You can be sure that the desired radiation pattern will be downgraded.

The most unpredictable and harmful effect of an antenna in the field is the ground reflection. In most of the installations, the ground acts as an almost lossless conductor and sets up a radiation pattern of its own that, at the receiving antenna, may arrive at an opposite phase and cancel most of the desired signal. At TV frequencies, the vertical signal will display nulls, frequently at the desired receiving antenna heights. In the primeval days of UHF transmission, my company would often get complaints that our UHF converters were defective, since the customer was only a mile away from a multi-megawatt station and it had to be our product. Try explaining nulls to him!

Building valid antennas

From 1962-1966 I served as a member of the FCC CAB, whose mission was to revive UHF broadcasting. One task was to specify and recommend consumer UHF receiving antennas. All of the antenna manufacturers were represented. Practically none of the published UHF antenna specifications matched each others' products. It also turned out that the laboratory test ranges showed widely differing patterns and gains for each others antennas. Surprise, surprise. Some companies

"Every tuned element possesses an unknown resistive component as well as reactive, and the uncertainty of these values make the design and performance of the antenna more of a guessing game than a given."

didn't even bother with test ranges — they didn't square with the designer's specifications! The result was a whitewashed booklet showing the consumer what antenna configuration would meet his needs.

It took me a very long time to design and build a valid antenna test range for our own use. The typical horizontal test range described in the textbooks had severe ground reflections that could not be suppressed by the described remedies. Finally I visited the RCA Service Co. featuring its slant range system that we copied successfully. The transmitting antenna was a broadband, low gain, log periodic sitting on the ground pointed at a 45° angle toward the antenna under test, mounted on a tall tower. The site was an open field and fiberglass rods were used to support the antenna. Our measurements were repeatable and accurate to at least -20 dB.

You may remember the typical puffery used by some manufacturers to describe their antennas as being designed for reception by mileage, up to 175-mile designs. We published our measurements as found, with minimum, not typical values. It was strange that our antennas with the same number of elements never seemed to possess the gain figures of our competitors! By the way, never buy a Yagi with sharply tuned directors to squeeze out the last dB of gain. We have measured too many that seem to have suffered from manufacturing tolerances, and exhibited a sharp gain reduction at the high end of the channel. The result is a fuzzy picture.

As an intuitive physicist, I pictured the radio signals as clouds. The stronger the signal, the darker the atmosphere. What a mess ensues! Every conducting element in the path of the signal reradiates energy as if it were another antenna. The top of a hill reradiates the signal into the valley. Hot and cold layers of air act as reflecting ducts to send signals far beyond their normal ranges. To anticipate precisely the signal level and quality at any one location is a task beyond human skills. Fortunately, we humans tolerate and enjoy low quality television.

In my early days of selling antennas, I would drive up in my test van to a distributor, erect my antenna on a short mast and find him proclaiming the superiority of my competitor's antenna located high above his roof. He obviously never took a course in physics. The meeting always degenerated into a price war.

Headends for cable systems were always a fun visit. It seems that the antenna designer and his kindly words of advice were the last items on the plate of the installer. Yagis or log periodics must be end-mounted or the performance suffers. Ghosting varies with the height of the antenna and its location on the site. Hopefully each antenna must be spaced so that its near-field is intact. If you are creating your own multiple high gain antenna with a homemade harness, pray. Any attempt to cancel ghosts or in-channel artifacts with physically separated antennas is always subject to atmospheric vagrancies. Several antenna sites, with their own natural shields, is better and may even be cost-effective. If you examine a linear (not log) pattern of a Yagi, the front-to-back ratio is never as good as the front-to-perpendicular ratio. Often an interfering signal is best canceled by pointing the 90° side at the unwanted signal, even if the desired signal is somewhat weaker.

Fingers and other corrections

In the '60s, as a member of the board of WNJU-TV, Ch. 47, Newark-NYC, I was assigned the task of placing the transmitter and antenna on the Empire State Building. To get sufficient power for our transmitter, the elevators had to be rewired to balance the phase loads and squeeze out enough electricity for us. Since the antenna mast was fully loaded we had to buy dual-segment N-S RCA antennas installed in the lighted section below. Understandably, the other broadcasters forced us to measure their signals before and after the installation with a helicopter. The patterns delivered to us by the survey were distinctly different from those submitted to the FCC. Perhaps we had paid for the only airborne study; if others existed, they were kept confidential. Incidentally, you can only purchase a transmitting antenna based on its antenna range measurement, not its pattern in place. The most striking variance was that of Ch. 13. The 13-antenna system consisted of four Yagis distributed around the observation level, supposedly able to deliver a smooth omnidirectional signal. Our survey showed the messiest, random, spiky pattern I had ever seen, with peaks and valleys of 20 dB or more. Yet, the public and the professionals had not commented on the inferior signal that should have resulted. Since the signal was VHF and the antenna had low gain and probably a good null fill, poor reception just may have been accepted as a normal occurrence.

One observation that might be of interest, my fingers often added exactly the right correction to the antenna elements to improve the match, pattern and overall performance of the antenna under design. Yet, I could never find a good substitute for my fingers by merely changing the size of the dipoles. But then, who would buy an antenna with a body attached? **CT**

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TECHNOLOGY

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Fiber supertrunk, amplifiers, taps

Scientific-Atlanta Inc. announced a new AM supertrunk product for transmitting cable TV signals simultaneously on 1,310 and 1,550 nm wavelengths that it says allows cable operators to use less fiber than most other technologies. By using wavelength-division multiplexers, two signals, rather than just one, can be sent through each fiber, thereby reducing the fiber count to a maximum of four fibers.

Two variations of the dual-wavelength supertrunk are available: a four-tier, two-fiber option and a seven-tier, four-fiber option. According to the company, the four-tier option offers performance comparable to the traditional AM supertrunk, while using only two fibers as opposed to nine, and that the seven-tier, four-fiber option provides performance comparable to digital fiber.

Also announced was System Amplifier II (SA II), an upgradeable and replaceable amplifier unit that S-A says eliminates the need for multiple modules and interconnections. The improved housing design serves as a platform for future upgrades to 1.5 GHz. The 1.5 GHz platform will eventually be upgradeable from its current 550 MHz version to 750 MHz and higher by replacing the unitized amplifier module.

The SA II contains no spark gaps or fuses and features the company's Surge Resistant Circuitry (SRC), which provides protection against outages during lightning storms and power surges. If the 550 MHz module fails, the unitized modular design allows a technician to drop a new module into place. In addition, the signal flow direction through the SA II can be reversed without replacing the SA II housing. The module can be turned around and re-inserted.

S-A has upgraded the Line Extender II to full 750 MHz service. Along with 750 MHz taps, the LE-II will allow more channels as well as the ability to eventually use the same cable to transmit telephone signals and provide other future services, according to the company.

The line extender features a reversible module that the company says can be easily replaced and serviced. Other features include a high-efficiency power supply and high-gain and low-gain versions with automatic gain control.

The new 750 MHz taps are designed to work effectively with the 750 LE II. The company says the taps are "backwards compatible" with all other S-A taps manufactured since 1980. Features include low insertion loss, component covers, F-ports that meet the latest specifications of the Society of Cable TV Engineers and easy servicing. The company says a 3/8-inch wrench can loosen or tighten all attachments.

Reader service #200 (supertrunk), #199 (SA II), #198 (line extender), #197 (taps)

Ghost canceling hardware

In conjunction with Philips Broadband Networks, Tektronix announced it is producing the first hardware to generate the ghost canceling reference (GCR) signal developed by Philips and adopted as a U.S. industry standard by Cable Television Laboratories and by the membership of the Advanced Television Systems Committee. The hardware is available as an option to newly purchased Tektronix test equipment or as a field upgrade to existing equipment.

Under terms of an agreement between the two companies, Tektronix will make and sell PROM signal sets for its VITS (vertical interval test signal) inserter products. As part of the agreement, Philips also has the right to develop its own PROMs and to sell them as upgrades to the Tektronix 1910 digital generator.

Once installed, the PROM signal set will enable broadcasters to transmit along with their video signals a reference that can be used to remove multipath interference, according to the companies. Also, headend operators will be able to correct ghost-laden signals received from local transmitters and pass ghost-free signals on to their subscribers.

Reader service #180

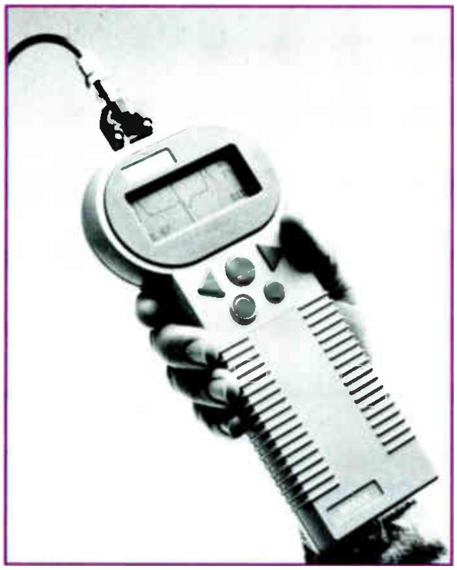
Batteries

Yuasa-Exide Inc. announced the new DMS line of valve-regulated lead-acid batteries specifically designed for uninterruptible power supplies (UPS), telecommunications and cable TV applications requiring back-up power.

The batteries will be available in 12-volt units, ranging in size from 45 AH to 100 AH. In addition, the product family includes 200 AH-6V, 300 AH-4V, and 600 AH-2V products. The 100 through 600 AH batteries all utilize the same jar size.

The 90 through 600 AH products have incorporated Yuasa-Exide's patented Slide-Lock Post Seal to help make these batteries virtually maintenance free. The threaded copper termi-

nals on the 90 AH and larger batteries eliminate the need to annually retorque the bolts to ensure a true connection.
Reader service #196



TDR cable/fault locator

The Biddle 511 TDR (time domain reflector) from AVO International is designed to locate and identify cable faults as close as six inches or as far away as 950 feet. The company says it is the only light-weight, hand-held TDR featuring a full trace LCD.

The full cable trace display allows the operator to see initial pulse, all reflections, distance to the reflections in feet, the nature of the impedance change, propagation factor and battery condition.

The unit is available with a fused blocking filter option for uninterrupted testing of on-line cables up to 440 VAC, 230 VDC. The unit has simple five-key operation that requires minimal operator training.
Reader service #195

Uninterruptible power

Sola added two new models (8 kVA and 10 kVA) to its Interact uninterruptible power system (UPS) product line. These "interactive" UPSs, available in both 50 Hz and 60 Hz, are designed for single-phase power installations.

Sola says the Interact UPS is a true on-line, no break UPS because the inverter always runs the load. The bidirectional converter/inverter charges the battery and eliminates the need for a separate rectifier/charger. Power conversion losses are minimized because, during normal conditions, most of the output power is derived directly from the AC line input. This topology also eliminates the traditional need to transfer critical UPS loads onto an unprotected raw power AC bypass during high inrush start-up periods.

Standard internal batteries provide 10 minutes at full load runtime for the 8 kVA and seven minutes for the 10 kVA units. Free-standing battery packs match the UPS cabinets and provide backup times typically of 30 minutes.
Reader service #193

Fault locator

Laser Precision Corp. unveiled the FL-550 fault locator, designed to locate a break or fault in an optical fiber cable in less than 60 seconds. The unit is equipped with 1,310 nm single-mode optics that provide 19 dB of dynamic range and a distance range of 40 km. The FL-550 automatically determines the optimal test parameters, allowing full user operation with just two keys, Power and Test. Distance to the fault or break is clearly displayed on the unit's backlit LCD. It can operate for eight hours on its rechargeable lead-acid battery pack or it can be powered using the AC adapter/charger included with the unit.
Reader service #191

Amplifier

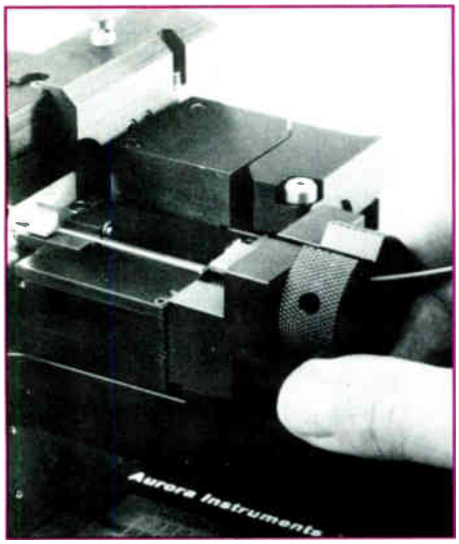
C-COR introduced the FT549, its latest feedforward trunk line amplifier. According to the company, the feedforward technology of the new amplifier, utilizing 33 dB spacing, provides superior distortion performance over amplifiers built with push-pull or parallel hybrid device technologies. The FT549 is compatible with C-COR's 8-port housings and standard trunk accessories.
Reader service #194

Reel Platforms

Spoolmaster Products now offers the Dispense-a-Reel SMP-RP-BTX, a dispensing system for pay-out and take-up of wire, cable, rope, etc. When used in pairs, the company says the platforms will accommodate reels of unlimited width, and are rated for reel weights up to 2,500 pounds.

Features include bolt-together construction, a five-position rear roller adjustment and a slanted front loading ramp for easy reel loading and unloading. Also standard are: lever-operated front roller block, ball bearing side rollers, powder-coated polyester resin finish, hex-bore ball bearing rear rollers, solid steel hexagon axles and predrilled base for bolt-down installation.

Reader service #192



Fusion splicer adapter

Aurora Instruments now offers a rotating fixture adapter for precisely aligning polarization, maintaining optical fibers on their rotational axes prior to splicing. The adapter mounts onto the company's FW-310 automatic and FW-305 semiautomatic fusion splicers.

Reader service #179

Fiber-optic source

The MPS-8035, introduced by ILX Lightwave Corp., is a dual-wavelength version of the company's MPS-8033 precision fiber-optic source. Designed specifically for lightwave test and measurement in the lab, the unit provides 1 mW of laser light coupled into a single-mode fiber at 1,310 and 1,550 nm wavelengths. The FC/PC output is attenuateable over a 10 dB range and has internal modulation at 270, 1,000 or 2,000 Hz. The optional GPIB/IEEE 488.2 interface allows complete system integration with other instruments.

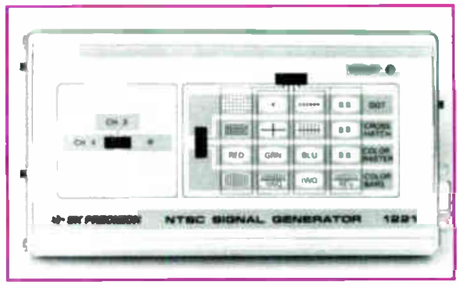
Reader service #178

Visual fault locator, OTDR

EXFO introduced what it says is the first visual fault locator using a 650 nm wavelength laser. The FLS-230A features its 3-way powering, 1 Hz modulator for enhanced visibility, low/high power modes and a protective circuitry against overheating that can destroy the laser. It is offered in a rugged polycarbonate case with protective holster.

EXFO also introduced a card-level 1,310/1,550 nm OTDR that fits into the AT-size slot of a PC. The company says the FCS-123B offers full auto-analysis of fiber from one keystroke. The auto-analysis feature selects OTDR parameters, locates events and characterizes them. The unit features three operation modes: break finder, feature finder and full-OTDR. The software allows for F-key or trackball operation through pull-down menus.

Reader service #177 (fault locator), #176 (OTDR)



Color generator

The new Model 1221 from B & K Precision is a portable TV/video signal generator that generates 14 patterns of stable video signals for testing, servicing and adjustment of virtually all types of TV and video equipment. Applications include video monitors (color or monochrome), CGA computer monitors, VCRs, TV receivers, closed-circuit TV systems and components, and cable TV systems. Suitable for field or shop use, it is small enough to fit into a field service kit.

Generated patterns include standard NTSC color bars with and without IWQ; full-field IWQ; split-field color bars with reverse bars; red, green, blue and black rasters; and six convergence patterns. Chroma can be turned off to display the luminance level only (monochrome). A 1 kHz subcarrier audio tone also can be switched on or off.

Outputs include composite video, IF (45.75 MHz, crystal-controlled), and Ch. 3 and 4 (crystal-controlled). A 9-pin D-type connector provides an RGB output for testing CGA computer monitors. The user can select either interlaced or progressive scan, TTL or low level (analog level) for RGB outputs, and can output composite sync through Pin 7 of the D-connector, or green signal with negative composite sync.

Reader service #175

BOOKSHELF

The Society of Cable Television Engineers enlisted the services of William Grant, author of "Cable Television," to conduct a series of seminars available on videotape. The following are available through the Society. The prices listed are for SCTE members only. Non-members must add 20 percent when ordering.

☛ *Coaxial Cable Transmission Systems/Understanding Decibels/Introduction to Equipment* — This program defines some basic CATV terms and explains the basic theories upon which systems are designed. Topics include wideband transmission, electromagnetic spectrum, coaxial cable transmission and spectrum allocation. It also deals with the related mathematics by covering ratios, decibels, logarithms, power ratios, the relationship between voltage and power calculations, Ohm's law, and dBmVs. Finally, it introduces basic CATV equipment. (2 hrs.) Order #T-1121, $65.

☛ *Noise* — This program covers the origin and nature of noise in a CATV system. Grant details factors such as noise figure and C/N, together with their applications and calculations. Equalization and equipment specifications also are covered. (55 min.) Order #T-1122, $45.

☛ *Intermodulation Distortion* — Grant deals with distortion as a system phenomenon, covering the forms of intermodulation distortion and how they relate the modern CATV system. He also discusses amplifier output levels and X-mod. Intermod specs, the calculation of X-mod, combining equal and unequal X-mod distortion, and equalization and X-mod are covered. (45 min.) Order #T-1123, $45.

☛ *Amplifier Gain/Noise and Intermodulation in System Design* — This program covers the relationships of gain, noise and intermod, including the calculations of operating levels vs. system C/N and system composite triple beat. Grant discusses X-mod and noise in cable plant design. (45 min.) Order #T-1124, $45.

☛ *Cable Television* by William Grant — The book that inspired the video series. Order #TR-5, $30.

Note: 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: Items are shipped UPS. No post office 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 book or 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 MasterCard or Visa.

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 ID# 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 (215) 363-5898.

CALENDAR

1992

December

2: SCTE Ark-La-Tex Chapter seminar, FCC proof standards, Longview, Texas. Contact Robert Hagan II, (903) 758-9991.
2: SCTE Cascade Range Chapter seminar, Installer exams to be administered, Beaverton, Ore. Contact Cynthia Stokes, (503) 230-2099.
2: SCTE Delaware Valley Chapter seminar, EBS and your headend, and BCT/E exams to be administered in Categories VI and VII at both levels, Williamson Restaurant, Willow Grove, Pa. Contact Lou Aurley, (215) 675-2053.
3: SCTE Florida Chapter seminar, Installer and BCT/E examinations to be administered in all categories at both levels, Hialeah, Fla. Contact John Tinberg, (800) 327-9767.
3: SCTE Great Plains Chapter seminar, Installer and BCT/E exams to be administered in all categories at both levels, Crown Court Quality Inn, Bellevue, Neb. Contact Jennifer Hayes, (402) 334-2336.
3: SCTE New Jersey Chapter seminar, headend, earth station and TI satellite realignment. Contact Jim Miller, (201) 446-3612.
3: SCTE Upper Valley Chapter seminar, modulation techniques, and BCT/E exams to be administered in all categories at both levels, Holiday Inn, White River Junction, Vt. Contact Matthew Alldredge, (802) 885-9317.
7-8: Scientific-Atlanta seminar, distribution, St. Louis. Contact Bridget Lanham, (404) 903-5516.
7-9: SCTE Technology for Technicians II seminar, Harvey Hotel, Dallas. Contact SCTE National Headquarters, (215) 363-6888.
8: SCTE Chattahoochee Chapter seminar, Perimeter North Inn, Atlanta. Contact Hugh McCarley, (404) 843-5517.
8: SCTE Desert Chapter seminar, customer service for field personnel. Contact Greg Williams, (619) 340-1312, ext. 277.
9: SCTE Central Indiana Chapter seminar, BCT/E exams to be administered in all categories at both levels. Contact Gregg Nydegger, (219) 583-6467.
9: SCTE Coastal Carolina Chapter seminar, Installer exams to be administered, Washington, N.C. Contact Larry Huffman, (919) 353-3500.
9: SCTE Dakota Territory Chapter seminar, Installer and BCT/E exams to be administered, Pierre, S.D. Contact Kent Binkerd, (605) 339-3339.
9: SCTE Inland Empire Chapter seminar, construction standards, equipment and safety practices, Shep Rock Hanger, Coeur d'Alene, Idaho. Contact Butch Boyd, (208) 667-5521.
9: SCTE Michiana Chapter seminar, BCT/E exams to be administered in all categories at both levels, Mishawaka, Ind. Contact Russ Stickney, (219) 259-8015.
9: SCTE Miss/Lou Chapter seminar, Installer and BCT/E exams to be administered in all categories at both levels, Gulfport, Miss. Contact Dave Matthews, (504) 923-0256, ext. 309.
9: SCTE Piedmont Chapter annual membership meeting and election of board, Hickory, N.C. Contact Tod Dean, (919) 662-1489; or voice mail, (919) 220-3889.
9: Tektronix Cable TV seminar, how to evaluate your system, Marriott Courtyard, Chicago. Contact Kathy Richards, (503) 627-1555.
9-11: Scientific-Atlanta seminar, headend and earth station, St. Louis. Contact Bridget Lanham, (404) 903-5516.
10: SCTE Satellite Tele-Seminar Program, *A Look Ahead: The Future of Broadband Communications* from Cable Tec Expo '91, to air from 2:30 to 3:30 p.m. ET on Transponder 14 of Galaxy I.
10: SCTE Central Indiana Chapter seminar, safety. Contact Gregg Nydegger, (219) 583-6339.
10: SCTE Chesapeake Chapter seminar, BCT/E exams to be administered, Holiday Inn, Columbia, Md. Contact Jennifer Wardrop, (410) 461-7017.
10: SCTE Dakota Territory Chapter seminar, Installer and BCT/E exams to be adminitered, Bismark, N.D. Contact Kent Binkerd, (605) 339-3339.
10: SCTE Music City Chapter seminar. Contact Dale Goodman, (615) 244-7462.
10: SCTE Shasta Rogue Meeting Group seminar, bench and field sweep, Redding, Calif. Contact Dan Barger, (916) 547-5438.
11: Tektronix Cable TV seminar, how to evaluate your system, Harvey House, Dallas. Contact Kathy Richards, (503) 627-1555.
12: SCTE Sierra Chapter seminar, BCT/E exams to be administered in all categories at both levels, Roseville City Hall, Roseville, Calif. Contact Rocco, (916) 354-3500.
15: SCTE Badger State Chapter seminar, BCT/E exams to be administered, Holiday Inn, Fond Du Lac, Wis. Contact Gary Wesa, (414) 496-2040.
16: SCTE Greater Chicago Chapter seminar, BCT/E exams to be administered, Willowbrook, Ill. Contact Bill Whicher, (708) 362-6110.
16: SCTE San Diego Chapter seminar. Contact Kathleen Horst, (310) 831-4157.
16: SCTE Snake River Chapter seminar, ad sales equipment and maintenance, CLI and leak maintenance. Contact Mike Dudley, (208) 377-2491.
17: SCTE New England Chapter seminar, BCT/E exams to be administered. Contact James Kelley, (401) 943-7930, ext. 230.
22: SCTE Southeast Texas Chapter seminar, Installer and BCT/E exams to be administered in all categories at both levels, Warner Cable, Houston. Contact Tom Rowan, (713) 580-7360.

Planning ahead

Jan. 6-7: SCTE Emerging Technologies seminar, New Orleans. Contact (215) 363-6888.
Feb. 21-26: OFC/IOOC '93 conference, San Jose, Calif. Contact (202) 223-8130.
Feb. 24-26: Texas Cable Show, San Antonio. Contact (512) 474-2082.
April 21-24: SCTE Cable-Tec Expo, Orlando, Fla. Contact (215) 363-6888.
June 6-9: National Show, San Francisco. Contact (202) 775-3669.

Western Show technical agenda

For the eighth consecutive year, SCTE is sponsoring the technical sessions for the Western Cable Show, to be held Dec. 2-4 in Anaheim, Calif. Besides a variety of sessions on topics of vital importance to the cable TV industry, examinations will be adminitered in its BCT/E and Installer Certification Programs.

The schedule for SCTE-sponsored events at the show is as follows:

Wednesday, Dec. 2

• *FCC/Washington Update* with Bill Riker, SCTE, moderator; Wendell Bailey, NCTA; Susan Herman, NATOA; and John Wong, FCC.

• *Implementing the New Technical Standards* with Chris Middleton, ONI, moderator; Jonathan Kramer, Communications Support Corp.; Joe Mardesich, Comcast; and John Sweeney, S-A.

Thursday, Dec. 3

• *Fiber-Optic Technology from the Operator's Perspective* with Pat Murphy, Cencom Cable, moderator; Marwan Farwaz, Times Mirror Cable; Ray Tyndall, Falcon Communi-cations; and Ron Wolfe, Time Warner.

• *An Introduction to Digital Technology* with Steve Allen, Jones Intercable, moderator; and Gratz Armstrong, H-P.

• *Bandwidth Management and Digital Compression* with Tom Elliott, Catel, moderator; Stephen Dukes, CableLabs; Kevin Hills, Texscan MSI; Carl McGrath, AT&T Bell Labs; and Ed Moura, Hybrid Networks.

Friday, Dec. 4

• Installer (written only) and BCT/E (in all categories at both levels) certification testing with Harold Mackey, Times Mirror Cable, proctor.

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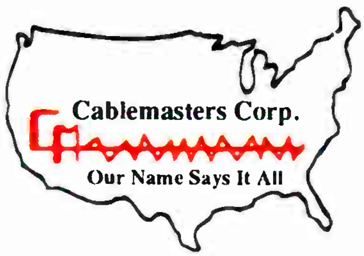

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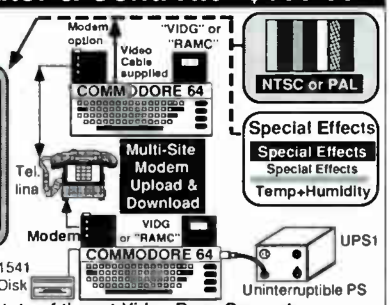

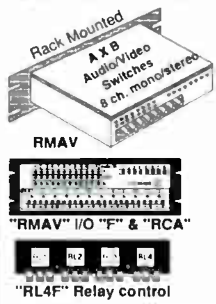

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"PK8"" $159.95; controls 8 external relays + 2 "WX1" inputs
"1541" $189.95; disk drive stores 1000 or more pages
"RL4F" $199.95; 4-75Ω hi isolation (DC to 600 Mhz) AXB switch
"RMAV"$ CALL; 2 to 8 75Ω "F" stereo or mono + video AXB switches
"C64" $159.95; Refurbished computer, with power supply
"Modem"$ 89.95; 1200 baud Hayes compatible

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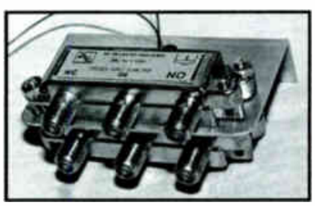

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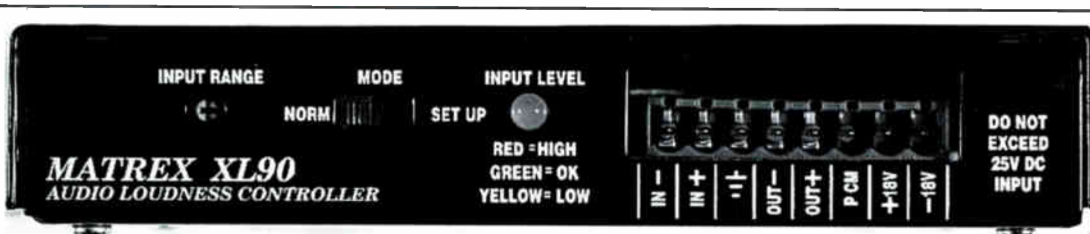

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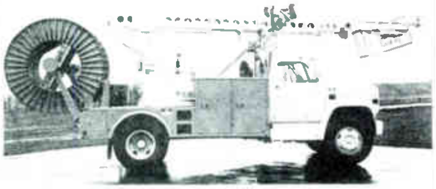

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What is SCTE membership?

By Bill Riker
President, Society of Cable Television Engineers

When I'm representing the Society of Cable Television Engineers at industry trade shows, people who aren't SCTE members frequently ask questions such as, "What is SCTE membership? How can it benefit me? What does it offer?"

I want to use this month's "President's Message" column as a forum to answer some of these questions for all of you who are considering joining our Society but are uncertain as to what it offers. I also want to let you know how SCTE membership can be greatly beneficial to your personal and professional growth.

What is SCTE?

The Society of Cable Television Engineers Inc. is a non-profit professional organization formed in 1969 to promote the sharing of operational and technical knowledge in the fields of cable TV and broadband communications. In short, the Society's mission statement is "Training, certification and standards."

Who is in SCTE?

SCTE members are individuals from all areas of the broadband communications industry. Among its members are cable system engineers and technicians, manufacturers, installers, construction personnel, even system owners and their operations staffs. Anyone involved with cable TV, radio and TV broadcasting or other allied communications fields may become a member. A majority of the membership are not degreed engineers, but individuals wishing to increase their working knowledge of communications technologies through participation in the Society. While most individuals choose to become involved with SCTE by joining as an Active member, Student and Sustaining (corporate) memberships also are available. The Society currently has over 10,000 members in the United States and 43 foreign countries.

How can SCTE help you?

SCTE's goal is to increase the technical knowledge and skill of members to advance personal career growth as well as to benefit the companies that employ them. The Society is widely recognized as an excellent forum for the exchange of information and ideas on important broadband technical issues. Cable-Tec Expo, the training and CATV hardware conference presented annually by SCTE, allows leading industry manufacturers and suppliers the opportunity to meet with cable system engineers and technicians. The expo provides an excellent learning environment and offers hands-on instruction not found at other industry trade shows. SCTE-sponsored technical seminars on current industry issues also are offered throughout the year. The Society's monthly newsletter, *Interval*, offers exclusive information on its activities and educational programs.

The Society's numerous (currently 74) chapters and meeting groups are an integral part of the organization, providing valuable forums for technical discussion at the local level, expanding each member's knowledge of the industry while aiding in his individual professional development. Through workshops, seminars, field tours and panel discussions, SCTE's local chapters and meeting groups cover a broad range of topics affecting cable system operations. Participating in a local group also is an effective way to establish professional contacts, develop valuable leadership skills, and contribute to the industry.

SCTE also offers its "Technology for Technicians" series of three-day training seminars at various locations around the country to accommodate attendees. Technology for Technicians I is designed for installer/technicians and service technicians, while Technology for Technicians II is for advanced technicians and covers spectrum analysis, signal leakage/CLI and system design theory.

What does membership offer?

SCTE has developed the Broadband Communications Technician/Engineer (BCT/E) Certification Program. This program rewards successful candidates with peer recognition and assists management with the promotion and evaluation of technical personnel. Examinations have been designed to measure a candidate's understanding of and competence in seven areas of cable TV technology. The Society also offers an Installer Certification Program designed to measure a candidate's installation skills through a program of training, written testing and practical examinations.

SCTE has produced many videotapes on technical training issues that are available for purchase or are presented through its Satellite Tele-Seminar Program, which distributes educational videotapes via satellite each month for cable systems nationwide to downlink and record. Scheduled times for these programs are announced in the Society's monthly newsletter, *Interval*.

The Society has several scholarship funds to offer to its members. The first works in conjunction with the National Cable Television Institute to provide correspondence school training for those installers and technicians whose company does not offer such training opportunities, and who cannot afford to pay for their own schooling. Another fund provides scholarship awards for other types of educational advancement, such as trade school electronics or college level courses.

Other SCTE benefits include: five different group insurance policies, discount registration fees for SCTE technical seminars and the Cable-Tec Expo; corporate discount hotel rates; car rental discounts; the ability to participate in the BCT/E Certification Program; discounts on all SCTE publications and videotapes, as well as premiums such as jackets, T-shirts and emblems; a complimentary subscription to *Communications Technology*, SCTE's official trade journal; and free or discount subscriptions to a variety of other industry trade publications. **CT**

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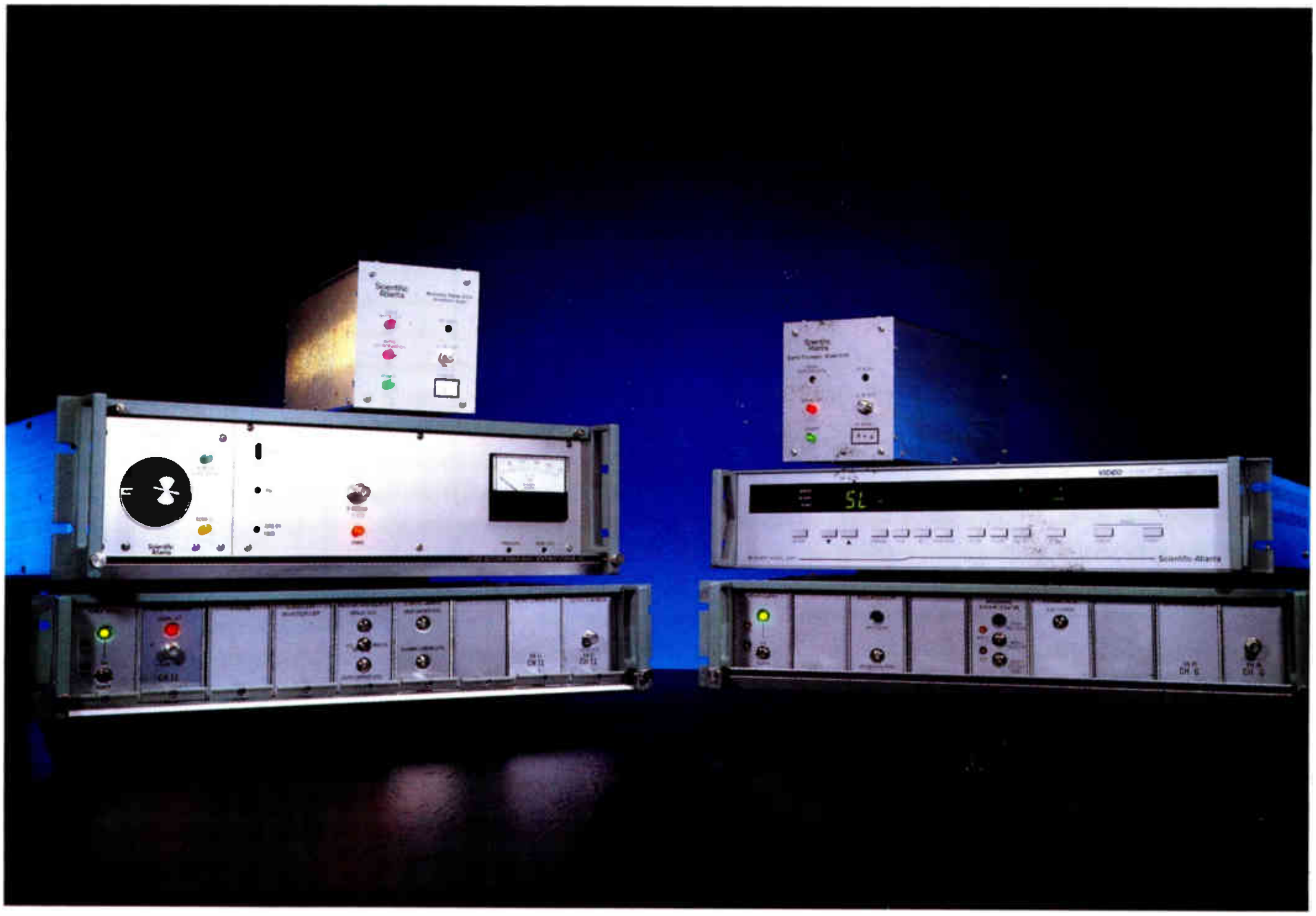

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