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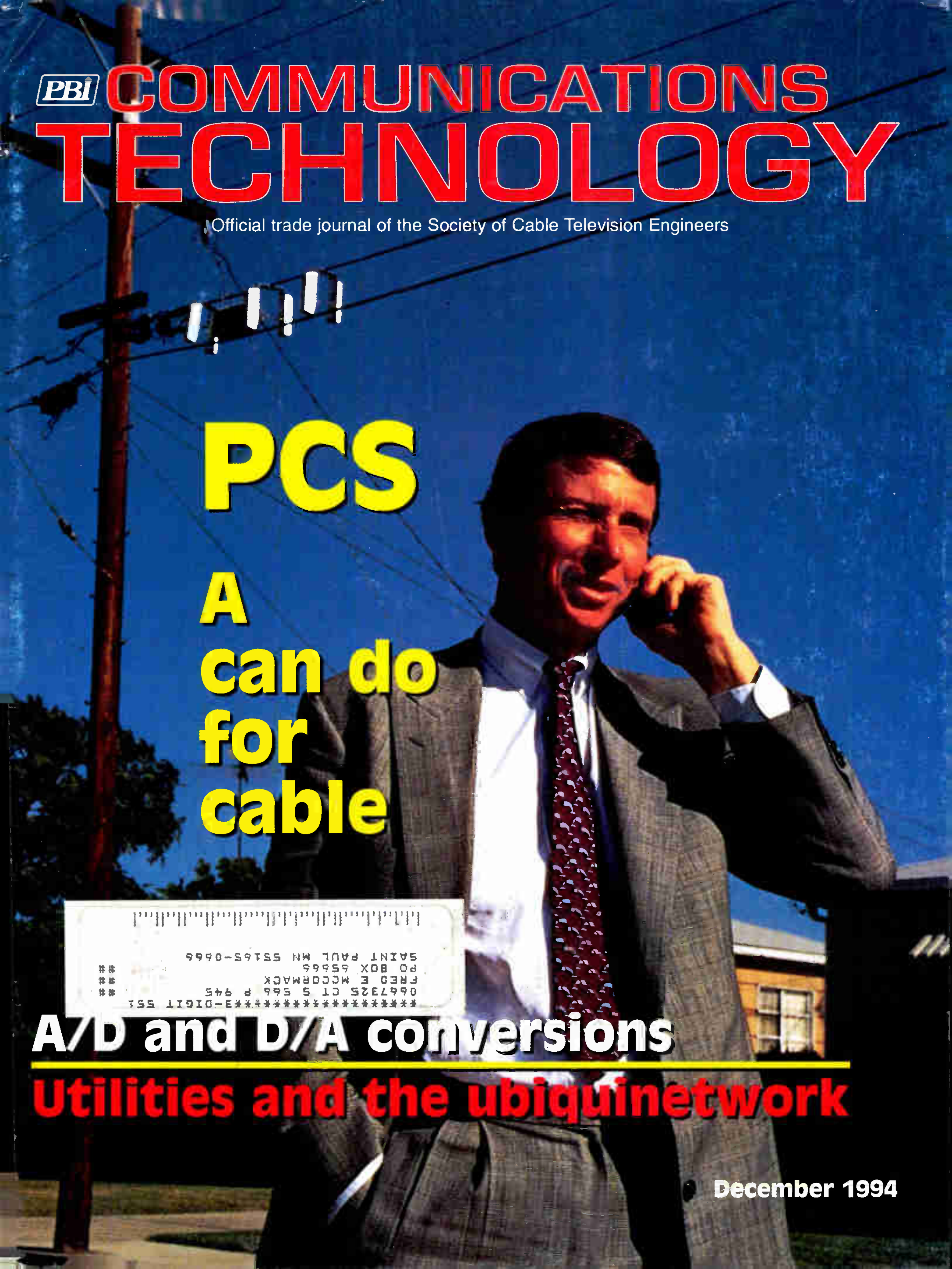
Official trade journal of the Society of Cable Television Engineers



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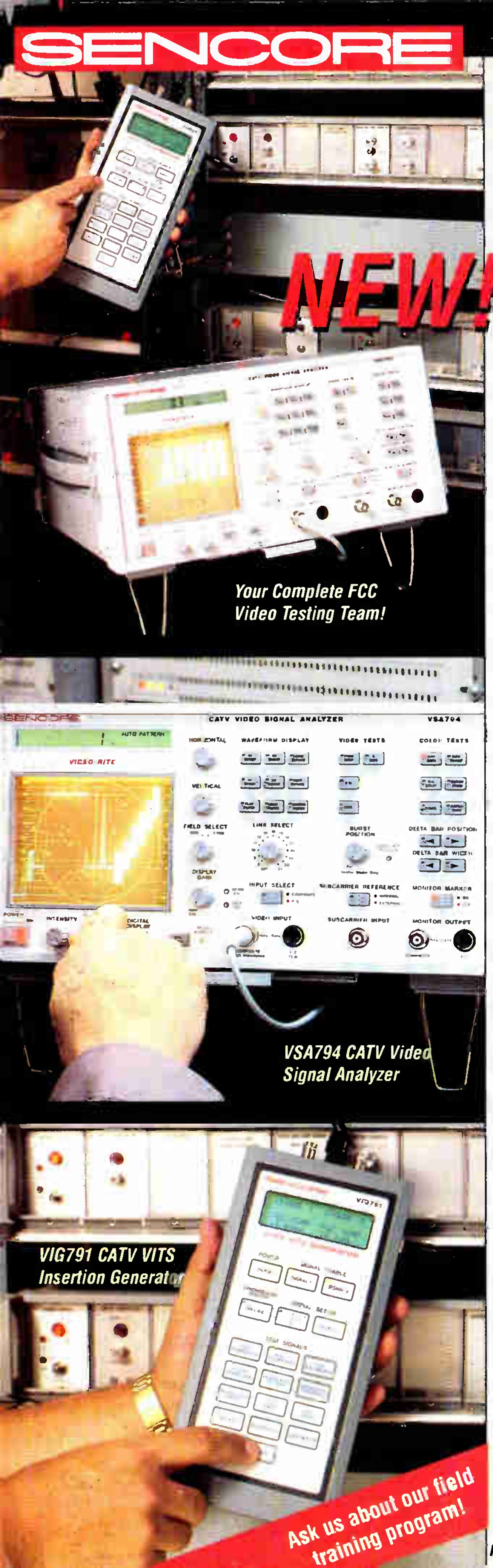

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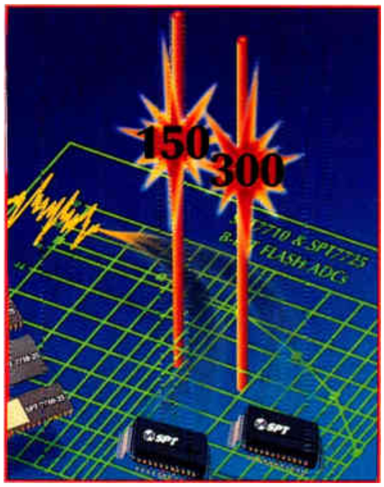

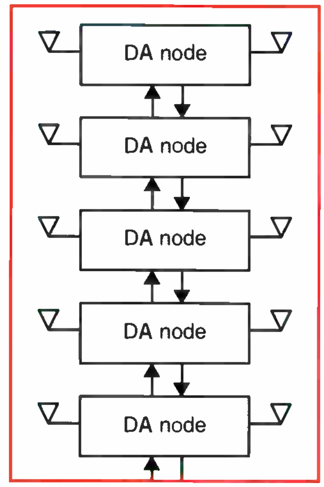

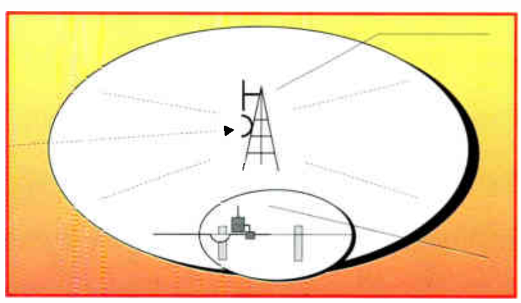

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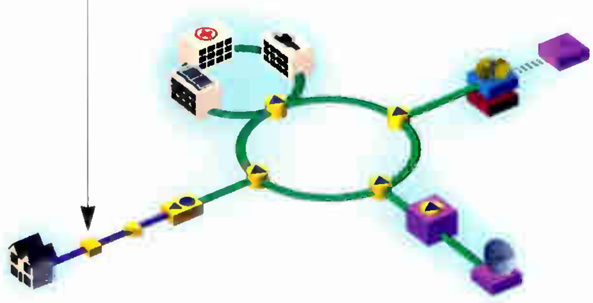

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EDITOR'S LETTER

Transition means competition

The big news as I write this month's editorial is the late October announcement that Sprint, Comcast, Cox and TCI have teamed up in hopes of providing consumers with one-stop shopping for local, long distance and portable/mobile telephony along with CATV service. Instead of cooperation with the regional Bell operating companies (RBOCs), this new venture hopes to compete against them. It wasn't all that long ago that TCI and Cox were involved in merger efforts with two of the RBOCs, Bell Atlantic and Southwestern Bell. Convergence is once again underway, except now it's down a slightly different path.

Of course some federal and state regulations will need to be tweaked a bit first, but this venture had to get off the ground before the government's deadline to register for December's auction of radio spectrum for new wireless technology. Personal communications services (PCS) using the newly available spectrum have the potential to be big sources of revenue to the license holders.

I think alternative revenue streams will be critical to the future of our industry, particularly in the light of increasing competition from the direct broadcast satellite (DBS) and multichannel multipoint distribution service (MMDS) fronts. Cable's bread and butter — multichannel entertainment delivery — is now a public commodity, available from a variety of providers, and soon to be available from even more. As this competition heats up, we'll likely see some of our market share lost to others. Thus there is the need for other ways to put cash back in the till.

I don't imagine the RBOCs will take this in stride, though. Video dialtone is on the horizon, cross-ownership restrictions are being challenged and this year's derailed telecommunications reform legislation will probably be back in some form in 1995. Even with the clout of the new venture — good national marketing strength plus its access to the

four partner companies' millions of homes passed — competing against the RBOCs, other long distance carriers and maybe even other multiple system operator/telco ventures will be tough.

The venture will be up against entrenched incumbent players, much like our own competition faces when trying to take our customers away. Furthermore, cable doesn't necessarily have the rosiest of reputations when it comes to the perception of a high-reliability, high-quality service provider. Even with the credibility of Sprint behind them, the three MSOs will have some image building to do to convince consumers in general that telephone-type services from someone other than the local phone company will be as good (or better) than what they have now. Choice will be important, too. If this new venture does indeed find success at providing local and long distance service, will consumers be able to choose AT&T or MCI for long distance or will they be limited to Sprint?

These and other questions will be answered in time. I for one find this period of transition to be an exciting one. Competition is here to stay. Let's do our best to make sure we're among the winners!

Ronald J. Hranac
Senior Technical Editor

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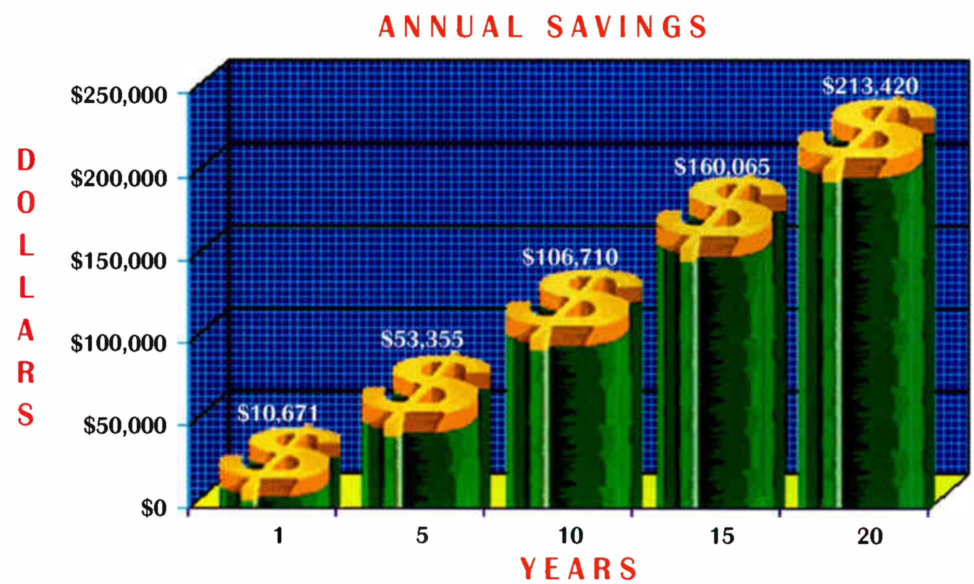

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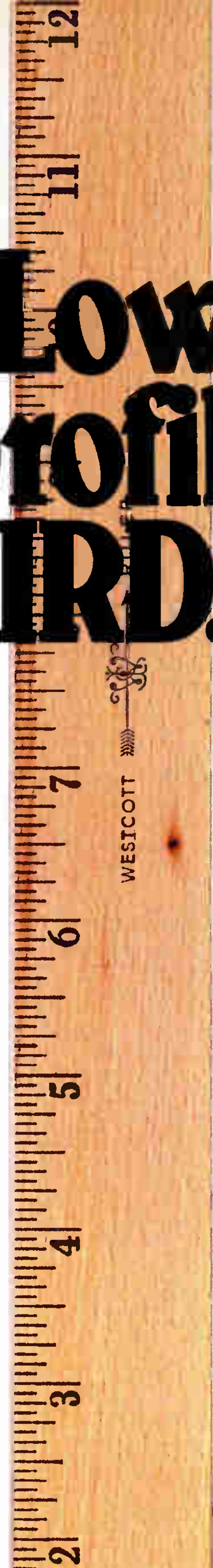

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Reader Service Number 13

Cable ops enter fray for PCS bids

One of the latest announcements in the personal communications services arena involves several prominent cable MSOs seeking to become full-service providers by participating in the FCC's broadband PCS auctions on Dec. 5, *CableFAX* says. TCI, Comcast, Continental Cablevision, Cox, Cablevision Systems and Century Communications join a list of 74 PCS applicants released by the FCC. TCI has a hand in three of the applications. It will use its stake in GCI Communications (along with MCI) to get a PCS foothold in Alaska; its 30% stake in WirelessCo — along with Sprint (40%), Comcast (15%) and Cox (15%) — to enter some 19 major PCS markets; and its 35.3% stake in its PhillieCo partnership, along with Sprint (47.1%) and Cox (17.6%), to enter the Philadelphia PCS market.

Continental Cablevision also is a party to several applications including two with Cablevision: Cleveland PCS Venture and Boston PCS Venture. Winning bidders will have five days to make a 20% down payment, and roughly 45 days after bidding closes to pay for the licenses. The FCC requires companies to build out one-third of the area's population within five years and two-thirds within 10 years. In other FCC auction news, the 28th round of the narrowband PCS auctions (30 licenses) concluded with high bids reaching a grand total of $405 million.

Atlantic Show satisfies the mood

Attendance at the recent Atlantic Cable Show held early October in Atlantic City, NJ, increased 28% to nearly 4,500 people. A representative for the show stated, "Along with higher attendance there is also an increase in the amount of exhibitors."

With the usual contradictions that one finds in the cable industry, booths representing adult services such as Spice coexisted peacefully with booths representing The Christian Broadcasting Network and The Family Channel. As one cable engineer put it, "It's just like on the dial. The adult entertainment is on Channel's 15 and 17 and the religious channels are on 16 and 18."

As for equipment and technology, hot topics were compliance with Federal Communications Commission regulations for video measurements and the ubiquity of fiber optics. The Society of Cable Television Engineers organized a series of four workshops for the technically minded. When not waiting in line for autographs from Playboy Bunnies or attending the workshops, cable engineers could be seen discussing the anticipated deployment of hybrid fiber/coax architectures and the integration of telephony with cable service. Considerable interest also was expressed in the new DBS services and the impact they might have on the cable industry.

Test equipment manufacturers seem poised to make hay with the new FCC technical regulations and with the deployment of increasingly sophisticated equipment in cable systems.

"Cable engineers are very interested in the test equipment required for compliance with the FCC's new color measurement standards," stated Dave Olps, a sales rep for Sencore.

Tektronix District Sales Manager Bill Denne concurred and added, "Cable engineers are also very concerned with end-to-end system tests. They are asking, 'How do I measure an all-fiber trunk system with coax going away?' Sophisticated, portable, automated test equipment is drawing the most interest."

Veteran cable TV engineer Len Muscato, now employed by Bell Atlantic as manager, video services operations, noted, "The most obvious change in the cable industry is the impact that wireless and DBS and the telcos have had. With the convergence of these industries around a common technology, equipment manufacturers are clearly anticipating a profitable journey on the information superhighway."

Representatives of major equipment manufacturers did not want to be quoted but were willing to state that it is clear that MSOs will spend increasing amounts of capital as they upgrade or rebuild their systems. The feeling among exhibitors at the show was that while some decision makers with authority were present, most major decisions would be made back at the home office.

Regulation and cable

The workshop on regulation and the cable industry focused on the FCC's mandate for standardization of the set-back device. A committee of representatives from the cable industry, broadcasting, telephone, DBS, computing, the Electronics Industries Association and many of the EIA's consumer electronics manufacturing members has been trying to develop a standard interface to be built into TV receivers and VCRs. This effort has included the type of connector, the signals carried on each pin of that connector and the protocols for the signal reaching the consumer device whether it comes from cable, broadcast, satellite or telephone. To illustrate how difficult it is to come to agreement, the committee could not meet an Aug. 15 FCC deadline for the standardization of infrared codes that will be used to talk to the TV receiver and its set-back device. Roger Pience, director of engineering at the National Cable Television Association, stated, "There is speculation that the FCC will come out with a ruling at the end of October regarding the IR code issue."

On other regulatory issues Charles Cerino, Comcast director of technical operations, stated, "The leakage regulations of a few years back really forced cable operators to make their plants a lot tighter. Cable operators hired and trained technicians to bring their plants in compliance with FCC CLI regulations. Compliance with the regulations on signal-to-noise and baseband video should be relatively easy to accomplish with the current generation of test equipment."

In response to a question on the emergency broadcast system, Pience stated, "The FCC has made a number of false starts on new EBS rules and is not doing anything at the moment. I do expect there will be new regulations by March 1995."

One proposal involves requiring cable operators to interrupt audio and

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video on all channels for an EBS alert. Broadcasters objected to this as it would override their EBS alerts. Pience stated that his hope is that cable operators will be required to interrupt only the audio portion of selected channels.

Video proof measurements

Terry Bush of Trilithic Inc. moderated a panel on meeting the new FCC requirements for video testing. Mark Everett of VideoTek explained the information that one can derive from reading test signals on a waveform monitor and a vectorscope. He also explained in detail the components of an NTC-7 composite test signal and how each component can be interpreted for evaluating the video performance of the channels on a cable system.

"The video specs the FCC is requiring cable systems to meet are very, very loose," stated Linc Reed-Nickerson of Tektronix. "Ninety-nine percent of the channels in a cable system should pass these tests. If they don't it means the equipment has experienced a hard failure or the equipment is very, very old."

Nickerson explained the meaning of differential gain, differential phase, chrominance/luminance gain inequality and chroma/luma delay inequality. He emphasized, "It should not be difficult to meet 20% differential gain, 10° differential phase and 170 nanosecond chrominance/luminance delay requirements. I also suggest that cable systems do more than the FCC requirement of testing some channels every three years but should test all channels periodically to ensure that their systems remain in compliance. The reason for meeting these specifications is not so much to satisfy the FCC as to provide better quality video to subscribers."

Fiber architectures

Wendell Woody of Sprint/North Supply presided over a panel discussion on fiber-optic architectures. Panelists were Jeff Korkowski, ADC senior marketing manager, Steve Day, president of Comm DOC, and Gregory Hardy, director of transmission products for Scientific-Atlanta.

Day stated, "Hybrid fiber/coax (HFC) more appropriately represents a service intent than a technical architecture, and that service intent is multimedia. HFC represents a broadband pipeline that is 3D. It will have 6 MHz analog video, MPEG-2 compressed digital video and telephony."

Korkowski of ADC discussed the need to focus on cable management. This includes a comprehensive data base that identifies each and every fiber and the signals on that fiber. "A plan is needed that provides a strategy for balancing conflicting design criteria," stated Korkowski. "You need to be able to manage both the analog and digital portions of your plant as well as be able to integrate fiber, coax and twisted-pair into your cable management scheme. Everything starts with the fiber frame. That is where you cross-connect, it is where you have test points for the network and it is where you should put any optical splitters."

The biggest problem Korkowski sees is the data base, "You must be able to administer the entire frame and the entire fiber route. You must have a data base that helps you maintain and monitor the entire fiber route."

S-A's Hardy discussed the route that most cable operators seem to be traveling. "Almost every cable operator is planning either a rebuild or an upgrade. The vast majority of MSOs are deploying 750 MHz systems with active reverse paths at 5-40 MHz. Fiber is being installed deeper into the system in order to accommodate smaller and smaller nodes."

Hardy emphasized that cable operators must consider designing their rebuilds or upgrades with telephony in mind. This implies that a cable operator ought to be installing power passing taps and must be concerned with the sizing and location of power supplies.

All panelists agreed that the challenge in deploying HFC architectures is not technical. As Hardy stated in response to a question from the audience, "The biggest HFC risk is not in building the system but whether or not the business will come home."

Telephony over cable

Moderated by George Duffy of C-Tec Cable, participants in the cable telephony workshop emphasized that the burden of administering a telephone system should not be underestimated by cable operators.

"A tremendous amount of support services are required," stated David Lieberman of CAP-Gemini, a competitive access provider.

Mark Zambarro of C-Tec agreed, stating, "Don't overlook administrative tasks involved with the switch. This in-

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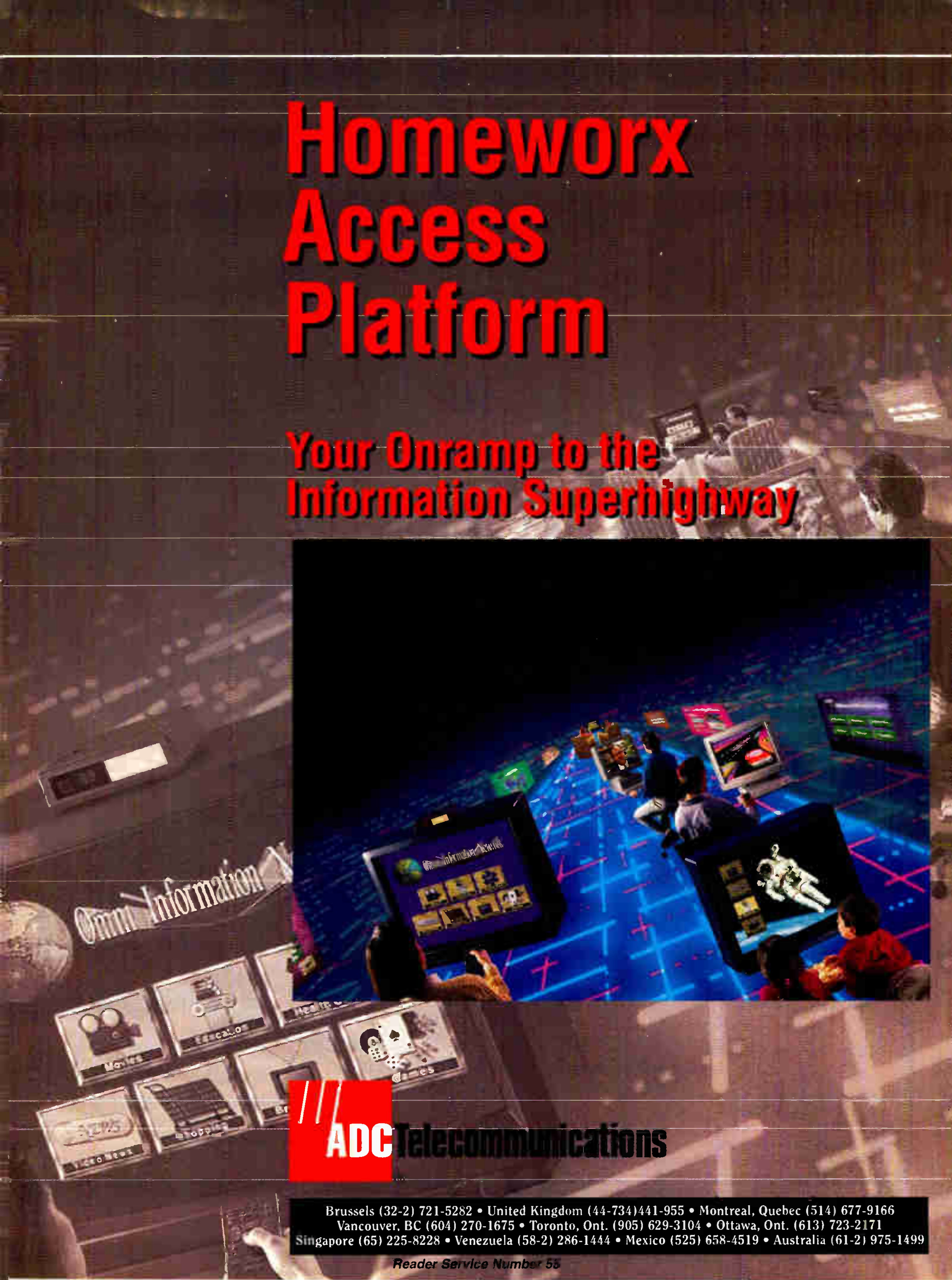
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Roman, General Instrument's vice president of technology and business development, expects digitally compressed video will evolve in four phases. "The first phase is satellite delivery, which is already here in the form of DBS and a modest amount of satellite distribution to headends and affiliates by a few cable operators and broadcasters. The second phase is digital to the home over cable, which will begin next year. The third phase is headend compression of video and the fourth will be HDTV."

"Digital brings many benefits," stated Roman. "These include signal security, video quality, reduced degradation, reduced power and bandwidth utilization." As an example of reduced signal degradation Roman pointed out, "In a sun outage an analog video signal on satellite will fade quicker and the fade will last longer. A digital signal will survive down to a carrier-to-noise ratio of 4.5 or 5 dB while an analog signal will fade at about 9.5 dB."

Joe Parola of Antec's digital video division, discussed some of the problems recently experienced with the use of asynchronous transfer mode (ATM) switching for the transport of digitized compressed video.

"The problem with ATM is that it doesn't scale very well in a switched environment," stated Parola. "ATM has had problems with blocking. The switch can only handle so much input before it reaches its threshold and somebody gets blocked. The result is you need buffers to prevent interruption of data. Without buffering you get jitter. The schemes and algorithms to deal with buffering are quite formidable." Parola stated that sophisticated switching such as ATM was not necessarily required for the transport of interactive video if the video serving devices are brought closer to the home. — *Andy Morris*

Time Warner requests telco offering consent

Time Warner requested permission from the Public Utilities Commission of Ohio (PUCO) to offer business and residential telco service in the state. If the request is granted, TW would provide head-to-head competition with Ameritech, *CableFAX* reports. In addition to basic telco service, Time Warner wants to offer custom calling services such as call forwarding, call waiting, caller ID, conference calling, automatic dialing and sophisticated voice messaging. The company also filed a petition to address interconnection and related competitive issues with the PUCO. Time Warner, which expects to launch phone operations in New York next year, currently operates competitive access telco service in 15 areas across the country, including Cincinnati, Columbus and Lima, OH.

In other news, Time Warner Communications unveiled its National Operations Center in Englewood, CO, which will provide 24-hour management of the company's networks across the country and is a principal technological element of the company's entry into the telecommunications business. The center is staffed by teams of network analysts and customer interface specialists who provide customers with a single point of contact for network ordering, provisioning, billing, collections, network maintenance and performance management services.

Also, General Instrument announced that Time Warner Cable will purchase 1.5 million of its analog addressable CFT 2200 set-tops, to be deployed over the next three years in TW's systems nationwide.

Macrovision protects Time Warner's FSN

Macrovision Corp. announced that Time Warner Cable's (TWC) digital set-top decoders for its Orlando, FL, full service network will include Macrovision's proprietary video copy protection feature. In addition, the company announced that TWC acquired the rights to turn on the copy protection feature on an individual video-on-demand program and individual set-top decoder box basis.

In order to deploy copy protection in the network, Macrovision licensed TWC's supplier of set-top decoders, Scientific-Atlanta, to include the video copy protection feature inside its digital set-top decoders. Macrovision also collaborated with Silicon Graphics Inc. to ensure the system software allows the network to activate the copy protection feature on an individual decoder basis for designated movies and events. In order to embed the technology in digital set-top decoders, Macrovision's licensed set-top manufacturers can buy Macrovision-enabled integrated circuits from a num-

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ber of semiconductor manufacturers.

The company now lists six licensees that provide the video copy protection feature in off-the-shelf semiconductor components: Brooktree, Philips Semiconductors, Raytheon Semiconductor, Samsung Electronics, Sony Electronics and Texas Instruments. Also, five digital set-top manufacturers have been licensed to date: General Instrument, DiviCom, Philips Consumer Electronics, Scientific-Atlanta and Thomson Consumer Electronics.

Wall Street predicts DBS slowdown

CableFAX reports that at SBCA's SkyForum, Wall Street analysts predicted a considerable slowdown in sales of DBS, which have been reported as red hot by DirecTv and USSB since the units went on sale in June. According to predictions, sales will fall as much as 20% below the most conservative industry projections by 2000 due to increased competition from cable and telecommunications companies.

The analysts almost all gave sales estimates below the 10 million subscriber base DirecTv is predicting. Two of the analysts expect DBS subscribers will total no more than 8 million households by 2000 — roughly half of the 15 million forecast by USSB. At least two or three DBS companies should be able to survive and prosper with 8 to 10 million subscribers, according to the analysts.

The Wall Street forecasts contrasted sharply with the views of USSB's Stanley Hubbard, who claimed DBS subscribers will top 15 million by 2000. DBS sales have totaled 100,000 subscribers in slightly more than three months, Hubbard said, noting the 500,000 mark is attainable by year's end.

☛ Bell Atlantic, Nynex and Pacific Telesis Group formed two new companies to deliver the next generation of home entertainment, information and interactive services: a media company to develop a portfolio of branded programming and services, and a technology and integration company to provide the systems to drive the delivery of programming over the telephone companies' new video dial tone networks. The initial rollout of the media company's services is slated for the second half of 1995.

☛ Tellabs Inc. announced sales for the third quarter ended Sept. 30 topped $123 million, up 59.6% over sales of $77 million in third quarter 1993, the highest third quarter results in the company's 19-year history. Sales for the first nine months of the year exceeded $345.5 million, up 62% from sales the previous year.

☛ Zenith Electronics Corp. reported a net profit of $9.4 million (21 cents per share) for the third quarter of 1994, compared with a net loss of $14.5 million (44 cents per share) for the same period a year ago. Third quarter 1994 results include a $5 million gain on the sale of real estate. Total revenues in the quarter were up 39% to $419 million from $302 million in 1993.

☛ C-COR Electronics Inc. reported a net income for the first quarter ended Sept. 23 of $2.19 million on sales of $27.55 million. Earnings per share for the quarter were 46 cents. This compares to a net income of $1.13 million on sales of $15.7 million (23 cents per share) for the first quarter of the previous year.

See you in Orlando: Emerging Technologies

Registration brochures have been sent to the Society's membership for its 1995 Conference on Emerging Technologies to be held Jan. 4-6 at the Stouffer Orlando Resort in Orlando, FL.

The Emerging Technologies Program Subcommittee, headed by Chairman Michael Smith of Adelphia Cable, has assembled an incredible program for the next edition of what is considered to be one of the most important conferences offered for cable and telephony technical personnel.

This year's conference will address many of the technical issues that are currently hot topics of discussion in the world of broadband communications, including digital compression, alternative transmission techniques, telephony over cable and the technologies collectively known as multimedia.

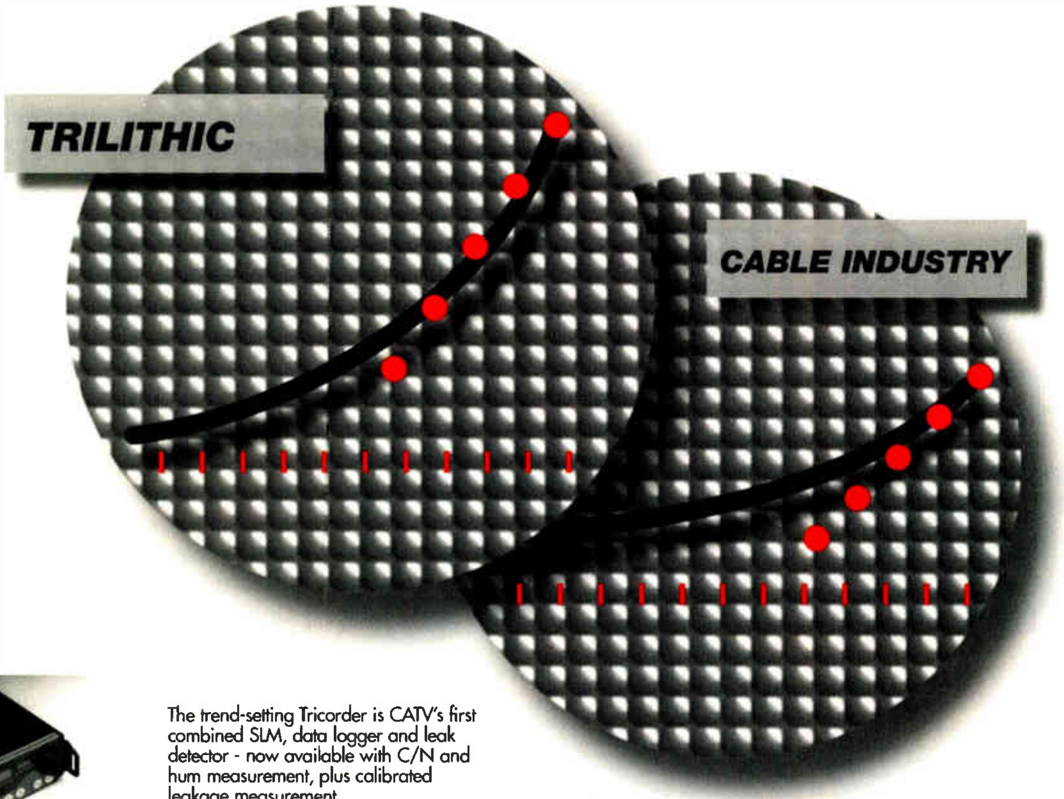
Recent mergers within the cable and telephone industries have confirmed the importance of being in the forefront of future technological advances. "Emerging Technologies '95" will serve to inform attendees of the latest developments and trends within the industry.

Preconference tutorial sessions, which previously were optional for attendees, have now become a permanent staple of the annual conference, and will be held Jan. 4 for all attendees, allowing them to gain in-depth knowledge of several key technological advances. Topics and speakers for these sessions are: "Time Warner's Full Service Network" with Jim Chiddix of Time Warner Cable; "Intel's Proposed Broadband Cable Network Infrastructure" with John Mascarenas of Intel Corp.; and "An In-Depth Look at File Servers" with Jim Barton of Silicon Graphics.

The two conference days are packed with presentations by over 25 speakers. On Jan. 5, Session A, "Digital Compression and Alternative Transmission Techniques," will be moderated by Paul Gemme of Time Warner Cable, and will feature the following presentations: "Compression Trial Results" with Mike Hayashi of Time Warner Cable and Brian James of CableLabs; "Susceptibility in Home Wiring" with Claude Baggett of CableLabs and Brian Bauer of Raychem; "A Digital Architecture for Delivery of Broadcast Switched and Interactive Services" with John Mattson of Northern Telecom and Jack Terry of Bell Northern Research; and "Server Architectures" with Mike Maslaney of Digital Video and Chris Pedersen of Hewlett-Packard.

The keynote speaker for the Jan. 5 luncheon is Richard Smith, chief of the Federal Communications Commission Office of Engineering and Technology.

Session B, "Telephony and the Cable Industry," will be moderated by Dan Pike of Prime Cable and will feature: "Engineering Economic Issues" with David Reed of CableLabs; "A Compari-



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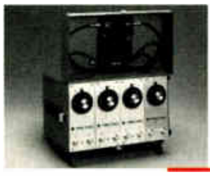

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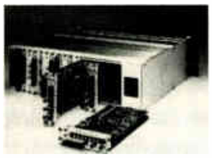

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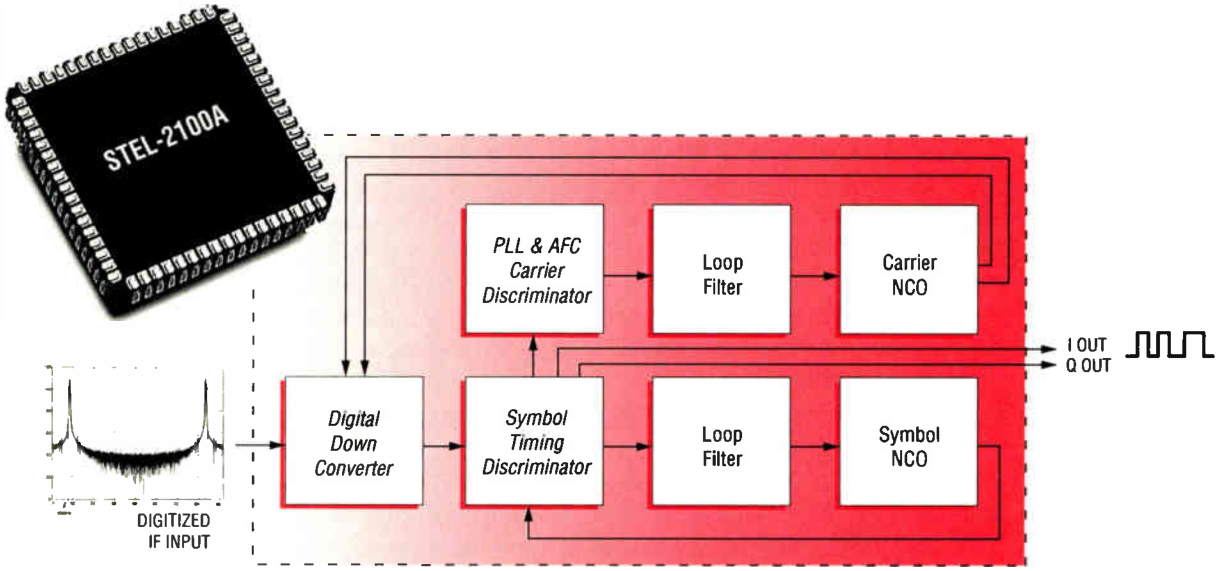

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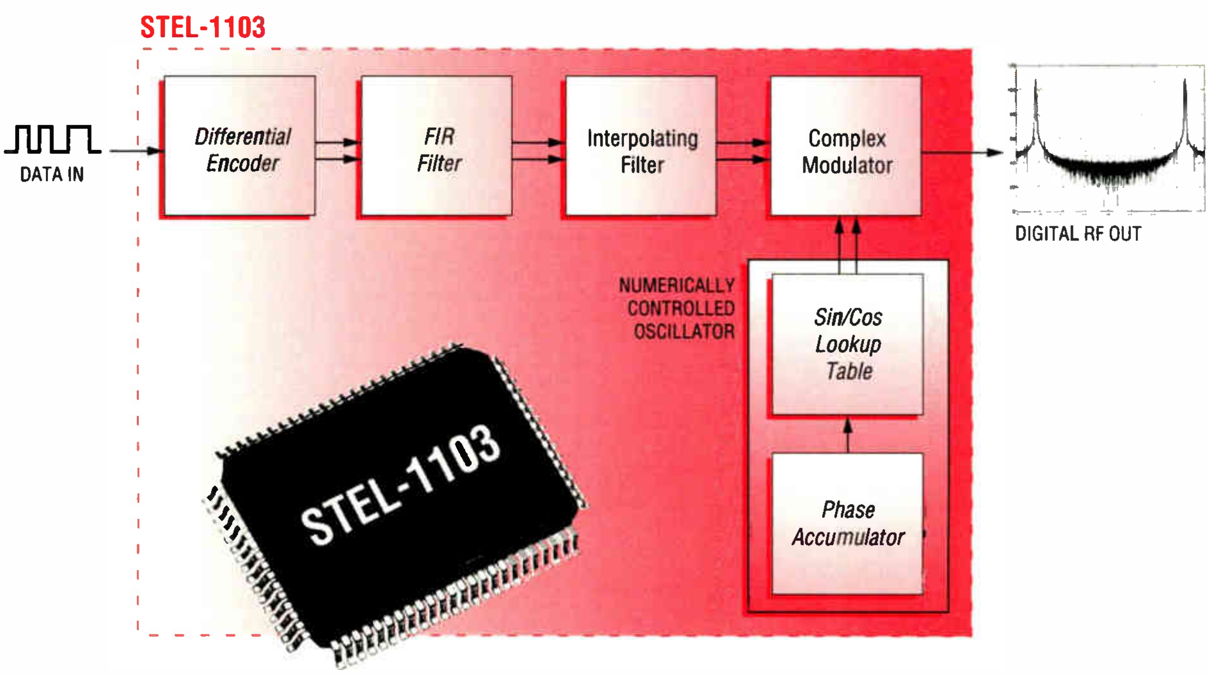

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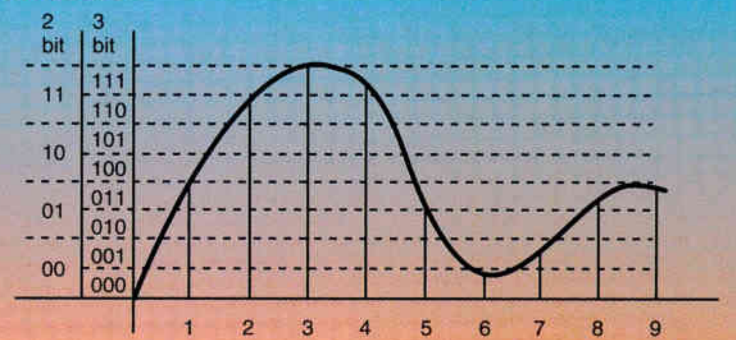
A/D and D/A

By Lawrence W. Lockwood
President, TeleResources
East Coast Correspondent

Figure 1: Analog signal quantized to quantization levels of 2 bits and 3 bits



	1	2	3	4	5	6	7	8	9
2 bit	01	11	11	11	01	00	00	01	01
3 bit	011	110	111	111	011	000	001	011	011

The real world is analog. When one views a scene or hears a sound the experience is purely analog — no digital data is involved. Yet we (especially in the TV world) are racing into a digitized future. Why? Because once an analog signal is represented by a mathematical series of numbers — e.g., a series of binary numbers — they can be manipulated, achieving results that cannot be achieved using the analog signal alone. Such results as putting more than one TV signal in one channel by compression or the faithful reproduction of a TV signal with no noise after a transmission over long paths could not be achieved by any operations on the analog signal.

But first the analog signal must be converted to a digital one — analog-to-digital conversion (A/D) — and after the operations are performed in the digital format the resultant digital signal must be converted back into an analog format — digital-to-analog conversion (D/A) — for use in the real world.

A/D conversion

There are several different types of A/D converters (ADC) but the end result for each is the same. Samples of the analog signal are periodically taken at regular intervals (sample rate) and the voltage level of each sample is determined and its value is represented by a binary number. The sample rate must be at least twice the highest frequency in the analog signal or spurious results known as aliasing will result. This minimum sample rate is called the Nyquist rate after the Bell Labs researcher who first defined it. In reality the sample rate is always somewhat greater than the Nyquist rate. In digitizing composite video it usually is 3 or 4 times the color subcarrier frequency; i.e., $3 \times 3.58 \times 10^6 = 10.74 \times 10^6$ or $4 \times 3.58 \times 10^6 = 14.32 \times 10^6$ samples/sec. The process of determining the value of the signal and its number is known as quantization. The number of bits of the binary number is called the level of quantization or resolution, and for television it is usually 8. That means that a full scale video signal is quantized or sliced into 256 levels since $2^8 = 256$.

A brief review of binary numbering can be done by evaluating one. To determine the digital equivalent of the 8 bit binary number 10011010 see the accompanying table. The leftmost binary number is called the most significant bit (MSB) because it has the highest digital value and the rightmost binary number is known as the least significant bit (LSB) because it has the lowest digital value. This binary number could well be the quantization of a

Digital value of a binary number

Binary number	MSB 1	0	0	1	1	0	1	LSB 0
Digital values for each binary position	128	64	32	16	8	4	2	1
Digital value of binary number	154 = 128	+ 0	+ 0	+ 16	+ 8	+ 0	+ 2	+ 0

Glossary of acronyms

A/D	*Analog-to-digital*
ADC	*Analog-to-digital converter*
D/A	*Digital-to-analog*
DAC	*Digital-to-analog converter*
DIP	*Dual-in-line package*
FS	*Full scale*
LSB	*Least significant bit*
LUT	*Lookup table*
MSB	*Most significant bit*
S/H	*Sample and hold*

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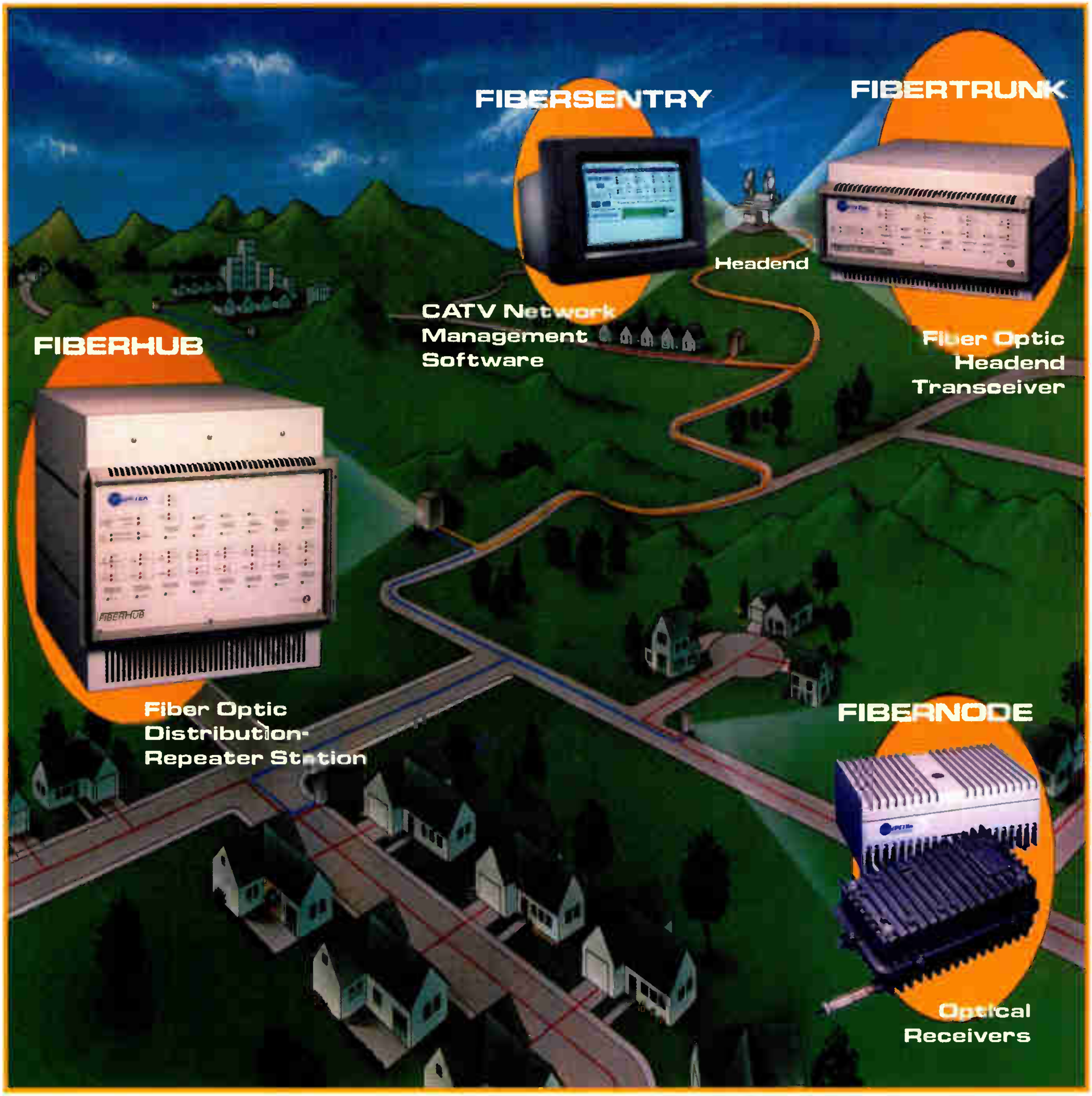

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sample during an A/D conversion of a video signal. A sampled and quantized analog signal is shown in Figure 1 on page 26. To simplify some of the figures, low quantization levels (in this figure 2 and 3 bit) are illustrated.

Figure 2: Sample and hold operation

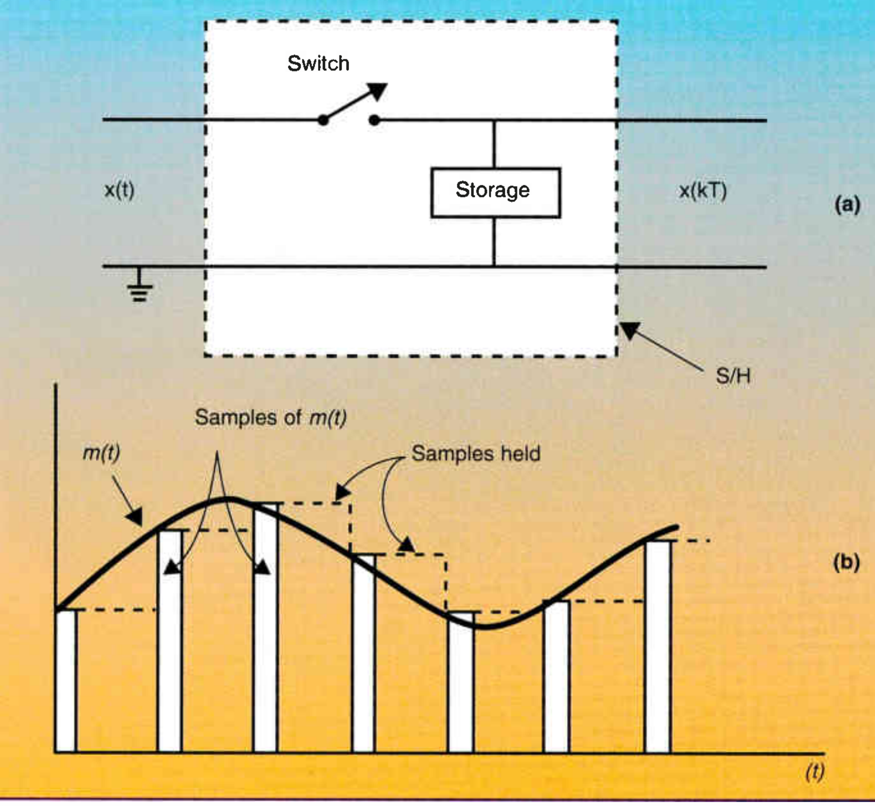
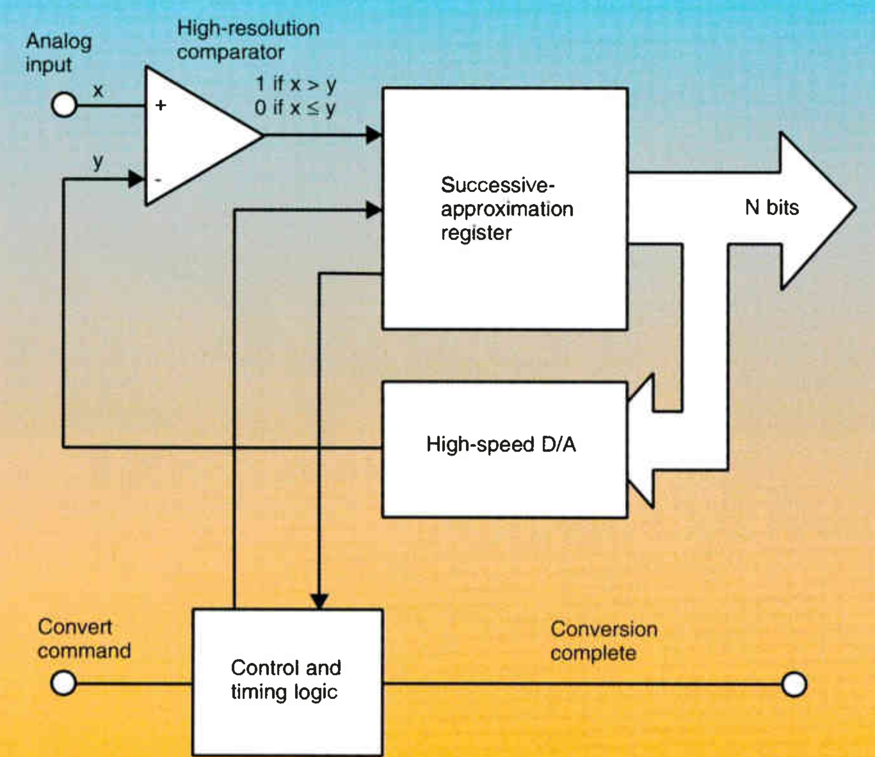


Figure 3: Successive-approximation ADC



During the sample period while the level of the analog signal is being determined the signal level must change so a process known as "sample-and-hold" (S/H) is used. It is shown in Figure 2. The S/H process consists of charging a storage element (such as a capacitor in the simplest case) to a potential that represents the sample amplitude over a small duration of time when the switch in Figure 2a is closed. When the switch is open, the charge is held or retained for the sample period while the quantization is performed as indicated in Figure 2b.

Over a period of time different techniques were developed to perform the A/D conversion depending largely on a combination of the state of technological development and the requirements of the user. In any choice of an ADC there is a tradeoff of sampling speed and resolution. If the requirement for a high resolution of say a medical X-ray is possibly 10 or 12 bits, then the sampling speed must be lower than the sampling speed for TV video at only 8 bits resolution.

A/D successive-approximation converter

Introduced in 1958, this type of converter has a sample speed limit of about 1 Msample/sec with a resolution of 12 bits. (See Figure 3.) The building blocks for the successive-approximation ADC consists of a comparator, a successive-approximation register, a reference DAC, and control and timing logic to perform n single-bit conversions.

The ADC compares the analog input with the output of an n-bit DAC in a series of successive approximations. After the conversion command is applied and the converter has been cleared the DAC's MSB output (1/2 full scale) is compared with the input. If the input is greater than the MSB's value, it remains "on" (i.e., "1" in the output register) — if the input is less than this value, it is turned "off" (i.e., "0" in the output register) and the next bit (1/4 FS) is tried. If the second bit's value doesn't exceed the input, it is left ON ("1") and the third bit is tried. The process continues in order of descending bits until the last bit has been tried. When the process has been completed the contents of the output register now form a binary word corresponding to the input signal's magnitude. In most successive-approximation ADCs the output data also is available in serial

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Figure 4: N bit flash converter

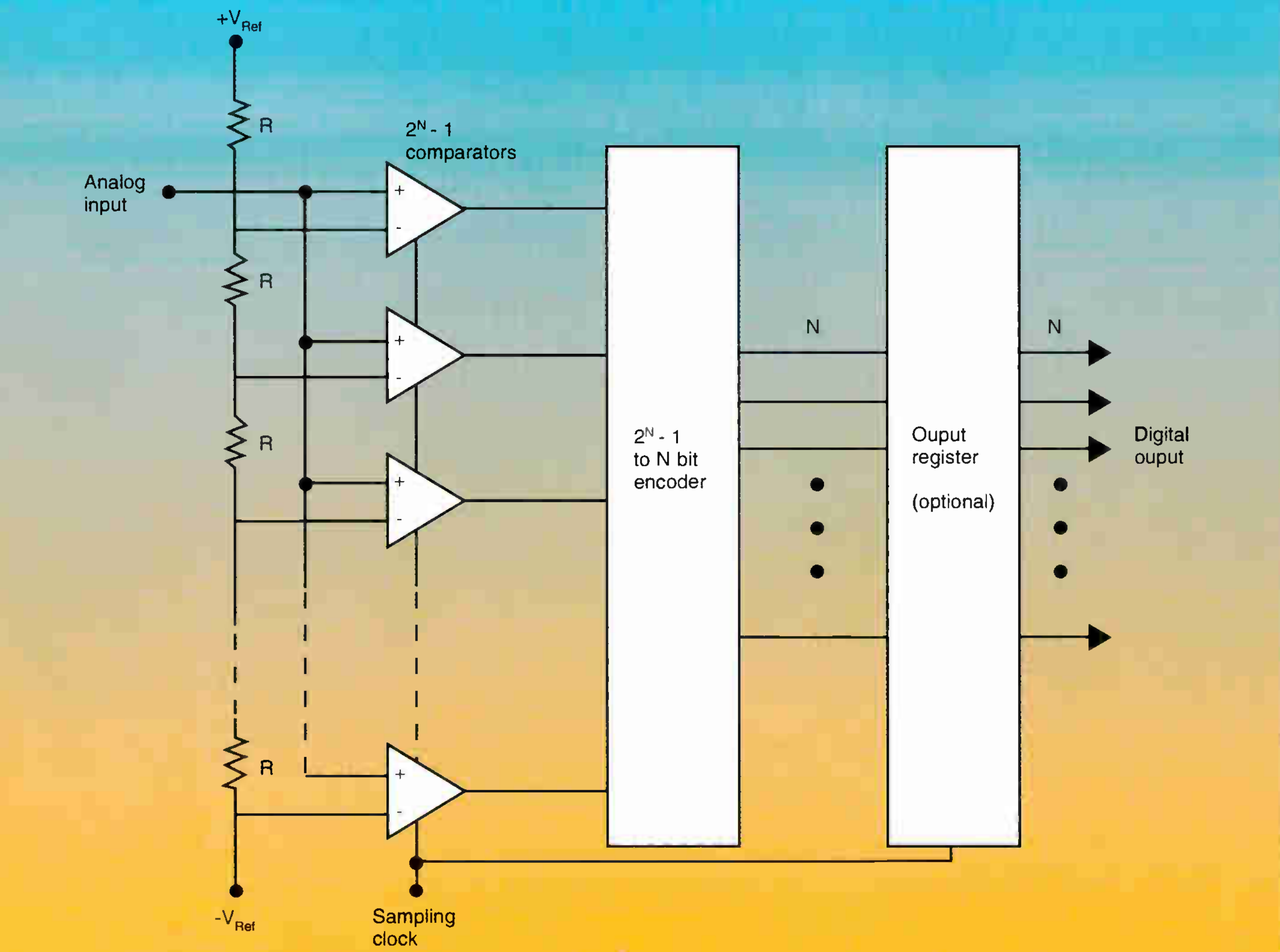
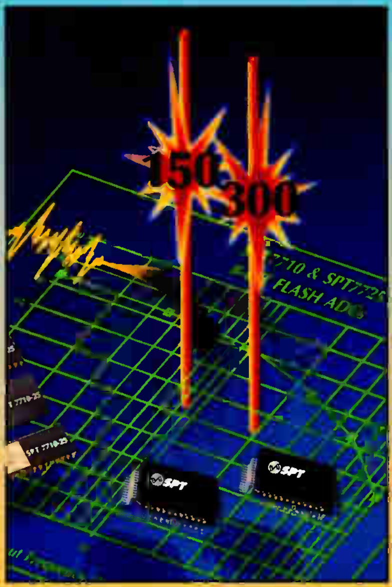


Figure 5: Two high-speed SPT 8 bit flash converters



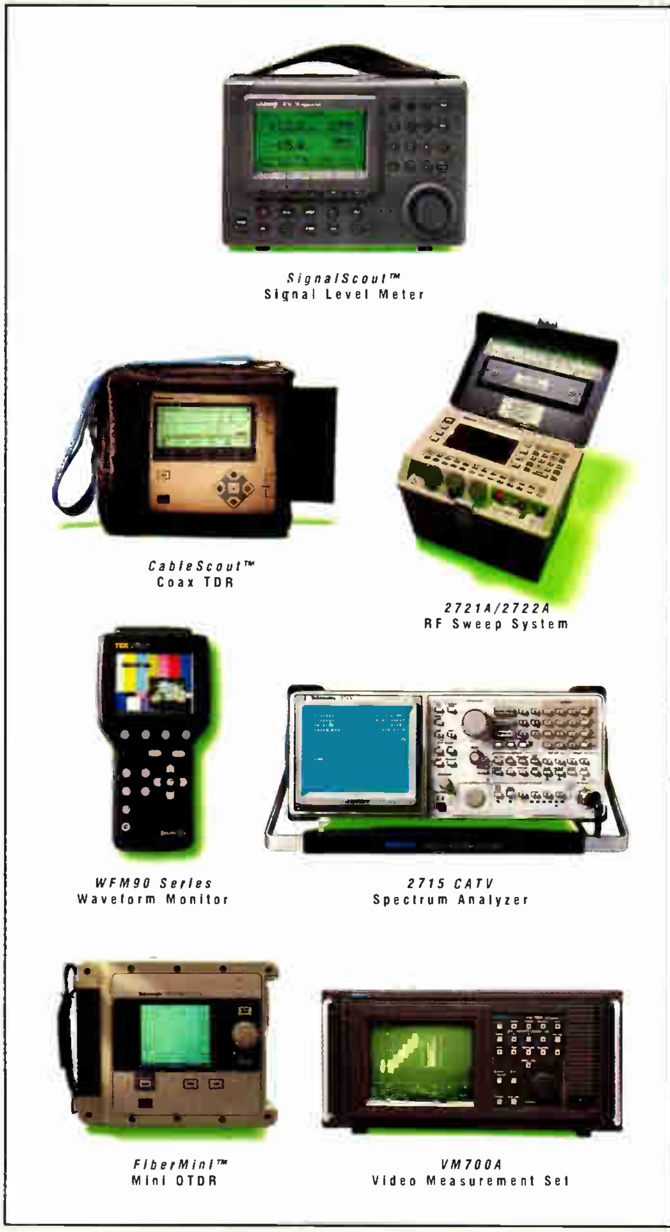
format. Each of the bit decisions requires a clock period and this type ADC usually requires an S/H. The conversion process is strikingly similar to a weighing process using a chemist's balance with a set of N binary weights (e.g., 1/2 lb, 1/4 lb, 1/8 lb, 1/16 lb, etc.) for unknowns up to 1 lb.

Flash ADCs

The successive-approximation converter uses sequential conversion; a flash converter (introduced in 1969) provides direct conversion. That is, it processes all bits at essentially the same time rather than through a series of individual steps. The parallel nature of the conversion cycle makes the flash converter capable of very high speed sampling. (See Figure 4.)

The speed range extends from about 1 Msample/sec to as high as 500 Msamples/sec for some devices. Sampling rates of 75 to 100 Msamples/sec are common. The main disadvantage of the flash converter is its 10 bit resolution limit. This limitation is inherent in the flash converter's architecture. The flash converter needs 2^n-1 comparators, where n is the number of bits. A 4 bit flash converter, which needs only 15 comparators, is easy to construct. Even an 8 bit, which needs 255 comparators, is not especially difficult to fabricate on a chip. The practical limit is a 10 bit converter, which needs 1,023 comparators.

In operation, a flash converter derives a reference voltage input for each comparator from a resistive voltage divider that spaces each comparator one LSB higher than the comparator immediately below it. When an analog signal is present at the input of the comparator bank, all comparators that have a reference voltage below the level of the input signal will assume a logic "1" output. The comparators that have their reference voltage above the input signal will assume a logic "0" output. The



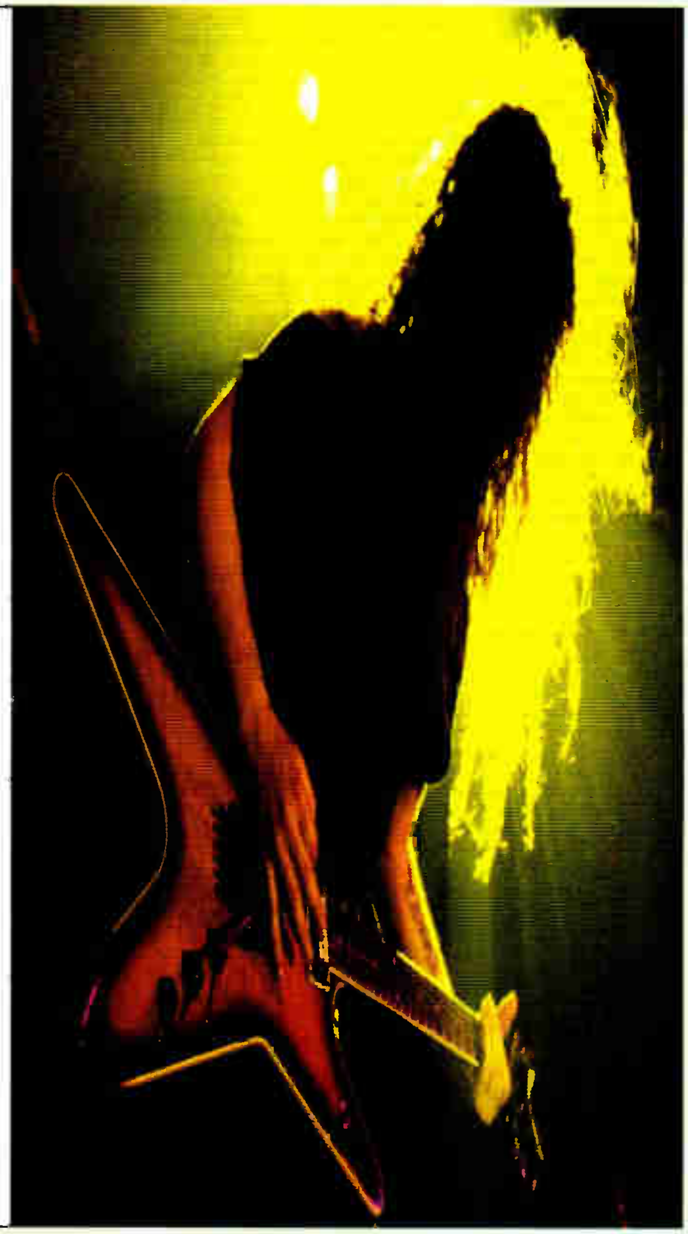


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Figure 6: Eight bit subranging ADC

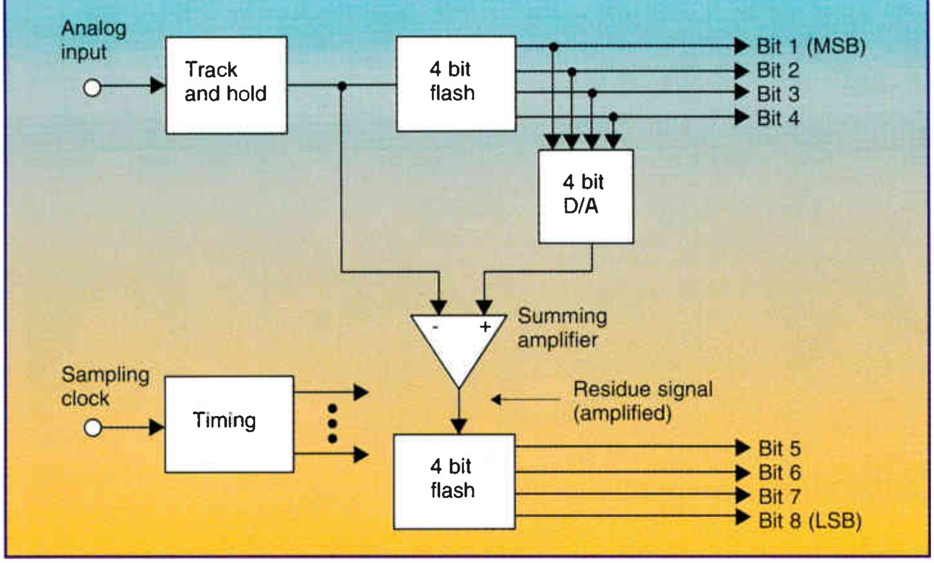


Figure 7: Idealized 4 bit DAC

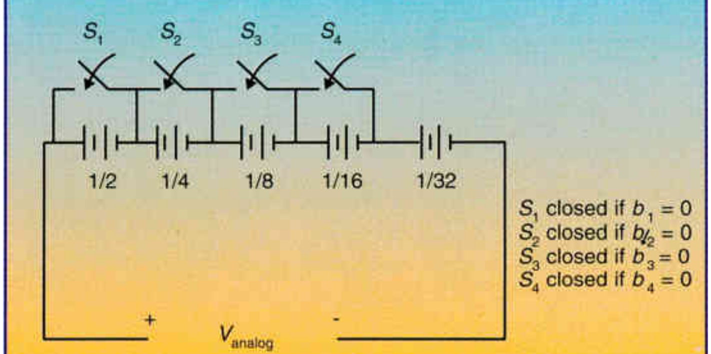
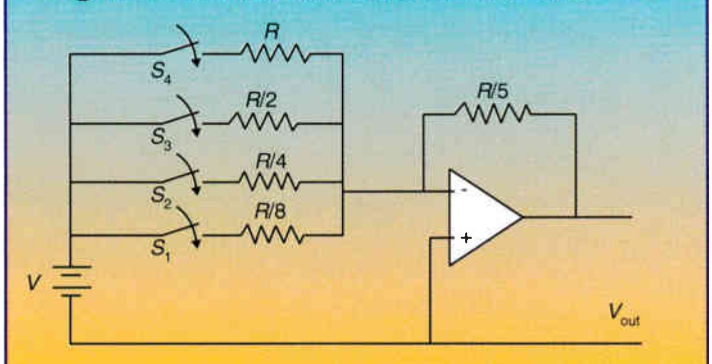


Figure 8: Functional diagram of a DAC



result is often referred to as "thermometer code" and is applied to a stage of decoding logic that forms an n-bit binary output word. Flash converters are sampling devices and do not usually need an S/H circuit.

Because of their high-speed capability, flash converters find extensive use in applications such as communications, radar, digital scopes, waveform analyzers and video signal processing. In general, any application in which high-speed conversion is necessary is a candidate for a flash converter. They are widely used for digitizing video.

Figure 5 on page 30 shows two DIPs (dual-in-line packages such as those seen inside personal computers) containing flash converter chips manufactured by SPT (Signal Processing Technologies, Colorado Springs, CO). They both have 8 bit resolution but one samples at 150 Msamples/sec and the other at 300 Msamples/sec. In 100-piece quantity the 150 Msample/sec unit sells for $70.90 and the 300 Msample/sec sells for $99.30.

Subranging ADCs

Although not capable of the extreme high-speed performance of a flash converter or the absolute resolution limits of other types of converters, the subranging converter offers an excellent compromise. The converters (introduced in 1975) offer resolutions as high as 16 bits and speeds as fast as 40 Msamples/sec. Subranging converters typically use two or more steps of flash conversion but have an architecture that has a singular advantage over flash converters — a great reduction in the number of comparators. In the simplified 8 bit example of Figure 6, the two 4 bit flash converters need only 30 to 32 comparators. By contrast, a single 8 bit flash converter would need 255 comparators.

Although the 8 bit flash converter and the 8 bit subranging converter have the same resolution, to equal the overall speed of a single 8 bit flash converter, the two 4 bit DACs must be twice as fast.

In Figure 6's two-step subranging circuit, the first flash converter digitizes the first 4 bits and applies the binary output to the 4 bit DAC. The summing amplifier then subtracts the DAC's analog output from the held analog input; amplifies the resulting signal, or residue; and applies it to the second 4 bit flash converter. The outputs of the two 4 bit flash converters are then combined into a single 8 bit output word. All subranging converters require an S/H circuit. They are available that have resolutions of 8 to 16 bits and speed ratings of 100 ksamples/sec to 40 Msamples/sec. Although not as fast as a true flash converter, subranging converters offer an effective compromise in applications that require high-speed operation at resolutions greater than 8 or 10 bits.

D/A conversion

The process of converting a binary signal to an analog signal is essentially the reverse of the A/D conversion. The fundamental operation of a 4 bit DAC is illustrated in Figure 7. The conversion of the binary number to the decimal equivalent is accomplished by recognizing that each position in a binary number has associated with it a power of 2 (as seen in the table on page 26).

Thus in a 4 bit binary number, a "1" in the leftmost position — the MSB — indicates 2^3 or 8. A "1" in the next position indicates 2^2 or 4. In a 4 bit ADC the interval is divided into 16 regions. Therefore, for example, the lower limit of the region corresponding to the word "0011" is 3/16 V. The lower limit

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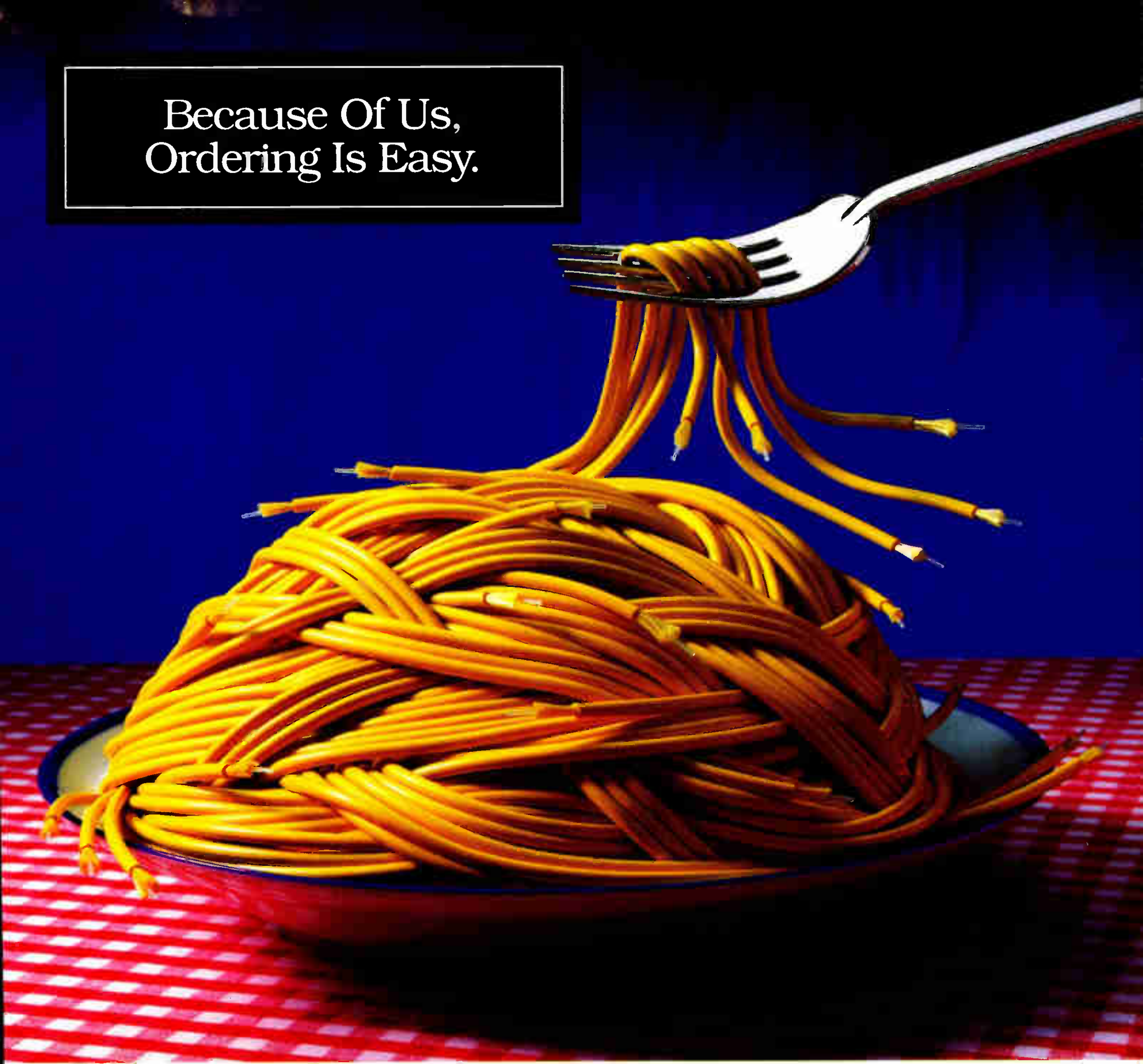

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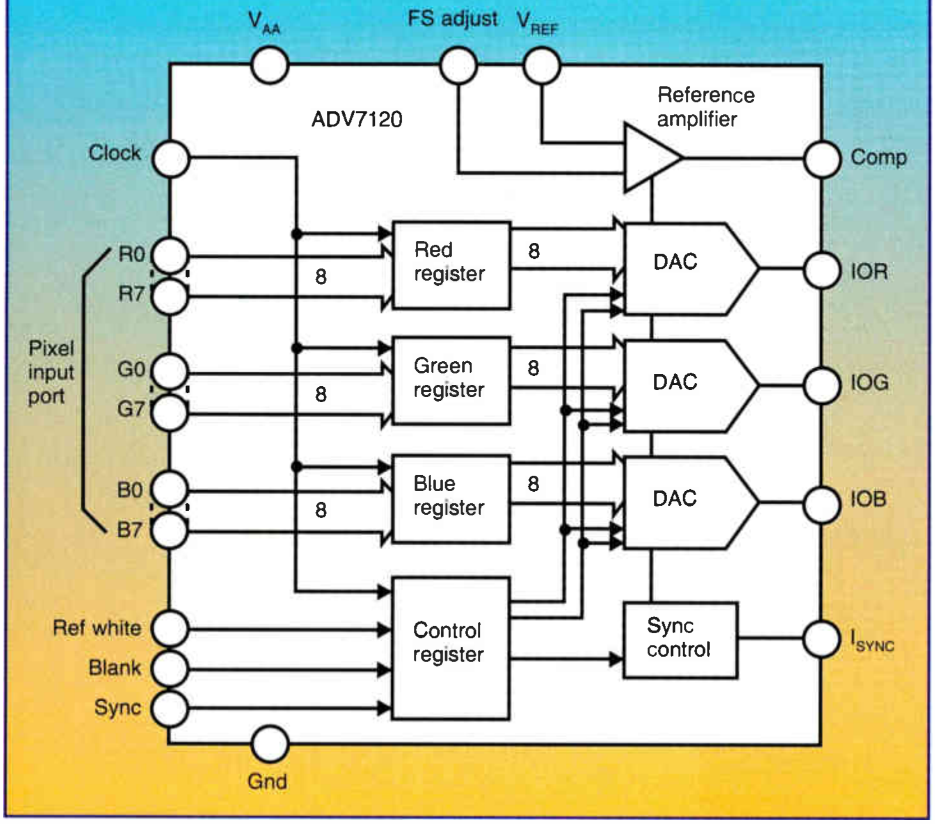
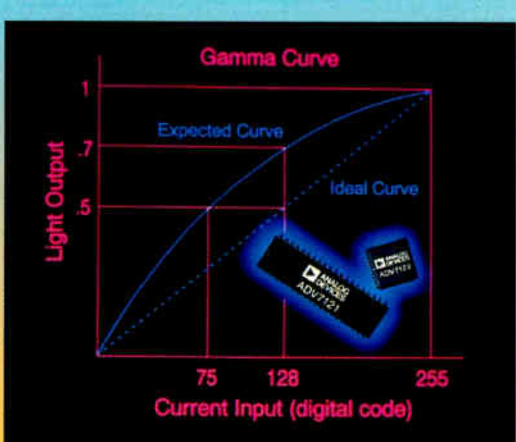
Figure 9: ADV7120 color DAC functional block diagram



of the region corresponding to the word "1111" is 15/16 V. To reach the midpoint of the region, 1/32 V is added to each of these lower limits. An analog voltage can be reconstructed from a binary word by using the 1's and 0's to switch appropriate sources and adding the results together. If a 1 appears in the first position, a 1/2 V battery is switched in. The second position controls a 1/4 V battery and the third position a 1/8 V battery.

Practical DACs use linear circuits for the addition and one source with dividing networks to generate the various voltages as illustrated in Figure 8 on page 32. The block diagram of a color video DAC (the ADV7120) made by Analog Devices, Norwood, MA, is shown in Figure 9. Each chip comprises three high-speed 8 bit DACs (one for each color, red, green and blue), an input interface, analog outputs, reference amplifier and internal control register. A photo of the DAC in its DIP is shown in Figure 10.

Figure 10: Analog Devices' DACs in DIPs



The gamma curve shown there refers to the gamma correction supplied by the chip. Gamma is a term borrowed from photography. The relationships between corresponding electrical and optical quantities in both the camera and receiver are not linear, and if a correction is not applied to linearize the relations a picture would appear "false" — perhaps "muddy" or "washed out." Gamma correction is not done only in digital operations, it is and has always been used in the purely analog domain. The required corrections for each color in this DAC are provided by separate lookup tables (LUT). For example, an input sample value of say 142/256 of a given primary color has a gamma correction value for it stored in the LUT, which is the value sent to the primary color DAC.

"It is a remarkable example of the current state of solid-state technology that such complicated operational capabilities using mixed signals ... can be fabricated on a silicon chip no bigger than a thumbnail."

Analog Devices offers two versions of this DAC, an 8 bit and a 10 bit, both available in 30, 50 or 80 MHz versions. Depending on clock speeds, in 1,000-piece quantities, the 8 bit version sells for $13.60 to $23.75 and the 10-bit version for $19 to $35.30.

Conclusions

It is a remarkable example of the current state of solid-state technology that such complicated operational capabilities using mixed signals (i.e., wide bandwidth analog and high-speed digital) can be fabricated on a silicon chip no bigger than a thumbnail. ADCs and DACs are currently available for use first on NTSC TV and later on HDTV. In CATV usage the number of DACs will always vastly outnumber the ADCs since only one ADC is required for each signal but a DAC will be required for each set-top, although in accordance with agreements submitted to the Federal Communications Commission by the joint Electronics Industries Association/National Cable Television Association committee, the DACs may well be built into future TV receivers. **CT**

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2) "Principles of Communication Systems," H. Taub, D. Schilling, McGraw-Hill, 1986.

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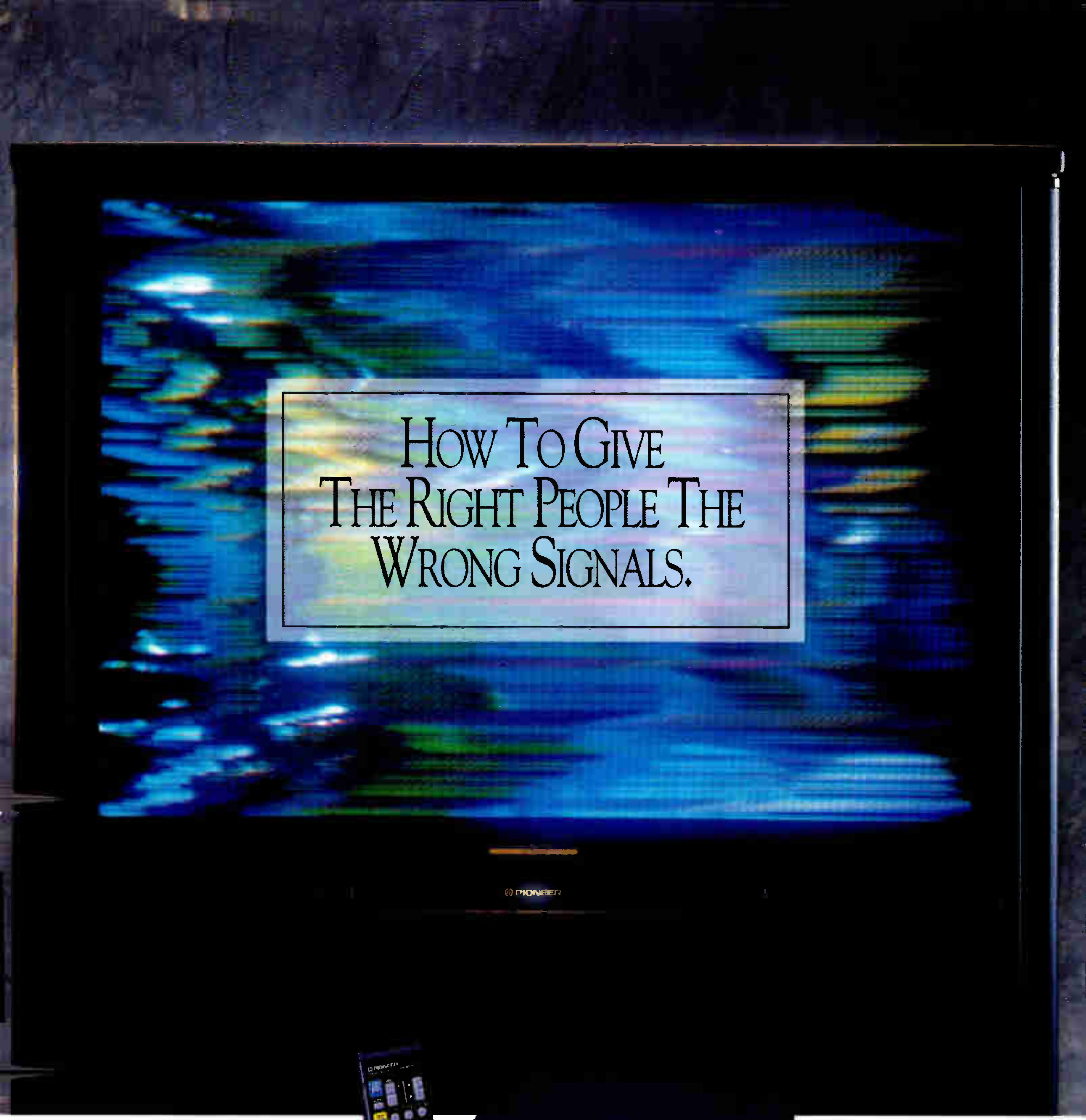

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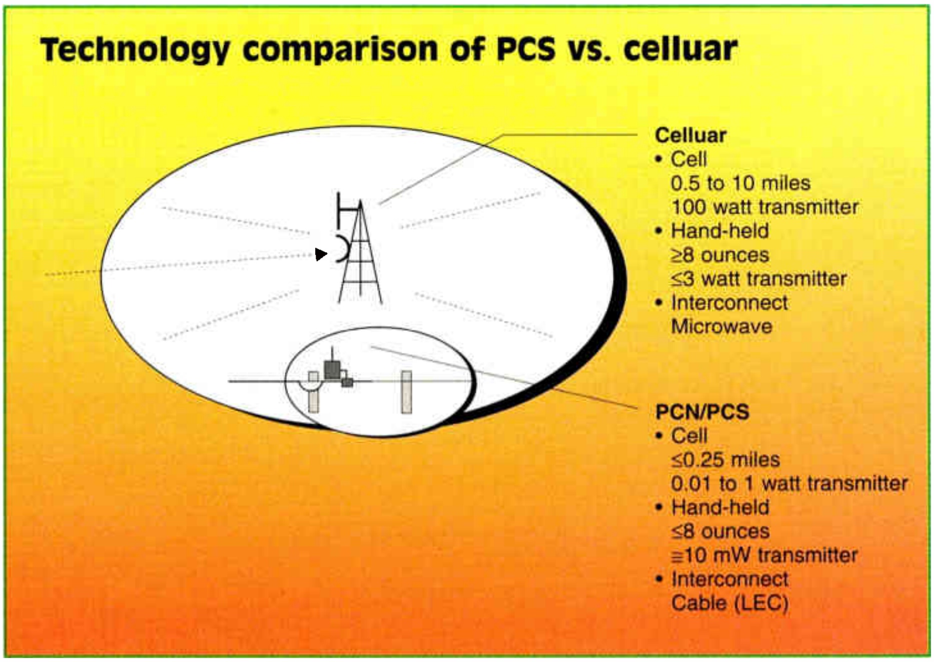
PCN/PCS: A Q&A primer

By H. Mark Bowers
President

And Wesley T. Sterling
Staff Engineer
Cablesoft Engineering Inc.



While much has been written and discussed regarding PCS/PCN technology and its potential impact on the cable industry, a great deal of confusion remains regarding this new technology. What is it? How does it differ from cellular? How could cable become a part of the network? What are the potential revenues for the cable operator?

What do the acronyms PCS and PCN stand for?

PCS stands for personal communications service(s) and PCN stands for personal communications network(s).

What is PCS and what does it do?

PCS, basically, is the concept of a mobile telephone system that would "find you anywhere," yet employ small, lightweight and inexpensive transceivers — even as compared to cellular. PCS would permit a user to move from small cell to small cell, allowing uninterrupted service from any location. It also would allow, as envisioned by some, connection(s) for home or office equipment such as fax machine, computer, pager, etc., thus possibly even replacing the twisted-pair entry to the home at some point in the distant future.

What is the difference between PCN and PCS?

A good question, and a very common one. PCNs are the "highways" that PCSs drive on. That is, a PCN (network) is what is needed to get PCS (services) from the switch to the user and back.

How does PCS differ from cellular?

PCS conceptually differs from cellular in several areas (see the accompanying figure):

• *Cell size.* In PCS, cell size would be considerably smaller than cellular, resulting in a rapid increase in the number of cells required for a given area. If cell site equipment costs can be significantly reduced as well, the overall result should be more uniform coverage for the user, minimal mobile transmit/receive requirements and similar (to cellular) customer operational costs similar to cellular.

• *Network requirements.* Since the number of cells increases dramatically, interconnection requirements between user/cell and the public switched network become far complex. Microwave or leased land-line, as is often employed for cellular interconnection, will be become cost-prohibitive in most instances with PCS. Twisted-pair local exchange carrier lines might be utilized and LECs would like to be the carrier of choice; however, cable TV's parallel broadband network pre-

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LEC vs. CATV for PCN interconnection

	CATV	LEC
Citywide coverage	Most	All
Network reliability	Improving	Good
Control and billing	Good	Excellent
Two-way transmission/bandwidth	Excellent	Problems
Powering of PCN equipment	Problems	Problems
Rural coverage	Rare	Typical

sents the most likely medium for traffic requirements of this new technology in our opinion.

The precise amount of forward and reverse bandwidth required per microcell is still somewhat of an unknown. What is known is that the coaxial environment will require activated reverse spectrum if it is to be employed by the system. One might contemplate fibering directly to all microcell locations, however, fiber to receive node locations in combination with portions of reverse activated coaxial plant is the most likely scenario for many if not most operators. While many operators shy away from activating coaxial reverse plant spectrum, our experience is that reverse plant operation presents manageable technical and maintenance issues, perhaps even offering some advantages.

What is the difference between micro and macrostations?

Macrostations are large cellular transceiver locations operating at power levels of up to 100 watts, covering a cell radius of anywhere from one-half mile to as large as 10 miles. Microstations, on the other hand, operate at power levels as low as 100 milliwatts, not to exceed 1 watt. This of course makes for a considerably smaller radius, usually no larger than one-quarter of a mile. Microstations also use a much smaller antenna, typically about the size of a telephone directory, which hopefully makes for versatile mounting procedures.

How is less radius an advantage?

OK, this is a tough one because there are several opinions. With less power usually comes less bulk. Fortunately, that is the case here. Although cellular consumer equipment has definitely shrunk from early sizes (some portable cellular phones are as small as 9 cubic inches and weigh in just under 8 ounces), hand-helds typically do not have adequate power for general use unless you are in the center of the cell. Since some cells are as large as 5 or more miles in radius, that may mean trouble for the half-watt hand-held unit. PCS phones, on the other hand, would be able to fit in your shirt pocket comfortably. Why? Well, remember that the microcells used for PCS have a power output of only 1 watt maximum and have considerably less radius than a macrocell. Since they are so small, they are able to be installed in scores of locations never dreamed of with a macrocell, so coverage will stay the same or better, while handsets will require less output power as well. (Notice we said coverage, not radius.)

From a slightly different perspective, have you ever used a cellular phone in an office building or other large structure like a mall? What happens? More often than not, you'll find that you have to find a window to stand beside or walk around to find the "sweet spot" for a clear transmission. PCS eliminates that by each structure having its own microcell, or perhaps several. Now you've got the "cell site" right there in the building for ideal operation.

What does PCS have to do with cable TV?

As already mentioned, cable TV has what would appear to be a great opportunity to provide the interconnection medium for personal communication networks. In our view, the LECs offer the most viable alternative for the PCN medium in competition with cable. The accompanying table demonstrates our "read" on that future competitive environment.

Even allowing for a variance in your point of view on the criteria, cable has an edge in some areas, with the LEC having a clear edge in others. In our view, the PCN business is up-for-grabs with either "carrier" having the opportunity to gain the business depending on their approach to deficiency resolution.

Will a community/customer really "want" PCS?

One could ask this about almost any new technology, but consider this: PCS could be referred to as the "pedestrian's cellular phone." That is, although cellular is wireless, it has not been truly embraced by the general public for many reasons. It may be the cost to own or operate, ignorance of the services, or simply that Joe Average still doesn't perceive a great need for it. However, when Joe can reach anyone, anywhere and at any time with a small inexpensive handset — only having to know one phone number per person — PCS advantages may cause him to change his mind.

"PCS certainly intends to supplement existing POTS ... Whether the intent is to eventually replace twisted-pair depends on whom and which company you would ask."

Suppose Joe has to call his wife and let her know that he will be home late, and she has a cellular phone. First, he calls home, only to get no answer. Then he tries her office and finds out that she has left. He tries the cellular number, but by this time she is home. With PCS and a "one-number system," Joe would have saved himself a lot of headaches (and an angry wife if he never got a hold of her).

What will be required for the "typical" cable system to carry PCS traffic?

Connecting a multitude of microcells will present some rather stringent requirements for the cable network, some already mentioned. The following list is not intended to be exhaustive.

- A (proven) reliable system, 99.++% uptime or better.
- Adequate spectrum for PCN traffic, bidirectionally.
- Interconnection with PCS company(s) switch(es), or to provide switching capabilities. →

• Adequate interconnection with the public switched telephone network and long distance carrier(s).

What are the FCC frequency allocations for PCS?

PCN America states that an allocation in the range of 1.7-2.3 GHz will support the technology. Frequencies below this range would propagate too far, and frequencies above this range have limited propagation characteristics, therefore making them unsuitable. In addition, PCN America notes that this allocation takes into consideration other parts of the world in that an international allocation would be desirable. With this in mind, the FCC allocation for PCS will extend from 1.950-1.990 GHz and comprise three 30 MHz bands and three 10 MHz bands.

Does PCS intend to replace or supplement existing phone services?

PCS certainly intends to supplement existing POTS (plain old telephone service). Whether the intent is to eventually replace twisted-pair depends on whom and which company you would ask. Twisted-pair service has been around for a long time and exists in most U.S. homes and businesses. We feel that there are a variety of reasons why this service is unlikely to be displaced for many many years. On the other hand, it is certainly possible that PCS could make significant inroads into areas that have traditionally belonged to the LEC — and local exchange carriers are not likely to ignore this certain threat to their established cash flow areas.

We are often reminded of a past quotation that reads: "Well-informed people know it is impossible to transmit the voice over wires; and that were it possible to do so, the thing would be of no practical value." That quote appeared in a 1865 edition of the *Boston Globe*.

Conclusions/unknowns

There are open issues remaining for the cable, telco and PCS industries. In particular, a few of them are:

• Antenna size and where to mount? This is an open issue for any PCS (and network) provider. A plethora of antennas, admittedly small, will have to be mounted in the field. Where the network provider will "mount" these antennas, or even their ability to do so, may be a formidable challenge. The typical cable operator does not own the poles, and we would raise the issue of whether the utility pole owner will even allow antennas to be mounted. In our opinion, this may be a serious obstacle in a future and perhaps very competitive environment with the LECs.

• How to power the microcell equipment? We believe that powering PCN equipment at 60 VAC will present some serious challenges as well. Other viable powering alternatives may have to be considered.

• How to handle transmitter and antenna placement in predominantly underground plant areas?

• Amount of spectrum needed for the typical PCN cell, and how it can best be managed from a network perspective? **CT**

Sources

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4) "Microcells: Big Potential," Stuart Crump Jr., *Mobile Office*.

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ALPHA TECHNOLOGIES

Cable in PCS: Pioneering telephony's future technology

By Andrew Morris

A number of cable multiple system operators (MSOs) are looking at personal communications services (PCS), the next generation of cellular telephone technology, as one of the next great business opportunities available to cable operators. Utilization of the existing cable plant infrastructure is a great economic incentive for cable operators to participate in the deployment of PCS.

In contrast to today's analog cellular service in the 800 MHz range, PCS is a

Figure 1: PCS/FSN overview

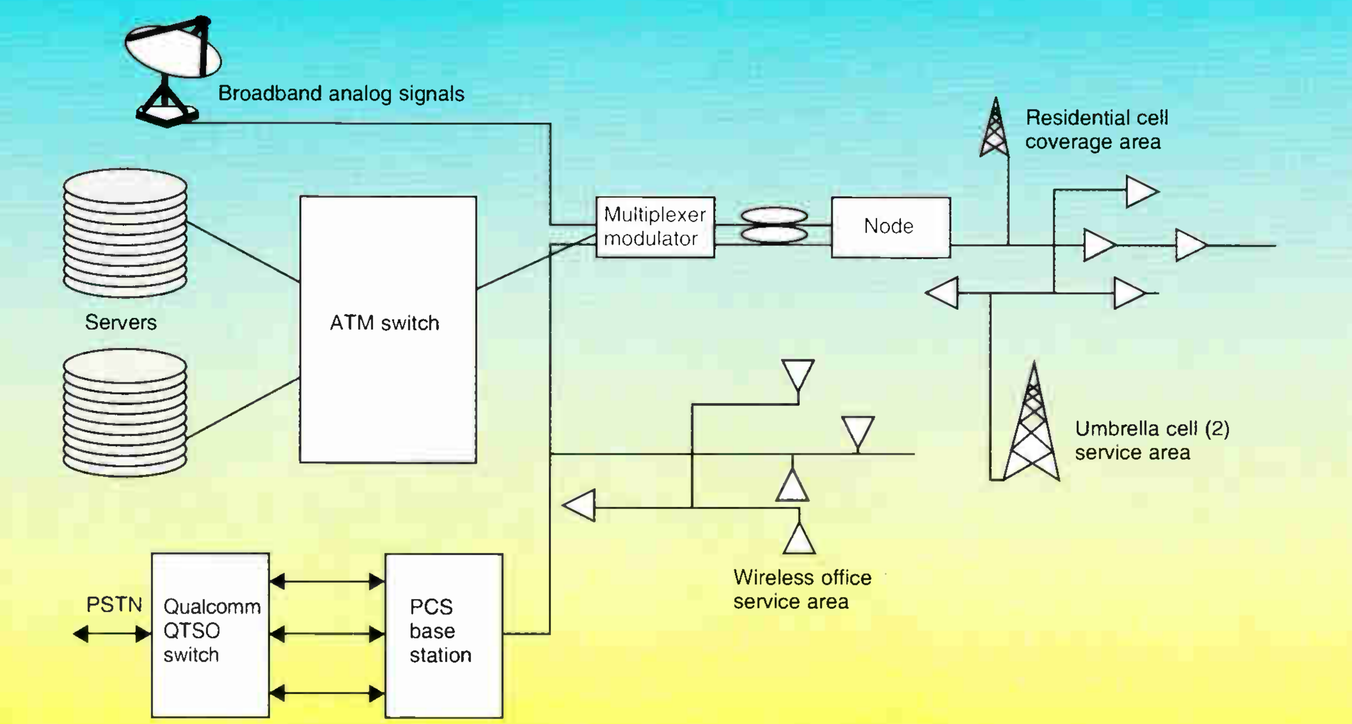
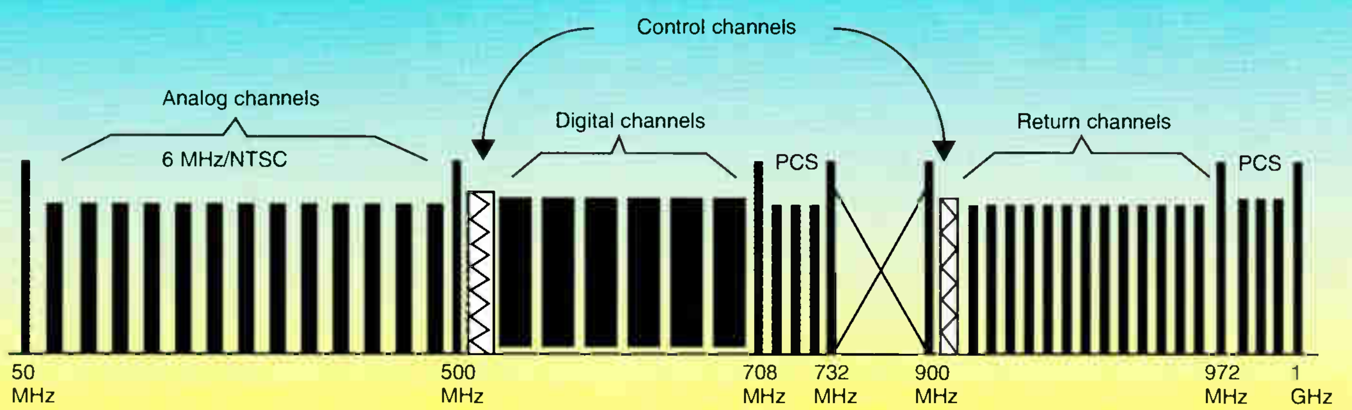


Figure 2: FSN 1 GHz spectrum allocation

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"PCS will be deployed as many small cells and this always brings up problems with community opposition to antennas of any kind."

digital service in the 1,900 MHz range. Plans called for the Federal Communications Commission to auction the 1,900 MHz PCS frequencies throughout the country early this month.

Three companies have received pioneer preferences from the FCC for their work on broadband PCS in the 1,900 MHz band. These companies are Cox Enterprises, Omnipoint Communications and American Personal Communications. The FCC granted licenses to Cox for the San Diego/Los Angeles major trading area (MTA), Omnipoint for the New York (including northern New Jersey) MTA and APC for the Washington, DC/Baltimore MTA.

Why PCS with cable?

Why implement PCS utilizing the cable plant? Why not implement PCS as a purely wireless system? Cable has a couple of very strong attributes, explains Mark Vonarx of Omnipoint, which is a developer and manufacturer of PCS equipment. Foremost is the existence of plant where you need it, particularly in the suburbs. The distribution systems are out there and PCS will by its very nature require more base stations.

In aerial cable plant, antennas and base stations can be mounted on poles. While strand height of 18 to 23 feet is far lower than the optimum antenna height for PCS, it provides an opportunity to deploy PCS equipment quickly and inexpensively. Antenna height and site density are engineering trade-offs in a PCS system. A properly engineered PCS system should work well with antennas mounted at strand height. An example of the benefit of building PCS using existing cable infrastructure is Omnipoint's development of a base station that fits inside a CATV distribution amplifier housing.

There are those in cable who say that PCS is an essential business for cable's future. Time Warner Cable's Lex Felker says that cable must have wireless in order to compete. He adds that wireless looks like it will be a good business and, in fact, it may substitute for wireline in the future.

Technical benefits

"There are real economies to be gained on the technical and marketing side," continues Felker. "On the technical side there is the sharing of facilities. On the business and marketing side there is the sharing of billing systems and customer service as well as the bundling of telephone and video services."

Time Warner's trial of its full service network (FSN) in Orlando, FL, has included testing of PCS. (See Figure 1 on page 42.) Time Warner is using Qualcomm's spread spectrum code division multiple access (CDMA) technology and Felker says, "Once interfaced properly the system worked great." Time Warner allocated frequencies between 720 and 732 MHz for the PCS downstream path and 976 and 996 MHz for the upstream." (See Figure 2 on page 42.)

The Time Warner trial used a variety of cells including one in the Time Warner FSN building and one on a crank-up tower in order to simulate strand height. "This PCS trial was a test of spread spectrum on cable," says James Ludington, vice president, technology, Time Warner FSN.

Felker says, "We were very cautious that the PCS signal not interfere with the video carried on cable."

Testing of PCS included coverage loading and handoff capability. Time Warner also successfully tested wireless access to America On Line via both fixed and mobile PCS terminal.

"It was not that difficult to integrate PCS into our cable plant," explains Ludington, "We had already deployed wideband amps in the field as part of the FSN upgrade. Nothing leapt out at us that a good, clean installation would not fix. There was nothing eccentric in the results. The problems we experienced were due to high SWR. Signals would not lock up. A signal would go one way but not the other. Our problems were caused by cut or kinked cable and bad connections that caused reflections. These needed to be replaced anyway for digital video to be successfully implemented on the FSN. Replacing them solved the problems."

(For more details on Time Warner's PCS trial in Orlando, see Steve Johnson's article beginning on page 50.) →

"Are there any reasons why cable might not be suitable for PCS? 'Reliability of the cable plant is a big issue.' "

Technical challenges

Current analog cellular systems employ frequency reuse techniques in order to provide mobile phone service over a geographic area. The digital PCS services will be lower powered services on higher frequencies. This presents a variety of technical challenges to the implementation of PCS services.

Since free-space propagation diminishes as the frequency gets higher, the 1,900 MHz PCS will have 6-10 dB less signal than an 800 MHz cellular system over the same area. The higher frequency PCS signal will also suffer a 6-10 dB loss due to diffraction and a 2-3 dB loss due to multipath as compared to 800 MHz cellular.

It is estimated that four to 10 times as many base stations will be required for PCS compared with cellular. PCS will be deployed as many small cells and this always brings up problems with community opposition to antennas of any kind. This translates into another plus for cable operators because they can use their existing aerial plant to install the antennas and base stations on without having to build new structures to hold them.

PCS technologies

New technologies that address PCS technical requirements are Qualcomm's CDMA and Omnipoint's combination of CDMA, TDMA (time division multiple access) and FDMA (frequency division multiple access).

The Qualcomm CDMA technology uses spread spectrum techniques for its PCS service. A voice signal is digitized by a µLaw codec at a 64 kb/s rate. The 64 kb/s signal is compressed by a variable rate vocoder from a 1 to 13 kb/s signal. The error corrected vocoder output is multiplied by a unique 44 digit code and transmitted. It is the multiplier that spreads the signal into a 1.25 MHz wideband signal. On the receive side the signal is divided by the same code, detected by the receiver and returned to its original format.

Benefits of spread spectrum include reduction of noise in the system. This results when the wideband signal is despread and detected by the narrowband IF filter in the receiver. Spread spectrum allows for low power transmission because it is the coding that allows for detection of the signal. The coding also provides for secure communications because it is impossible for a receiver to detect a spread spectrum signal without knowing the 44 digit multiplier as well as the deinterleaver and viterbi decoder sequence. In fact, it was during World War II that the military first developed spread spectrum in order to provide secure communications.

Omnipoint is promoting a hybrid system that is a combination of CDMA, FDMA and TDMA. Mark Vonarx, Omnipoint's director of sales and marketing, network systems, says, "CDMA relies on codes to provide separation. The problem is that it is an energy- and interference-limited system. Amplitude variance can destroy the system. In fact, a 2 or 3 dB variance gives you only half the capacity. It is a very complex system requiring precision power control and it is impossible for the receiver to discriminate between the codes if the amplitude is not exactly the same. This type of precision amplitude control is almost impossible to achieve."

Omnipoint uses TDMA within a cell. Sectorized cells and multiple cells within a densely populated area use FDMA with a frequency reuse factor of N = 3 in order to increase capacity. Multicell deployments within a given region use CDMA for each RF link in order to reduce co-channel interference between cells using the same frequency.

Companies that have used Omnipoint equipment for trials include Time Warner, Cox Enterprises, Continental Cablevision and four of the regional Bell operating companies. On Feb. 12, 1992, using Omnipoint equipment, Cox CEO Jim Kennedy placed the first PCS call through a cable system to then FCC Chairman Alfred Sikes.

Cox Enterprises has, in fact, probably performed the most extensive testing of PCS using cable plant. In addition to Omnipoint, Cox has tested PCS equipment provided by Qualcomm, a CDMA system from SCS Mobilecom and a Northern Telecom TDMA system known as global system for mobile communications (GSM). Cox would not comment for this article because of the upcoming FCC auction.

Motorola introduced its telephony offering for the cable industry this past

Time Warner's PCS experiment in Orlando

By Steven C. Johnson
Senior Project Engineer, Time Warner Cable

Recently, Time Warner completed a technical test of personal communications service (PCS) over its full service network (FSN) in Orlando, FL. It is hoped these successful tests will help pave the way to implement this and other nonvideo services over cable TV networks.

History

In 1990, Time Warner applied for experimental licenses for PCS testing in four of Time Warner Cable's cable systems: New York, Tampa, FL, Cincinnati and Columbus, OH. Each location was chosen for a reason that made it unique for the test. New York was picked for its high density and radio propagation challenges, Tampa because it had a fiber/coax hybrid architecture and flat terrain with extensive foliage for radio propagation challenges, and Cincinnati and Columbus because they had fully activated coaxial return as part of the Qube system. In 1993, Orlando was added to the list so that PCS tests could be run in conjunction with the FSN project.

During the life of these licenses, Time Warner has been reporting its findings quarterly to the Federal Communications Commission.

The Orlando FSN test

The players in the test were:

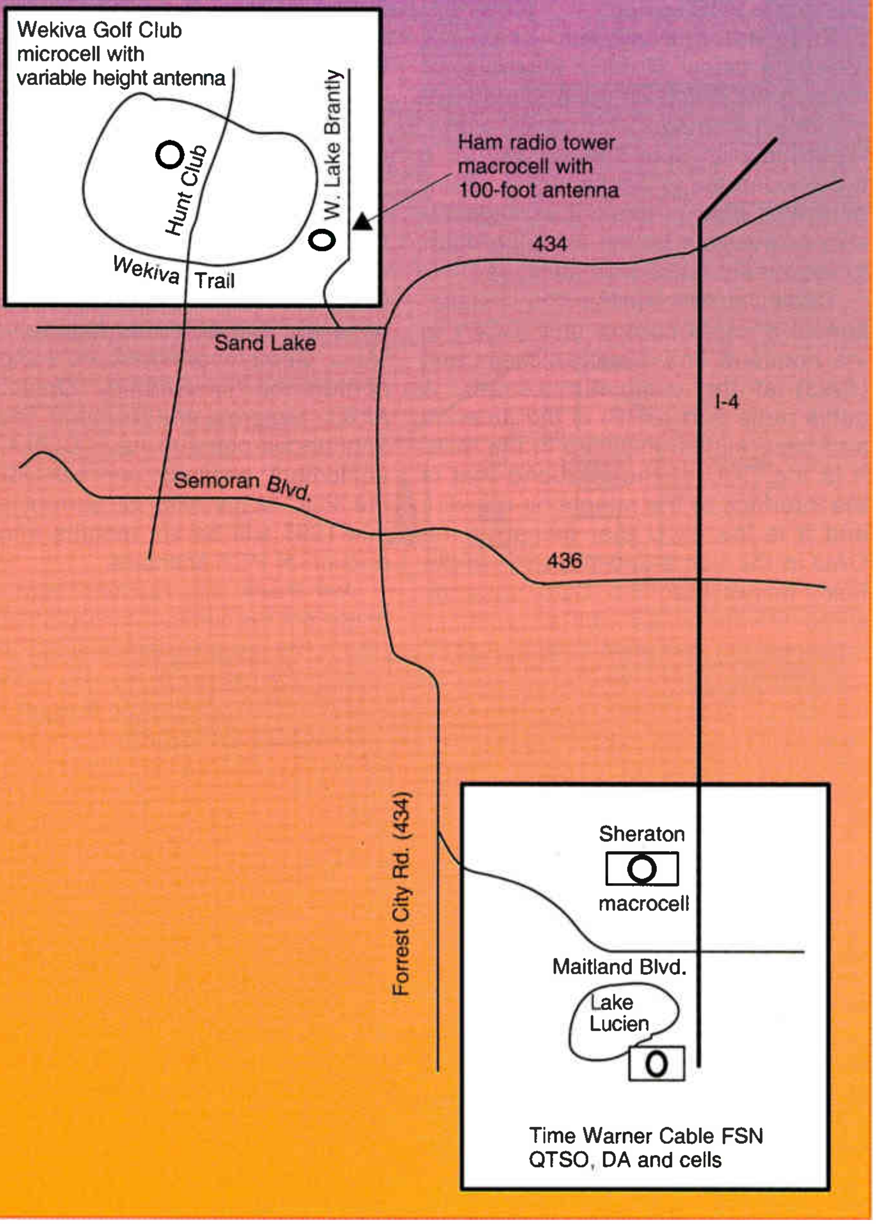
Time Warner Telecommunications — As activity increased in the PCS arena, Time Warner created a focus group. This group, based in Washington, DC, has the responsibility of coordinating the PCS tests.

Time Warner Cable — This group provided the cable systems and engineering support to interface the PCS hardware to the cable systems and ensure that the PCS and CATV signals could peacefully coexist.

US West — As an RBOC and investor in Time Warner Entertainment, US West contributed its telephony experience in this test.

Qualcomm — Qualcomm was the selected PCS hardware and software provider for the Orlando tests. It was responsible for assembling and operating all of the PCS equipment up to the CATV interface and conducting the actual tests and demos.

Figure 1: Location of CDMA hardware

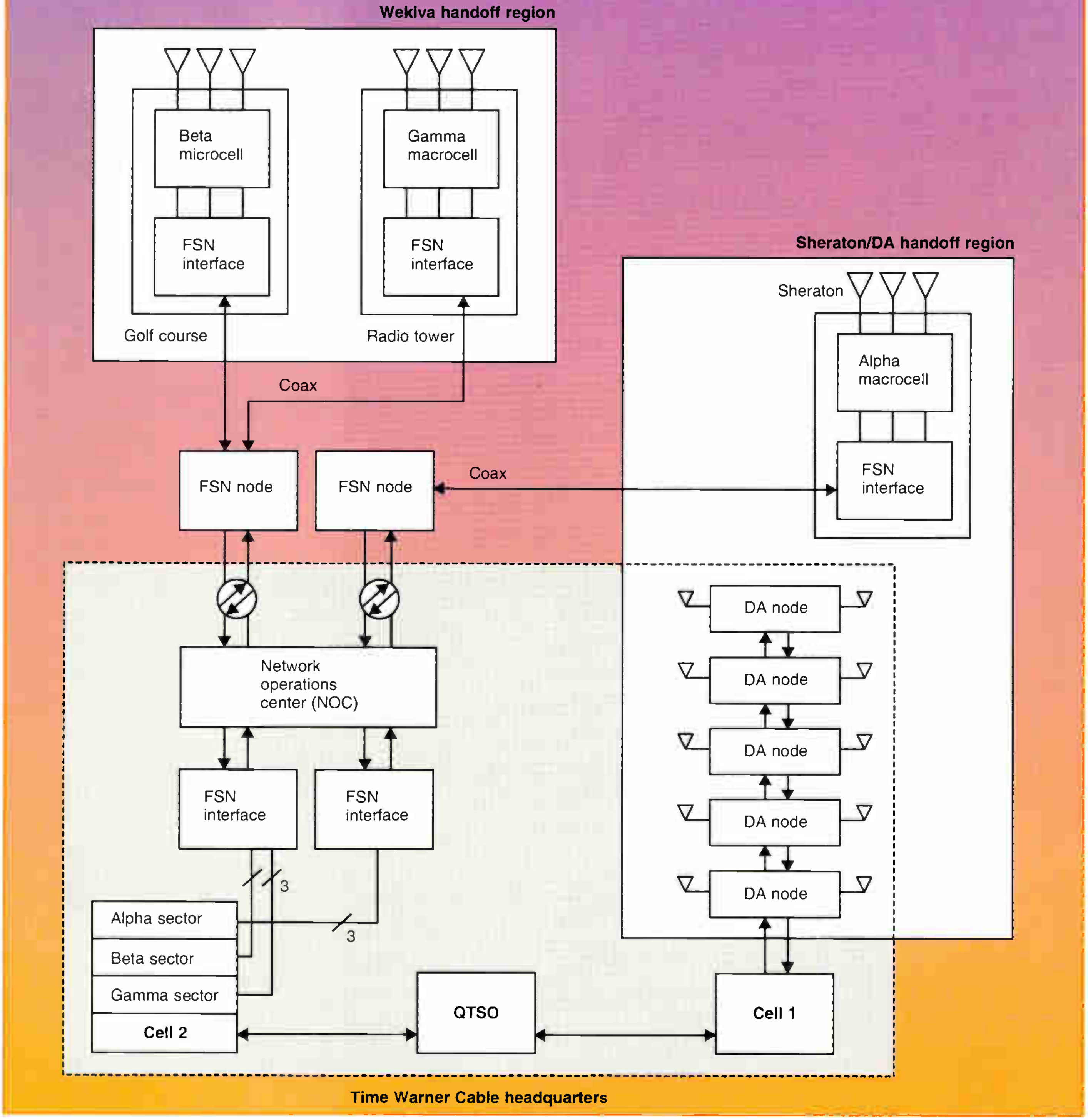


The system

The testing performed in Orlando was unique because it integrated a CDMA-based PCN (personal communications network) on a multimedia telecommunications hybrid fiber/coax network. The CDMA signals were frequency multiplexed with analog cable TV, digital video and data signals.

The PCN headend hardware consisted of a Qualcomm telephone switching office (QTSO) switch that interfaced with the public switched telephone network (PTSN). A three-sector cell (Cell #2) provided service from three locations back to the headend through three distinct coaxial cable runs and two separate fiber links. These locations were: →

Figure 2: Layout of base station and remote sites



1) The Sheraton Hotel (alpha macrocell)
2) The Wekiva Golf Course (beta microcell)
3) The ham tower (gamma macrocell)

The Wekiva microcell and the ham tower macrocell were both fed from the same AM fiber node and were physically close enough to allow intracell handoffs.

Another cell (Cell #1) provided service in the Time Warner Cable Division office building (the headend location) through a series of distributed antenna nodes. This cell was wired directly to the QTSO without going through a hybrid fiber/coax network. The DA network was nested within the alpha macrocell coverage area to permit intercell handoffs. See Figure 1 on page 50.

The cell electronics were split between sites such that the 2 GHz RF to 70 MHz IF stages were located at the alpha, beta and gamma antenna sites and the IF to telephony stages were located at the headend. The IF signals were mixed with local oscillators to upconvert to frequencies that could be used over the FSN and downcovertered back to IF at the other end of the network. These frequencies were in the 720 to 732 MHz range downstream on the FSN and 976 to 996 MHz upstream. (The Orlando FSN uses 50 to 750 MHz for the downstream spectrum and 900 to 1,000 MHz for upstream signals.) The

UHF upstream spectrum is used in lieu of the traditional 5 to 30 MHz band as a technique to obtain more bandwidth for return communications. See Figure 2.

The handsets and mobiles were Qualcomm PCN CDMA phones operating with a maximum power of 50 mW. The mobile phones were used for gathering data because the portable phones lack that capability. The portable phones were used solely for subjective tests.

Objectives

The test objectives were:

1) To prove PCS/CDMA-FSN compatibility.

2) To quantify PCS cell coverage and capacity trade-offs.

3) To determine handoff characteristics.

4) To determine in-building coverage.

5) To outline in-vehicle considerations.

6) To demonstrate data transmission capabilities.

Compatibility

The compatibility test of CDMA/PCS over the FSN was very successful. No interference from CDMA signals was present on the FSN signals or vice

"With the robust nature of CDMA spread spectrum, why not try it to transmit other data signals through the return band?"

versa. The CDMA signals were able to propagate in the CATV environment and tolerate all of the conditions listed below that are typical of cable TV systems:

1) Gain variations between AGC locations.

2) Frequency response (including changes over time).

3) Carrier-to-noise (C/N).

4) Intermodulation distortions.

5) Propagation delays.

6) Group delay.

Tests

To meet these objectives, a series of 10 tests were outlined and scheduled to be run over a three-week period. These test were:

1) *Cable tests* — Typical CATV proof-of-performance tests of C/N, distortions, frequency response and signal leakage to characterize the condition of the CATV plant before and after insertion of PCS signals.

2) *Microcell coverage vs. antenna height* — A series of single cell coverage tests under various system traffic loading conditions using cell antenna heights of 18, 35 and 50 feet above ground level.

3) *Microcell coverage and handoff vs. antenna height* — Performance tests to determine the handoff area of the microcell vs. loading and antenna height at the microcell.

4) *Macrocell/DA handoff test* — Testing the handoff among the distributed antennas in the Time Warner Cable Division office building and between the DA nodes and the Sheraton macrocell. These tests also were run under varying loading conditions.

5) *DA coverage* — Combined with #4 above.

6) *Microcell/DA building penetration* — Tests to characterize the path loss through different obstructions.

7) *Ham tower/building penetration* — Similar to #6 except in a residential environment. →

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8) *Wekiva building penetration* — Similar to #6 and #7.

9) *Random building penetration tests* — Additional building penetration tests.

10) *Demonstrations* — A series of subjective tests, including the data demo as follows, to demonstrate the system capabilities to the media.

Data demo

As part of the June 3 demonstration, a connection was made to America On-Line (AOL) over the PCN. A Toshiba T200 color notebook computer was connected via an RS-232 interface to a PCS portable phone. The signal was then transported through the network to the QTSO where it was backhauled to Qualcomm's headquarters in San Diego via a 56 kbps leased line. At San Diego, the signal was connected to AOL via Qualcomm's Internet link. In this configuration, multiple users could access AOL at 7,500 to 7,800 bps. The data transmission took place over both fixed and mobile PCN telephones and simultaneous with voice traffic.

Conclusions

CDMA spread spectrum proved itself to be a viable platform, from a technical standpoint, to operate a PCS business over a cable TV system. The coverage tests with the DA nodes and the Sheraton showed that as the volume of users increases, additional cells could be dropped in to handle that increase. Issues of frequency reuse or overlapping coverage would not be a problem as the handset would simply use the node that it received the strongest. If a stronger node is available, the handset can then back down its output power and thereby increase battery life per charge.

"CDMA spread spectrum proved itself to be a viable platform, from a technical standpoint, to operate a PCS business over a cable TV system."

Based on antenna height, path loss measured with a cell antenna height of 18 feet was slightly more than calculated, at 35 feet it was very close to calculated, and at 50 feet was less than calculated. The calculated predictions did not include the effects of terrain or other obstructions and this would explain the difference at the 18-foot antenna height.

Overall, the results were very encouraging and proved CDMA to be quite viable in a CATV environment.

Next steps

The Orlando test used a 900 MHz to 1 GHz return band, not the traditional 5-30 MHz ingress-prone CATV return spectrum. Since this UHF return spectrum was much cleaner, we did not get to test the robust nature of CDMA in extremely hostile RF environments. Conventional wisdom and other tests that have been performed previously indicate that spread spectrum is extremely robust in hostile interference environments. Therefore, we would not expect the results of a similar PCS test using the 5-30 MHz band to perform any less reliably. With the robust nature of CDMA spread spectrum, why not try it to transmit other data signals through the return band? **CT**

The author would like to thank Qualcomm and Lex Felker at Time Warner Telecommunications for input on this article and use of its diagrams.

Implementation of data and communications services

By Michael Angelo
Technical Marketing
Zenith Electronic Communications

Cable TV systems currently delivering TV programs, pay-per-view (PPV) events and other services also can provide the gateway for future opportunities. System operators are expanding their business scope by planning to supply services such as video-on-demand (VOD), data communications and telephony. When considering these services, preparation must be made to transfer the system from its traditional operation to a reliable, two-way data communications network. Initially, there may be some culture shock. While there are many parallels between cable TV and telephony systems, data communications networks are a different ball game with their own rules.

From a business standpoint, the positives in deciding to establish a data network are clear. High rates of data throughput, good revenue potential and easy network accessibility are but a few solid reasons to consider becoming a wide area network (WAN) data services provider. Several attractive and diverse markets such as business, education and government are waiting to be developed and expanded.

Business

With the need to receive more information faster and improve productivity, business-to-business, work-at-home and remote office concepts have become popular and appealing applications. A high-speed communications link for local area network (LAN)-to-LAN, remote user-to-LAN and user-to-user applications can be supported. Depending on what the customer's requirements are, this type of service can be billed on an hourly, daily, weekly or monthly basis, on a tiered throughput usage or application basis.

Figure 1 shows one example. This illustrates that by utilizing a modem and an Ethernet interface, users working from their homes or remote offices can participate in point-to-point and point-to-multipoint data sessions. Accounting, file transfers, electronic mail and Ethernet-based video teleconferencing between field personnel and the home office all become faster and more efficient.

Education

Internetworking between K-12 (kindergarten through 12th grade) schools, colleges and universities expands the opportunities for distance learning, instructional TV and improved interactivity between several levels of education. A variety of multimedia applications, accounting, purchasing and administrative functions are supported by such a network system.

In Figure 2 on page 60 a college student at home has access to interactive computer courses while information is shared and transferred between users on the college and grade school LANs. Providing a 6 MHz data channel in the

Figure 1: Zenith HomeWorks modem/ChannelMizer Ethernet interface

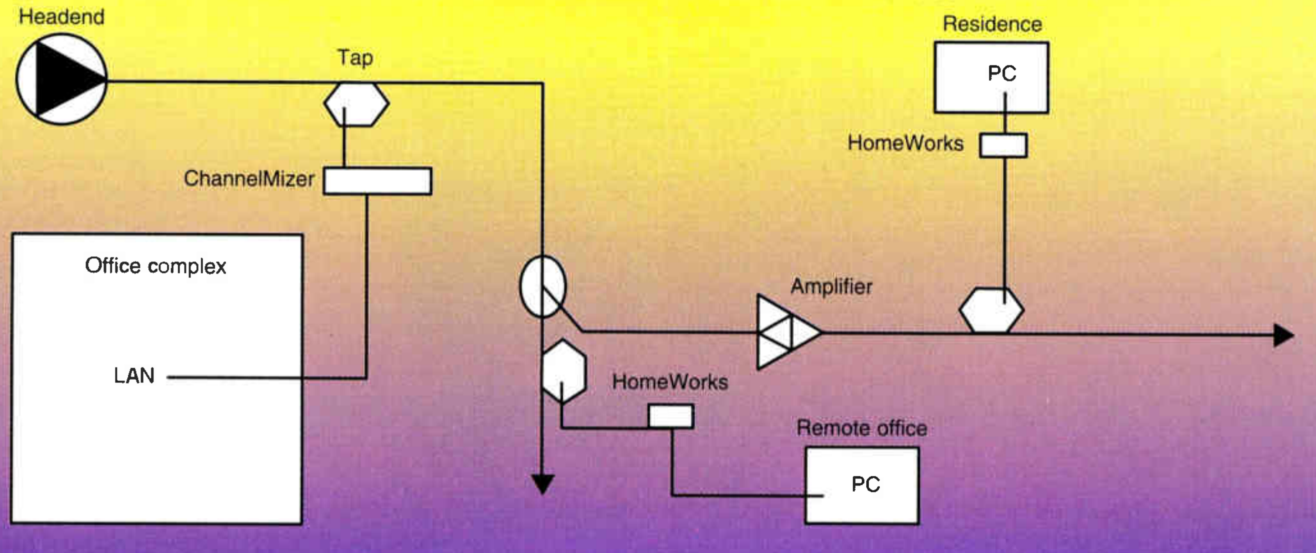
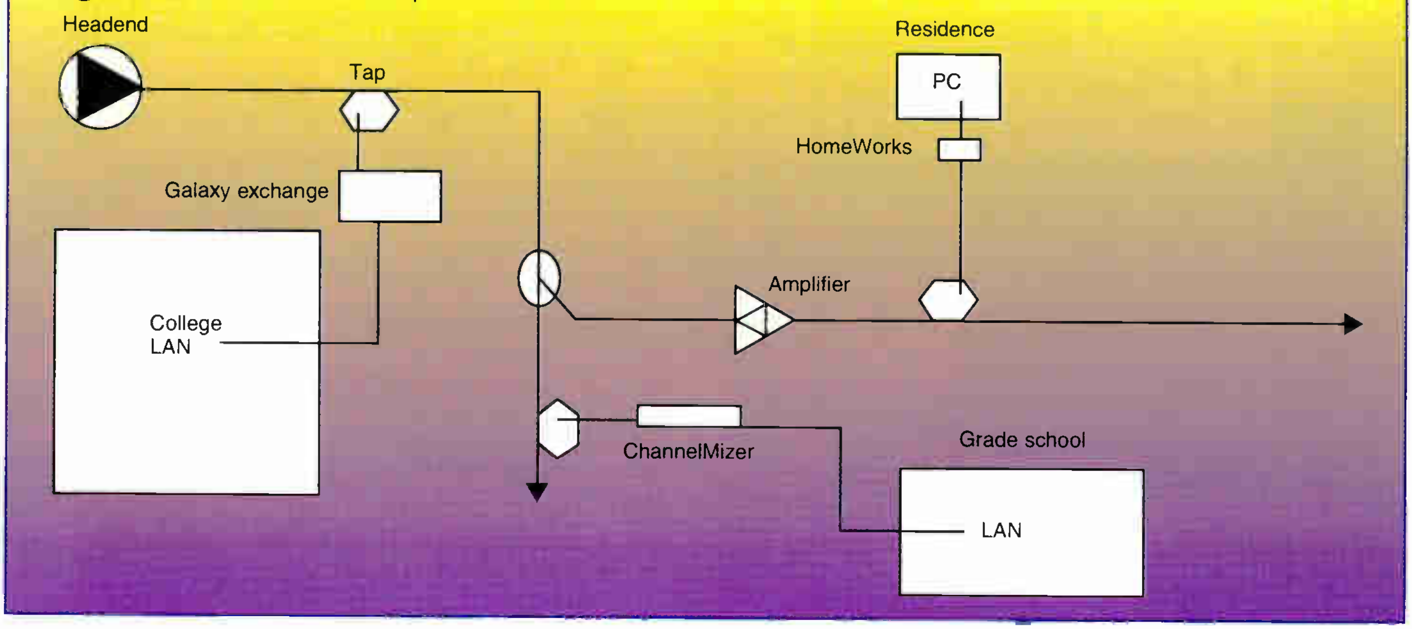


Figure 2: Interactive computer courses



forward direction and one in the reverse to a school district or educational body may help to meet franchise requirements or assist in franchise renewal or rewarding. Beyond offering complementary access to the WAN, billing for service on a tiered or usage basis would be more competitive and data throughput would be typically higher than using other communications alternatives.

Government

An institutional network for police, fire, emergency services and government agencies provides a true community link with access to real-time data. Geographically independent applications such as emergency response information, traffic monitoring, access control and energy management offer multiservice capabilities to a city or township. A network link between remote governmental departments and field personnel for administrative functions, file transfers and high-speed graphics also is available.

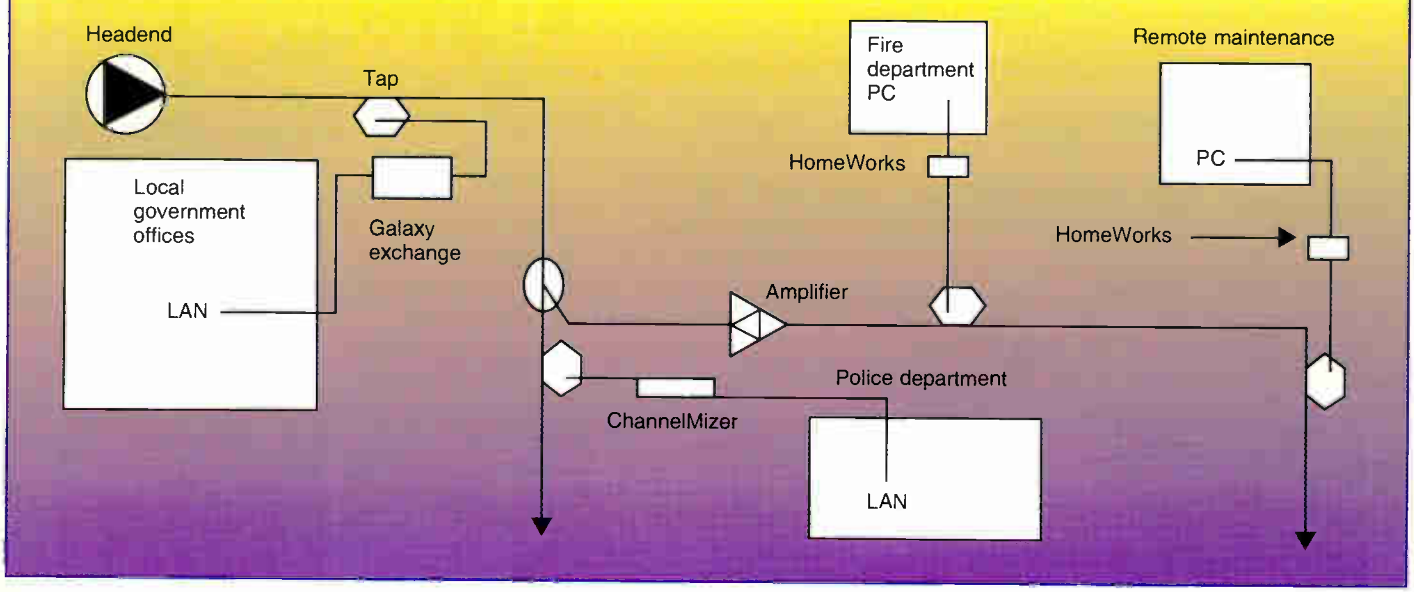
By connecting to a citywide data channel (Figure 3) various users are able to interact more efficiently. Providing this type of network access may help fulfill franchise provisions and maintain good governmental and community relations.

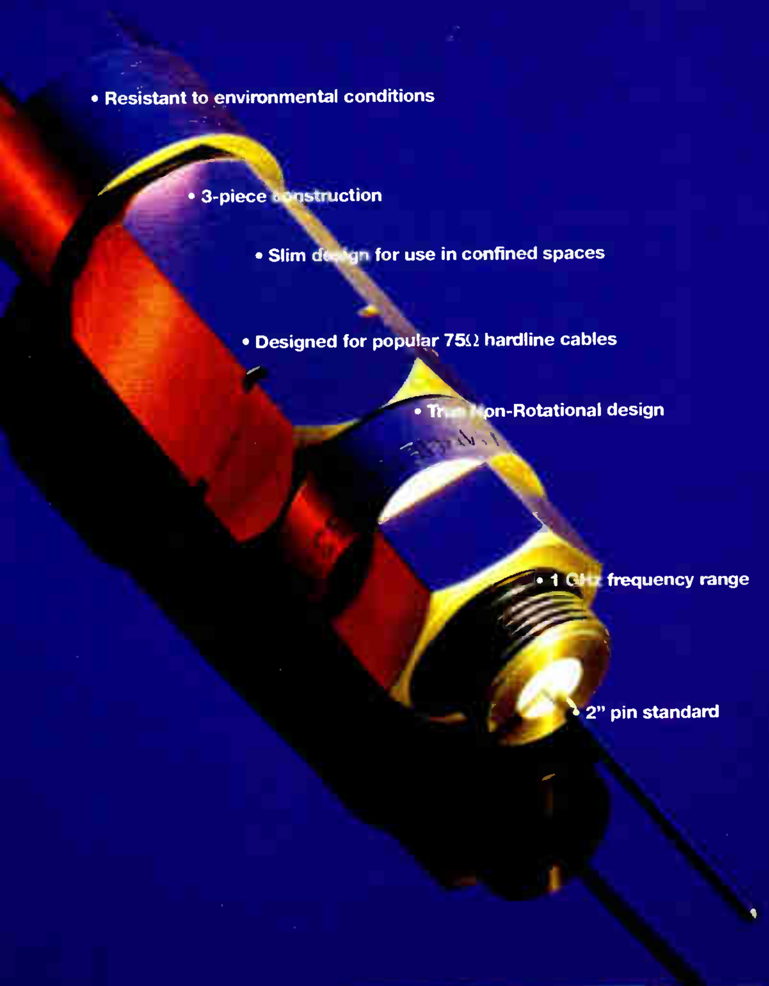
System architecture

To establish a full duplex communications link, one forward and one reverse channel (or a portion of) must be allocated. For example, with Zenith's technology a full 6 MHz for 4 Mbps of data capacity and 1.5 MHz for 500 kbps of data capacity is needed. Up to four 500 kbps networks can occupy one 6 MHz channel. This provides for network segmentation while occupying only one 6 MHz channel. In addition, these networks can be bridged together or routed onto a 4 Mbps channel.

In highly populated apartment buildings, complexes or large office buildings where the potential exists for a large number of users, segmenting and routing is strategic to system configuration and channel allocation. Physical plant opera-

Figure 3: Citywide data channel





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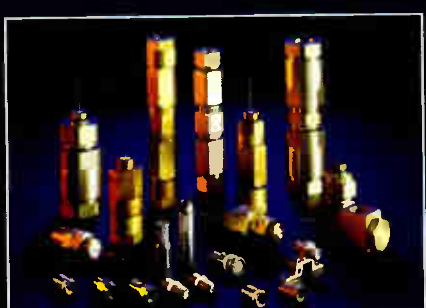

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Amphenol® CATV Connectors • Times Fiber Communications, Inc. • Amphenol® Fiber Optics tion can remain unchanged, but additional equipment should be considered in order to implement a functional and reliable data network. Amplifier and power supply redundancy may be necessary, depending on how critical the network is to the user or the type of information the network is passing. Also, in the event of power outages, battery backup of power supplies will keep the system amplifiers active. This is important if the information on the network is of a critical nature (i.e., police, fire, emergency services, etc.).

The ongoing transition to fiber over the last 10 years also allows for greater geographic coverage, improved system characteristics and less maintenance on a cable-based network system. If data services are to be carried, system configuration must be carefully planned when upgrading to fiber. The direct advantage of this is flexible network segmentation and management and more efficient bandwidth use. A 4 Mbps data channel may support a fiber segment with heavy use, while multiple 500 kbps networks can occupy a single data channel and support a fiber segment with light use.

Headend architecture

Processing data channels for broadcast onto the network not only involves wiring frequency translators into the headend scheme but, depending on the services carried, also can mean the addition of data bridging and routing equipment. Typically in a LAN-to-LAN link, bridging and routing would take place at the baseband data level of the remote sites being connected.

In this case, the cable TV system is acting as a wide area data transport. A good example is a college-to-college or business-to-business network communications. However, when the headend becomes a data hub or communications center and a large number of users are spread across the system, data traffic bridging and routing becomes necessary.

The principle of bandwidth management by segments for video applications also will apply to data delivery. The difference is that managing a segment to support data traffic is more critical because network usage is difficult to determine.

This also is where symmetrical data transmission is essential. Symmetrical data transmission provides the same amount of data throughput in the reverse path as in the forward path. In large file transfer applications or where

"While there are many parallels between cable TV and telephony systems, data communications networks are a different ball game with their own rules."

graphic images are downloaded and stored on a server, the amount of throughput necessary for a data session is generally unknown.

Bridging and routing and symmetrical data transmission both help to manage network bandwidth and loading issues. In order to help protect network equipment and your investment, basic recommendations include redundancy, battery backup and uninterruptible power supplies.

Status monitoring and control

This applies to both the RF broadband plant and data networking equipment. Monitoring the forward and reverse paths and active devices in a cable plant is a good practice whether or not you are carrying data services. Too much information is better than not enough. Most manufacturers of amplifiers, fiber-optic equipment and power supplies have monitoring transponders that can provide equipment status information. In addition, end-of-line and system monitors are typically capable of measuring composite triple beat and carrier-to-noise statistics while indicating potential trouble spots. Software packages and monitoring equipment are available to examine network traffic and data packets. Collisions, errors, network utilization and data throughput can be monitored along with the status of network equipment.

Also keep in mind if you are considering a data trial in your cable system that a pretrial system sweep of the forward and reverse paths is necessary. Start small with a limited number of users and plant segments. It is helpful to experience all the potential positives and negatives of any network system in order to make an intelligent decision on whether you are ready to get connected. But don't hesitate too long. The future is now and is quickly moving forward. **CT**

HDTV: Modem field tests a success

By Brian James
Director, ATV Testing
Cable Television Laboratories

Field testing of the transmission modem selected for advanced TV (ATV) transmission was completed during the summer and the results indicate that the vestigial sideband (VSB) modulation mode will operate successfully both over-the-air and on cable. Laboratory tests of the complete video encoding, transmission, reception and decoding equipment will occur early in 1995 with a report and recommendation of a standard going to the Federal Communications Commission by late summer.

"Operation with delivered signal levels below FCC specifications will continue to provide error-free ATV pictures until the level is reduced to near the threshold S/N for the receiver."

ATV testing history

The FCC appointed the Advisory Committee on Advanced Television Service in November 1987 with the purpose of advising the FCC on the technical and public policy issues concerning ATV.[1] Since that time the committee has been overseeing the development and testing of proposed ATV systems with the expectation that a high definition service would be recommended. A high definition service would have twice the horizontal and vertical resolution of current NTSC and an aspect ratio of 16:9 to more closely approximate current movie aspect ratios. Over 20 proposals were submitted for consideration and six systems actually made it to the test laboratories for evaluation.

The systems were tested objectively at the Advanced Television Test Center (ATTC) in Alexandria, VA, with subjective tests occurring at the Advanced Television Evaluation Laboratory (ATEL) near Ottawa. CableLabs conducted those tests directly applicable to cable transmission at the ATTC. The systems were tested to determine the quality of the picture delivered, the amount of interference they could tolerate, plus the amount of interference they would cause to existing NTSC signals or other ATV signals. The FCC hoped that the interference into NTSC would be less than current NTSC so that some of the taboos that now limit NTSC coverage could be reduced or eliminated.

The tests were completed in 1992 and the results analyzed by a special panel of the advisory committee. The special panel recommended and the advisory committee approved the recommendation that the four remaining digital transmission systems, DigiCipher, Digital Spectrum Compatible HDTV (DSC-HDTV), Advanced Digital HDTV (AD-HDTV) and Channel Compatible DigiCipher (CCDC) be subjected to a second round of tests, after proposed improvements were incorporated in the systems, with testing to start in March 1993.

The four digital systems had performed better than the analog NHK system, especially in the transmission area. The NHK system was eliminated from further consideration. The analog ADTV system had been withdrawn from consideration prior to the special panel meeting.

The four digital systems had proven to provide better performance than the analog system but none of the four digital systems performed better than the other systems in all areas resulting in the need for the second round of tests. The proponents were told to incorporate improvements and be prepared for a second round of tests in the spring 1993. They also were encouraged to consider forming an alliance so that the best features of all the systems could be utilized and a truly superior system could be adopted as *the* North American standard.

In May 1993, after the first system had arrived for retesting but before the start of tests, the formation of the Grand Alliance was announced. The Grand Alliance consortium members were AT&T, David Sarnoff Research Center, General Instrument Corp., Massachusetts Institute of Technology, Philips Electronics North America Corp., Thomson Consumer Electronics and Zenith Electronics Corp. The alliance indicated that they had an agreement to work together and develop the best possible system for HDTV. They would be using the best features of the four original systems to obtain the new improved single system. This, of course, would take some time and effort on their part with oversight from the advisory committee.

By late fall 1993 the alliance had determined that the MPEG transmission system would be used and Dolby AC-3 would be the audio system used to provide the surround sound audio of the system. One area that remained undetermined was which transmission system to use. It would either be the General Instrument proposed 32 QAM format or the Zenith proposed 8 VSB system.

In January and February 1994 the two modulation systems were subjected to laboratory tests to determine which one would be recommended as the standard. Both systems had a high data rate cable mode that would allow the carriage of two high definition channels within a single 6 MHz channel on a cable system. The higher data rate was accomplished by a reduction in the amount of error protection and an increase in the number of allowed states (either 256 QAM or 16 VSB). Cable system transmission is a more controlled environment than over-the-air transmission and a well-designed and

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maintained system should be capable of transmitting an error-free digital signal using either modulation technique.

The two proposed terrestrial systems, 32 QAM and 8 VSB, were tested for over-the-air performance and interference creation. The cable modes, 256 QAM and 16 VSB plus the over-the-air modes, were tested for their performance on cable systems. The results of the tests indicated that the VSB transmission system, as implemented, was superior to the QAM system in the majority of the tests, both for over-the-air and on cable. The VSB systems were recommended as the standard for the transmission of high definition signals on both cable and for over-the-air transmission.

The field tests

The next step was to perform field tests of the transmission system to determine if it would operate in an actual over-the-air and cable system environment. Charlotte, NC, was selected as the location for the tests.[2] One significant attraction was the availability of a transmission tower, made available by Loadstar Towers, which could be used for the tests. The location also has a variety of terrain features, gently rolling terrain to the east, mountains to the west and tall buildings in downtown Charlotte. Experimental licenses were obtained for Chs. 6 and 53 so that both VHF and UHF tests could be performed. PBS was the project manager for the terrestrial tests while CableLabs performed the cable portion of the tests and many manufacturers loaned the equipment necessary for the tests.

The terrestrial tests entailed a field truck equipped with a hydraulic mast and consumer-type antenna, test equipment, an NTSC receiver and the 8 VSB receiver and modem. The test truck would stop at predetermined locations at various distances from the transmitter and then determine the quality of the received NTSC signal, both on Chs. 6 and 53, and measure the bit error rate (BER) and margin of the ATV signal. Because only the transmission system was being tested it was not possible to determine the quality of the ATV signal during these tests. That will be determined during next year's field tests.

A total of 199 locations were tested. Of these, 128 were located along eight radials extending to a maximum distance of 55 miles from the transmitter. The radials were selected to obtain various terrain conditions. The remaining locations were two large grids with one mile spacing and three smaller grids with half-mile spacing. One grid was within the city of Charlotte.

To determine service availability of the ATV signal a BER measurement was made of the received over-the-air signal then random noise was added until the threshold BER of 3 x 10^{-6} was obtained and the margin above the threshold was determined. This measurement was made on both Chs. 6 and 53 ATV signals.

The threshold error ratio was determined to be the point at which the error corrector could no longer correct the errors and problems would be observed in the picture. One of the characteristics of digital transmission is a very sharp transition from no visible impairments to an unusable picture. Only 1 or 2 dB increase in noise or other impairment is necessary. This makes it very easy to determine when the picture is considered to be unusable.

NTSC pictures degrade gradually — at a signal-to-noise ratio (S/N) of 45 dB, noise can be seen in the picture but it is still a very good picture. At 30 dB S/N the picture is significantly degraded but can still be seen. The advisory committee decided that a CCIR impairment rating of 3 (slightly annoying) would be the criteria for comparison with the ATV signal. If the error ratio of the ATV signal was better than the threshold value of 3 x 10^{-6} and the impairment rating of the NTSC picture was worse than 3 the ATV would be classified as satisfactory while the NTSC signal would be considered to be unsatisfactory.

Test results

Analysis of the test sites showed the VHF NTSC signal to be satisfactory at only 39.6% of the locations while the ATV reception was satisfactory at 81.7% of the locations The UHF NTSC reception was satisfactory at 76.3% of the test locations while the ATV signal was satisfactory at 91.5% of the locations. The report concluded that the ATV signal worked well under "real world" over-the-air conditions and would provide satisfactory reception at more locations than a comparable NTSC signal.

The cable portion of the field tests involved receiving the transmitted Ch. 53 ATV signal at the eight cable system headend locations using specially installed log periodic UHF antennas donated by Wade Antenna Ltd. The data stream of the received signal was error corrected, if necessary, by the receiver then combined with a second data stream that represented a second ATV channel and modulated using a 16 VSB modulator. The 6 MHz signal, carrying the equivalent of two high definition channels, was inserted on a spare channel in the test cable system. The reception of the cable signal was checked at the headend and at locations at the extremities of the cable systems.

Five of the systems (Vision Cable of Albermarle, Vision Cable of Mecklinburg, Vision Cable of Shelby, Vision Cable of Kannapolis and Rockingham Cablevision) had channels available within the design passband of the system and were able to carry the 16 VSB signal without any problems. Locations were selected at the ends of the longer trunk runs and after AML or fiber links when possible. Two measurements were made, one with a standard 100-foot drop connected to the tap and a second after the standard drop, two four-way splitters and a drop amplifier. These two tests were felt to represent a normal single TV set customer and an "extreme" multiset customer home. In all instances the ATV receiver was operating above the threshold level and is expected to deliver error-free pictures to the subscriber. The longest cascade was 41 trunk amplifiers after an AM fiber link. The margin above threshold at that location was 9 dB.

Three of the systems, Monroe Cablevision, Gastonia Cablevision and Charlotte Cablevision, had fully occupied systems and it was necessary to perform the tests above the highest design frequency of the system (i.e., in the roll-off area). The received ATV signal was above threshold at all locations when the receiver was connected directly to the 100-foot drop. At three locations the additional loss in the multiset home simulation resulted in the signal being below the noise floor of the receiver. This produced too many errors for the receiver to correct and an error-free picture would not be available to the subscriber. In those instances the reduction in signal level due to the operation in the roll-off area would result in subscribers requiring service calls to reduce the signal loss of the in-home wiring or some reworking of the plant to ensure sufficient levels are delivered to the home.

The field tests have confirmed the laboratory results and indicate that digital transmission is a viable method of transmission both for over-the-air transmission and for cable TV distribution. Cable operators can expect there to be no reception problems if the system is meeting current FCC specifications and the average ATV signal level is set 6 dB below the NTSC signal level. Operation with delivered signal levels below FCC specifications will continue to provide error-free ATV pictures until the level is reduced to near the threshold S/N for the receiver. At that point the picture will begin showing errors or may freeze because of the high number of errors. The ability to operate in the roll-off area will depend on the equipment used in a system and the maintenance practices of that system. **CT**

References

[1] "Fact Sheet on Advanced Television," Federal Communications Commission, January 1992.

[2] "System Subcommittee Working Party 2 Document SS/WP2-1354," Advisory Committee on Advanced Television Service, September 1994.

Meeting the competition: Operations in transition

By Robert Bates
Vice President, Customer Service

And Robert Moel
Vice President, Technical Operations
Time Warner Cable, Houston Division

Houston Cable operates in the fourth largest city in the United States. It serves over 248,000 customers with nearly 5,000 miles of plant. The market can receive 13 over-the-air channels and is served by two other franchise holders that hold limited franchises to serve multiple dwelling units (MDUs) and commercial customers within the city of Houston and anyone they choose to serve in the county; one multichannel multipoint distribution service (MMDS) operator; and two direct broadcast satellite (DBS) operators. Clearly, Houston is a city in which competition is present.

To prosper in this intensely competitive system, my colleagues and I started to find ways to become the premium provider of cable service.

Organizational structure

The technical operations department is the one that installs, services, maintains, constructs and provides the physical connection to the cable service. In many ways, we are like a factory. We take the orders and turn them into products.

Originally, this function was organized partly along geographic lines in four district offices with each office managing a small warehouse, installation/service and maintenance. It also was organized partly along functional lines in a construction, electronic repair center and main warehouse.

One of the first changes we made in the technical operations area was to reorganize along functional lines. Therefore, installation/service, maintenance and logistics departments were created.

"In our operation we have decided that it is better to try something in a limited way and learn something through failure than it is to do nothing."

The reasons for moving to a functional organization were:

- *Economies to scale (especially in the use of labor).* When district offices existed, one office could have an overcapacity of appointment times and another next to it could have none. For example, a situation could develop where installation appointments were available in one district office the next day and in another district office the next week. The management of contract installation labor also was not consistent and more complex because of the erratic work demands between the district offices. The contractor often had difficulties managing its resources to meet our expectations. This led to confusion and missed commitments to customers. Ultimately this meant irate customers.
- *Higher consistency and quality in creating and delivering the product.* The various district offices sometimes had different approaches to solving the same problems. Often, one approach was superior but it was never transferred to the other district offices. Also, the level of expectation of what was a quality installation or service call was often very different from one district to another.
- *Changes in operational procedures are communicated faster and more consistently.* The way a change was communicated in each district office was different. Employees often received different messages from different interpretations or delivery by their district manager. While it is possible to have the same thing happen at the supervisor level, supervisors are less free to interpret the message.
- *Flatter organizational structure helps speed customer feedback.* Problems in the field surface faster. The flatter structure leads to more accountability and faster customer problem resolution.

The problems facing the customer service group were similar. The group focused on increasing commitment and accountability for attaining the customer service telephone goals, namely the service level (the percentage of calls answered in 30 seconds), the percentage of abandoned calls and call duration.

The customer service telephone organization was very traditional. The customer service manager had seven supervisors reporting to her and about 12 customer service representatives (CSRs) reporting to each supervisor working various shifts.

In the reorganization, a matrix structure was created. Three operations supervisor positions were added, one for each daily work shift, and were given ultimate responsibility for achieving the service goals. This position has no people reporting to it. The remaining regular supervisors were given responsibility for leading the people and making sure they are present and working. They focused primarily on the quality of the telephone contact by the CSR with the customer.

With the duties split, the operation supervisor was like the producer while the other regular supervisors were like the directors. The operations supervisor makes sure that the system, the CSRs and the telephone system are working together to handle the in-bound telephone volume. It is the responsibility of the operations supervisor to direct prob-

lems arising from system breakdowns to the right department. The regular supervisors tend to the needs of their CSRs and work with their employees to solve individual customer problems.

These changes brought increased focus and commitment in attaining the telephone goals and as a result we have improved our ability to answer calls within 30 seconds from 60% to over 90% (from 1992 to 1994).

The daily briefing meeting

W. Edwards Deming, the guru of quality and quality improvement, has said that four steps are needed to promote continuous quality improvement.

The first step is "plan." Most of us engaged in the operations side of the business are very familiar with this step through the assembly of budgets or the creation of policies and procedures. The second step is "do." Again this is a step that almost seems obvious. After all, this is what we spend most of our time engaged in — doing the business at hand. The third step is "check." Was what had been done appropriate, accurate and within specification? Most of us use this step through a formal quality control program where we inspect work in the field or monitor customer service representative calls.

Quality control (QC) usually points out an employee that can use some more training or a tool that is worn. Its intent is to focus on a single event in the process that delivers the service to the customer. However, it does not identify problems that arise from the process having problems. That is where the final step is needed. Deming calls this step "act." Act to prevent a problem or improve the system.

In our daily briefing meeting (usually lasting about 15 to 20 minutes) we review the previous day's results and the current day's scheduled activity, which usually includes installation and service calls booked and completed, outage activity, information on when crews finished and the amount of overtime, telephone volume and other key operating parameters. There are usually representatives from the customer service group, technical operations and the marketing group at the meeting. Current and future work volume is assessed and our plan for managing this volume is formulated.

The meetings create a cycle of conflict, understanding, change and consensus. When a problem is brought up, it usually exists at the connection point between two departments in the process. Both are trying to serve the customer but can't because of some impediment. The meeting's roll is to understand the problem, solicit ideas and solutions from the participants, and come up with an action plan that can be quickly carried out.

Changing data into information

The goals of our meeting are simple. Find out what is wrong and fix it. Seek the root cause of the problem and find a permanent solution that will lower costs, increase efficiency and improve quality. This is the key. To do this requires a flexible information system that can be tailored and fine-tuned to generate reports that take data and change it into information. Many reports generated by our billing system are either too late to be actionable, too voluminous to be manageable, or focus on the wrong data. What we have done is to take our reports and read them into a data base that we can then manipulate to extract the meaningful information we need.

For example, a report we get daily is a "repeat" report (which is a report listing customers that have had multiple service calls). The monthly repeat report we used to get was over 30 pages long and some calls that were repeats were more than 30 days old. The report we have created is currently five pages long and most of the calls are only one day old. If a customer has had two or more service calls in a 15-day interval, his account information and information about the technicians serving him are printed out. These customers are then contacted by our dispatch operation to be certain the problem is resolved, and if it is not, the effort to resolve the problem is escalated.

Moreover, a field supervisor takes this list and discusses it with the responsible technician within a few days of the repeated service call's occurrence instead of within a month. The list also helps us to send the same technician back to the customer's location with the repeated call to resolve the problem. This helps technicians to learn what they are doing wrong and to improve their problem solving skills. This helps us to get accountability from the technician. He or she has a better than 50% chance of having to face the same customer if the problem is not solved the first time.

"We are operating at lower cost and currently have reduced costs by over $100,000. We have reduced our undesirable work volume by nearly 13.6%."

There are seven key indicators that are generated by our billing information system that we evaluate each day:

- *Number of calls scheduled.* We are interested in this because to schedule more than the capacity means reschedules, extra handling and unhappy customers.
- *Sold pending.* This represents the number of queued installations. We seek to make this as small as possible because higher throughput means higher completion rates and fewer handling costs.
- *"Bin" counts.* These are the number of service calls in queue in each "management area." (The system is broken up into smaller geographical units that are related to the cable system network that we call management areas.) High bin counts mean there is some type of area problem that went undetected. We attempt to lower the bin counts by fixing the underlying problems and not by rolling service technicians on individual service calls that are often "found OK."
- *Daily repeat report.* These reports give us specifics on multicall service problems and help us find ways to fix the problem right the first time.
- *Outage breakdown.* We look at outages in a grid by day-part on one axis and by customers affected on another axis. We have one sheet with unplanned outages and one sheet with planned outages. Looking at outages this way helps us to determine what volume we could have avoided and helps us to identify plant with poor reliability.
- *Overtime.* This is a monetary measure, as well as a measure of routing effectiveness. Dispatch teams are graded based on their ability to minimize the

overtime worked by the technician teams they control.

- *Telephone volume*. High volume days are usually bad unless they are pay-per-view (PPV) event or in-bound sales driven. We attempt to understand why the volume was high and what we should do to lower it if possible.

These indicators force us to find ways to increase the efficiency of the work order process, decrease costs and enhance the investment we make when we visit the field. This list will change over time as we successfully resolve some system issues and new ones arise. New reports will be created to help us find new truths.

A small list helps us to focus on the key drivers of undesirable activity. If this list contained 20 items, we couldn't finish our meeting in 15 to 20 minutes. If the list were too short we wouldn't have enough information to find the root causes to problems and they would remain unresolved.

After the daily briefing

In our operation we have decided that it is better to try something in a limited way and learn something through failure than it is to do nothing. While we do not advocate making careless and ill conceived changes, we suggest that the solution to some problems is not obvious and it is better to "take your best shot" than it is to let the problem get worse. Usually you've got nothing to lose.

The second key thing that we have accepted is that "there are no home runs but only base hits." We do not expect perfection, only improvement. Our process will not find the one thing that will cure all of our ills but it will give us many small changes that add up to significant improvements over time. The final key thing we have accepted about implementing change is to seek employee and supervisor "buy-in." This has perhaps become an overly worn phrase but it is true nonetheless.

Employee buy-in can be encouraged by using an appropriate incentive program. Appropriate in our view means the incentive plan achieves three goals. First, it must be bottom-line oriented. Incentive plans that cost more than the value they are supposed to generate from employees is a waste of resources. Second, it must be objectively measurable. The rewards must be based on measurable statistics that are a subset of the company's goals. Without this requirement, the incentive plan would encourage employees to seek the wrong goals. Finally, it must reward superior performance. Rewarding all employees, even if they are mediocre for the misplaced belief that it is democratic is wrong. Not every employee can be the best. Someone has to be average. However, we will only provide extraordinary rewards for the best performance. The best is always being refined and improved.

The changes we seek to implement are reduction of costs, improvement of quality, and increase in efficiency and work volume. They are tied to any employee incentive plan implemented. Typically we structure the incentive plan to provide rewards for performing high work volume at high efficiency, generating high sales volume, and for low absenteeism, and to provide negative incentives for failing QC inspection on installation jobs, failing to repair a service problem on the first call and for having preventable accidents. The top 10% are rewarded with monthly bonus dollars.

The place of technology

Change can sometimes be speeded up through the proper use of technology in the operation. Our experience is that sometimes a simpler technology can give you most of the benefits available in more expensive and more complex technology. An example of this was our desire to reduce, if not eliminate, the paper we needed to support service calls and installations and to reduce the amount of radio and telephone waiting time our technicians were experiencing. It had been a long standing problem.

Most technicians lost nearly an hour each day waiting for their turn to use the radio to contact dispatch. We had examined several automated dispatch and routing systems that were on the market at the time and just found the cost and the technological risk too high. Furthermore, the implementation time would have required months and we needed to do something to fix our problem immediately.

We discovered that we could use alphanumeric pagers to dispatch work orders to the field. We attached a PC to the printer port of our billing system. The PC was programmed to capture work order screen print information and format it for the pager. The PC would then call the paging network on a dial-up line and automatically page the technician identified on the work order. Because these pagers are used by doctors and other customers that need high reliability, we rarely if ever, fail to contact the technician.

Our policy is to dispatch two calls at a time to each technician. This way, if a technician gets stuck on a larger than expected job, the dispatchers can reroute the work to other available technicians. Furthermore, the technician is not rushed because he only has one other appointment to worry about. The dispatchers and technicians are jointly responsible for getting all the work done each day. Moreover, dispatchers are not allowed to leave their stations until all of their technicians are working on their last job. This arrangement encourages team work through having common goals. Once the call is dispatched, it can be closed out over our voice response unit. Technicians can process most calls through the unit.

The pagers cost under $20 per month per technician and their use has increased the number of jobs that can be done by almost one per day per technician. While this technology lacks the vehicle location feature sometimes available in vehicle two-way terminal systems, it provides most of the benefits for a fraction of the cost and with little risk.

Results of our process

We have been applying this process for nearly one year and our improvements have been dramatic. We have resolved many technical and operational problems that have plagued the system for years. We have improved our performance to the point we are meeting all Federal Communications Commission customer service standards. For example, our ability to answer calls within 30 seconds has improved from 60% to over 90%. We are operating at lower cost and currently have reduced costs by over $100,000. We have reduced our undesirable work volume by nearly 13.6%. Our process has permitted us to make meaningful and lasting changes that provide us with a competitive advantage both in terms of a lower cost structure and becoming a premium service provider. **CT**

Re-engineering existing computer systems for fiber

By Bruce Waldron
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Cable TV companies are being pushed to provide more and more services directly to their customers. The forces behind this include subscriber demand, increased competition (including from some new sources) and developing technologies. Fiber optics is an important edge in the expansion program. But the move to fiber may not be as easy as expected.

Fiber offers several advantages over traditional wire-type signal transmission. The much greater bandwidth yielded by fiber will allow cable companies to increase their current services and to introduce new ones. Even the physical characteristics of fiber optics are an improvement. For example, fiber-optic systems will not corrode and are not affected by voltage surges caused by lightning.

But getting fiber into the existing plant in a cost-effective way requires some strategic decision making. One of the most significant and yet most often overlooked issues is whether the existing computer system that controls the services and brings revenue to the company will accommodate fiber. The key to cost-effectively solving this problem may be to re-engineer the computer control system.

How much is enough?

Re-engineering in this application is the analysis and modification of an existing computer control system to expand its capabilities while preserving as much of the physical plant as possible. Re-engineering can include: rehosting, which is putting the existing software on a new, more powerful computer platform; redesigning by modifying or rewriting segments of the existing software; and reusing the rest of the existing system. Simply, re-engineering is taking the existing computer control system in which you already have a large investment and upgrading it to meet future needs and requirements.

The magnitude of change depends on the condition and state of the existing CATV computer control system. An in-depth evaluation process will determine the amount of revision necessary. However, even before undertaking such an evaluation, there are a number of questions that company management can consider in making the choice of whether to re-engineer or replace an existing computer control system.

Can the current system handle anticipated future needs in its present form? That is, can you offer more services to your customers without changing anything? Can the current computer control system — hardware and software — be upgraded? More specifically, are there newer, upward-compatible releases of the hardware and software being made available to you?

Is the current system being supported by vendors or in-house specialists? Can you get problems fixed and changes made to improve the system?

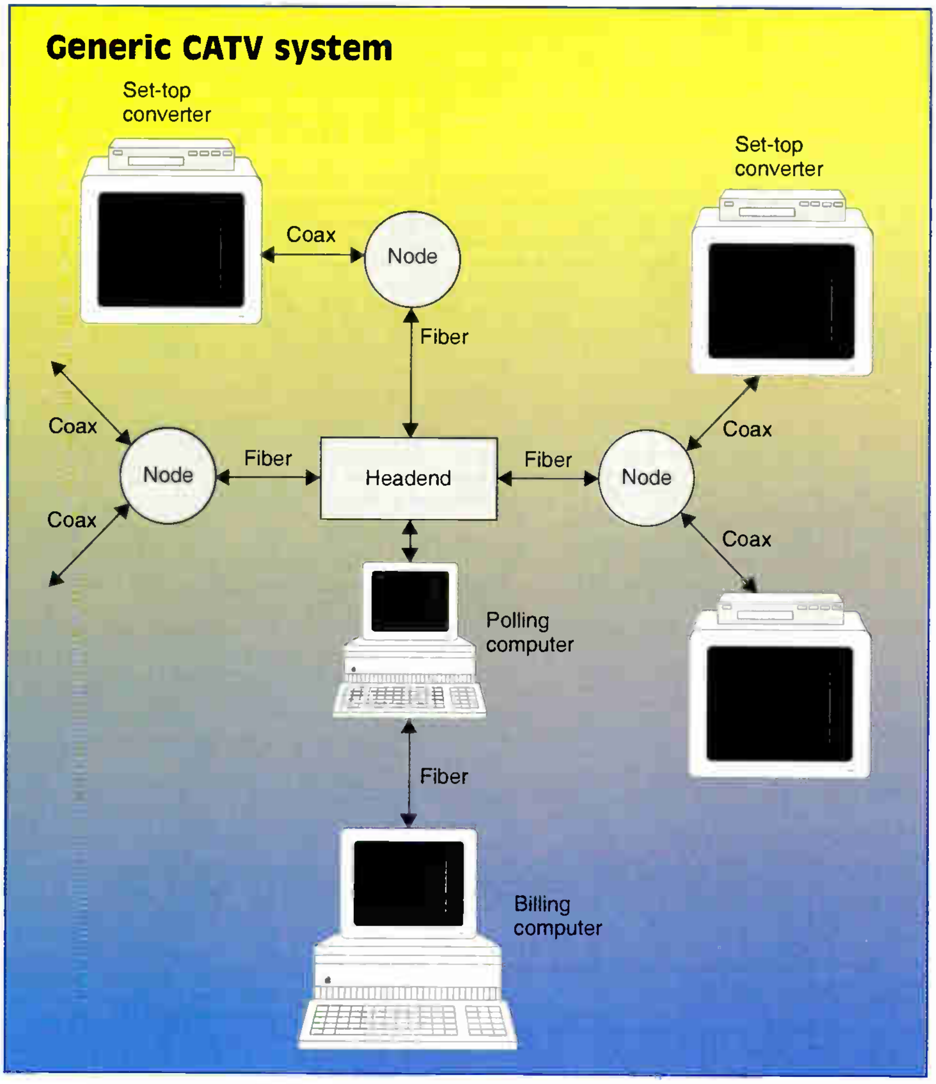
Do you own the data rights to the system? If the software you are using is proprietary to the vendor and you do not have the "source code," you won't be able to change it. Only the vendor with those rights can modify and redistribute the software.

Is this the right time to invest heavily in a new computer system? The industry is changing rapidly and until technology settles down, major changes today may become obsolete before the cost benefits can be realized.

Will you be forced by the major vendors to make expensive

changes in order to upgrade to their latest technology? For instance, can you remain operational with the existing set-top converters?

Unfortunately, many current systems are old and vendors are not releasing upgrades that are completely compatible with components of the existing system. Yet the uncertainty about where the industry is headed with new technology makes it difficult to consider a major investment in a new system. Additionally, many cable companies are being driven by products from major vendors, which means they may have to spend a lot of money when and where they would rather not.



Re-engineering may provide an appreciated alternative. It could include enabling your computer control system to run faster on more powerful, commercial, off-the-shelf hardware — using as much tested-in-service, commercial, off-the-shelf software as possible. Then the system would be modified to meet your near-term needs.

System integration specialists

Because many cable companies do not have in-house software development capabilities, they must contract out such a project to a software development and systems integration specialist. Whether its done in-house or by an outside source, the process is similar and a cost-effective approach should consider the three "Rs" of re-engineering: rehosting, redesigning and reuse.

The first step is to conduct an analysis of the enhancements and changes that are being proposed. Meetings should be held between the cable company's technical staff and the software development specialist to be sure that the proposed changes are fully understood by the system/software team. At the same time, an analysis of the current computer system should be conducted. During this analysis, the engineers need to identify the parts of the system that will be affected by the revisions. Then, a requirements document can be written to clearly define the changes to be made. Now, all involved should understand what will be reused, rehosted and redesigned — from both technical and financial standpoints.

After approval, the selection process for the off-the-shelf hardware and the software solutions can be conducted. A test set of the proposed hardware should be acquired and a prototype created to validate that the new hardware will function as specified. To ensure that data transmission and reception are effective, a predetermined set of data (dictated by the customer) should be sent and received on the new hardware. Timing studies should be conducted to ensure that the performance criteria for the hardware will be met. The results of the prototype tests should then be documented and presented to management for approval before the full re-engineering process is begun.

At this point, management knows exactly what has to be done to re-engineer the system, the magnitude of the changes being contemplated and the cost.

Meeting new needs

Introduction of fiber optics into a CATV system is in many ways transparent to the software control system. However, there are still a number of areas that can be affected by the increased load imposed by new and expanded services that will come once the fiber is in place. Expanding existing services and introducing new ones boosts traffic over the system. The software control system must meet these new requirements.

The CATV system shown in the accompanying figure depicts a fiber-to-the-node architecture with coax providing the transmission path between the node and the set-top converters in subscribers' homes. Because of noise buildup, some form of node switching or data receiving per node is required to recover the upstream data. The system is controlled by two computers, a polling computer and a billing computer. The polling computer polls each set-top converter, sending out signals for the converter to execute. For example, the polling computer reads pay-per-view (PPV) event information and the opinion information that has been entered by the subscriber from the remote control.

The billing computer communicates with one or more polling computers. The billing computer initiates PPV events

"One of the most significant and yet most often overlooked issues is whether the existing computer system that controls the services and brings revenue to the company will accommodate fiber."

and accepts operator entered menu requests and sends the requests to the polling computer. It accepts messages from the polling computer and generates history logs.

In the figure, fiber also is shown linking the polling computer and the billing computer. In actual implementation, there could be several polling computers distributed throughout the system. The link between the polling computers and the billing computer could be several fibers from the cable that connects the headend and the nodes. This design, along with standard ethernet interface cards, leads to a versatile local area network (LAN) configuration. With increasing capacity and decreasing prices, the PC is a good choice for the system control computers. A real-time UNIX operating system can meet the requirements as well as provide a standard, off-the-shelf environment for developing future enhancements. Future services will likely require real-time, two-way communications instead of the store-and-forward techniques currently in use.

The increase in traffic from expanded programming will impact a number of areas of the software as well. Seven major areas should be evaluated:

- Performance
- Security
- System monitoring
- Error processing
- Node switching
- Degraded mode processing
- Dynamic data base

Performance

Since fiber optics opens doors to many realized and unre-

The utilities' role: Building the ubiquinetwork — Part 5

By George Lawton
West Coast Correspondent

While cable and telephone companies are making bold plans for building the ubiquinetwork, utilities are more quietly making forays into the field. They already have a significant base of fiber alongside their networks, and yet they only require a small portion of it for their own network management. More significantly for the cable industry, many utilities believe that broadband networks, similar to those used by the cable industry, will enable them to reduce the need for new power plants.

The utilities have the money to make it happen. Last year they earned over $200 billion in total revenues. That is over twice as much as the local telephone companies — and 10 times what the cable industry earned. According to the Edison Electric Institute in Washington, DC, publicly owned utilities spent $23.9 billion on new power plants in 1992. A portion of this could be obviated by the use of telecommunications networks that could manage electrical demand in real-time. EEI estimates that utilities are currently spending as much as $4 billion annually on telecommunications, and this is growing at a rate of 25% per year.

Depending on the relationships they build with cable companies, the need for these new networks may turn electrical companies into profitable allies — or competitive enemies. Some are content to work with local cable operators in sharing the cost of their broadband networks or piggybacking on existing systems, while others want a piece of the CATV and telephony pie for themselves.

The players

There are currently four types of utilities in the U.S. The largest tend to be the multistate conglomerates that are regulated by the Securities and Exchange Commission through the Public Utilities Holding Company Act of 1934. There are currently nine regulated holding companies that control 16% of the total customers. They are prevented by law from investing in things outside their core business of electrical production, but many feel that they could offer limited information services related to the control and monitoring of their network.

The SEC has indicated it wants to do a staff study of its powers under existing legislation. According to industry insiders, it is extremely unlikely that Congress will legislate until after the study. Consequently we are not likely to see any new legislation on the table in this arena until next year.

The most prevalent utilities are the single-state publicly held utilities, which supply 61% of all customers. They are regulated by their own state public utility commissions. Their involvement in information services will depend on their ability to convince state regulators how that can benefit their customers.

The third type of utility is owned by the local government and accounts for 20% of the market. Some rather large cities control their own utility including Los Angeles, Seattle, Sacramento, CA, Omaha, NE, Memphis and Nashville, TN, Austin and San Antonio, TX. They have the most regulatory freedom since they are part of the government, and several have begun offering information services beyond what is required for monitoring their electrical plant, including cable TV.

The remaining 3% of all power is carried by rural electric cooperatives, which are owned by their customers. The rural markets that they cover are too remote for the bigger players to make a profit, and their budgets are too slim to move ahead with new services.

Steven Rivkin, a Washington-based lawyer who covers the electric industry, said, "The big players are holding companies on the one hand and municipals on the other, and the rest of the investor-owned companies are holding their hands seeing where it will go."

The registered holding companies are hoping to unshackle themselves from the watchful eye of the SEC so they can invest in other growth areas. The municipal utilities on the other hand are looking at how they can move into other information services like cable TV. Rivkin pointed out, "There is a history of municipal utilities longing to be in CATV and some have gotten quite bruised. They have tried to get into CATV and have been litigated by the cable industry on all kinds of real and flimsy claims. Legal expenses are death for a municipal utility."

At the moment, the regulatory environment is only putting a hold on allowing publicly held electrical utilities into services outside their core business, such as cable TV or telephony. Utilities have some degree of freedom in building an infostructure to help them monitor and control their electrical network. The key obstacle lies in proving that the emerging technology for doing this will save their customers money in the long run.

The good news for the cable industry is that the publicly owned utilities will not be moving into the cable business any time soon on their own. They are likely to work with existing cable operators where possible as that will help both parties minimize the costs associated with building a new network.

In fact, some utilities are even advocating taking on the position of "infrastructure provider" in which the utility would provide an open infrastructure onto which cable and telephone operators could run their networks, particularly for providing universal service in rural areas. Last May, Rick Green, CEO of Utilicorp United, based in Kansas City, MO, spoke on this area to the Senate Committee on Commerce, Science and Transportation.

"The good news for the cable industry is that the publicly owned utilities will not be moving into the cable business any time soon on their own."

He pointed out, "Universal service will require the creation of the necessary infrastructure. The telephone companies, cable companies and the electric utilities all have a potential role to play and assets to bring to the table. But it is unlikely that all markets in America could sustain multiple pathways, especially in rural areas. Perhaps no single entity could afford the investment necessary to bring the benefits of the national information infrastructure to our most rural communities. Yet, there could be a real synergy through collective involvement and partnership among cable, telephone, as well as electric utilities. In fact, in our rural service territory, we are talking with both local cable and telephone companies for partnering in our plans for new communications infrastructure."

The real threat to the cable industry is likely to come from municipal utilities, which are more interested in making sure that local residents get the best deal rather than making money. The end result of these operations can prove disastrous to cable operators.

Take the case of the city-owned Glasgow Electric Plant Board in Glasgow, KY. In 1988 it built its own cable TV network. The incumbent cable operator, TeleScripps, saw its profits evaporate over night. Its rates went from over $20 per month to only $5.95 for basic service. Furthermore, TeleScripps had to upgrade its own cable network from 21 channels to 48 in order to stay competitive.

TeleScripps tried suing, but to no avail. According to the superintendent of Glasgow Electric, Billy Ray, "We weathered a lot of litigation and won it all." Furthermore, most of the legal arrows fired by TeleScripps were rendered useless by the Cable Act of 1992.

Why it makes sense for utilities

Building a bidirectional network to the home will generate some modest savings for utilities in things like automatic meter reading, which could save $6 per year per customer. It also would enable electricity to be turned on and off at the power plant, saving the utility $90 for each avoided truck roll. But the real savings will come from managing electrical demand.

Electrical utilities have to build enough electrical plant to handle their peak load, although much of the time these "peaking" power plants remain idle. Building new power plants that sit idle during off-peak hours can be very costly. According to Vern Anderson, vice president of marketing at First Pacific Networks (FPN), a peaking plant, designed to turn on for high electrical loads, can cost $1 billion to build. However, this plant might be idle 90% of the time.

The problem is especially bad on hot summer days, when everyone seems to turn their air-conditioning on at once. If utilities could find some way of leveling out the demand for electricity, then they could save themselves the cost of a new plant. The telephone companies have been doing this for years by charging more for long distance during the day than at night. Electric companies want to be able to control electric demand in real-time. This is called demand side management. (DSM also is used to refer to more mundane things like the utility giving away free high-efficiency light bulbs.)

Real-time DSM architectures

The simplest architecture for doing DSM involves using a radio network to send control signals to electrical appliances. In its most basic form, customers receive modest monthly rebates for placing a radio receiver on their big appliances like air conditioners and pool pumps. When electrical demand rises above a certain limit, a central computer starts transmitting a signal to shut appliances off.

This is the most common type of real-time demand side management and according to some industry experts there are between 10 and 15 million of these units installed in the field. They typically operate in the radio bands controlled by the local utility and travel at speeds of under 100 bits/s.

Scientific-Atlanta happens to be one of the leaders in this arena. Matt Oja, vice president of marketing for the Control Systems Division at S-A, says that these systems tend to cost about $100-$175 per kilowatt of control.

One of the limitations in this type of one-directional control system is security. Unscrupulous customers can put a metal bucket over the receiver, thereby preventing it from turning off their air conditioner and still receive the rebate. But Oja points out that this can be minimized by periodic audits by the power company and that overall noncontrol is only on the order of 1-2%.

Scientific-Atlanta in conjunction with Itron Corp. (based in Spokane, WA) has developed a slightly different type of architecture that supports bidirectional wireless communications and enables consumers to change the settings for appliances in their home using their set-top box. Itron is the largest supplier of data acquisition and communications products for electric, gas and water utilities.

The system will use a wireless network in which wireless hubs connected to a utility network will communicate

"The real threat to the cable industry is likely to come from municipal utilities, which are more interested in making sure that local residents get the best deal rather than making money."

with 20-40 homes. It could communicate directly with heavy appliances or via a box on the outside of the home that will be able to send data over the home's power line network. The system will be used for controlling the load to homes as well as monitoring power outages.

Eventually this wireless network could be tied into a cable system employing S-A's 8600 line of set-top boxes. All of the monitoring data could be sent via the wireless network and consumers would be able to program their appliances via the set-top, which would communicate with the electric utility via a bidirectional link through the cable headend.

Others are proposing using a broadband network for directly supporting DSM. This has the advantage that it can support a greater data stream, but it also can incur a cost as high as $1,000 per home. However, this can be drastically reduced if the electric company can piggyback on an existing cable network. Oja believes that S-A's approach will cost significantly less.

Glasgow Electric has taken the simplest broadband approach using equipment from First Pacific Networks. The network is wired into a consumer's major appliances. When electrical demand gets too high, the electric company starts shutting them off, much like the wireless networks just described.

Since Glasgow Electric uses the network to offer cable TV as well, it is able to give customers a premium cable channel like HBO or Showtime in exchange for complying with the DSM program.

Glasgow Electric's Ray said that similar systems have been in place, but the utility generally only gives customers a $3 to $5 credit on their electrical bills. But he points out that a lack of consumer understanding of the need for the program and the lack of interest in a $3 to $5 per month savings have often weakened these programs. Ray believes that utility control of consumer appliances is only a primitive step. He is hoping to evolve it to a pricing-based control system in the near future.

Power company Central & South West launched a $9 million, 18-month trial in Laredo, TX, this past summer designed to support real-time pricing. A broadband network based on FPN's PowerView energy management system will be connected to 2,500 homes. Each of the participants will be given a controller that will allow them to set the maximum price paid for electricity. Prices will range from 5.6¢ per kilowatt-hour to 35¢/kwh during the peak period of summer months.

The nice thing about this type of system is that it allows the customer to stay in control. If they wanted to have a party, for example, they could raise the price they are willing to pay for air-conditioning.

According to FPN, PowerView costs about $875 per home to install for DSM. According to field tests done by Integrated Communications Systems Inc., this system can reduce peak electrical demand by an average of 1.5 kilowatts per home. FPN estimates it would cost $1,290 per home to build a peaking plant that supports 1.5 kilowatts per home. That represents a potential savings to the utility of $415 per home!

PowerView consumes less than 5% of the bandwidth of the coaxial cable. So for minimal investment, the utility can move into other services like cable TV or telephony. But if utilities only need 5% of the bandwidth for this service, why even bother with a hybrid fiber/coax network? Bill Morrow, project manager on the Laredo project, said, "To the utility planner it is important to verify that demand side management is there in a real way. With the hybrid fiber/coax approach we are able to know what is going on within a few seconds."

Inside the home

Once inside the home, these networks need a way of communicating with individual appliances. One approach is via radio. Alternatively, appliances could be plugged into the coaxial network, which carries data to and from the house. But then a coaxial connection would have to be pulled to every major appliance. One of the simplest approaches might be to send the data back and forth over the house's electrical network on the inside. A bridge could be installed that passes data between the coaxial network to the AC power network.

There are currently two dominant approaches in the U.S. for providing the AC wireline communications requirements for integrated home controls: the Electronic Industries Association's CEBus (consumer electronic bus) and Echelon Corp.'s local operating network, LonWorks.

CEBus originated as an attempt to standardize communications protocols across a variety of media. It is designed to support communications between any appliance over any media. Companies began working on its standardization back in 1984 and the final protocol is just now becoming a standard. The standard covers three areas: 1) communication protocol, 2) specifications for the network's physical layer, topology and medium, and 3) a language for device communications.

Although the CEBus standard itself is open for use by anyone, one company, Intellon Corp. in Ocala, FL, developed the spread-spectrum communications technology used in the standard. Consequently, everyone implementing CEBus must license or buy this component from Intellon. Intellon can sell a company a chip set that can be incorporated into a product or license the technology to be included in a manufacturer's own product.

According to a report published by research firm Parks Associates in Dallas, product manufacturers and developers like CEBus because it is an open EIA industry standard and developers are free to extend the system's capability and functionality to their heart's content as long as the basic system specifications are met. This is also its greatest weakness, since the freedom to implement the products in many different ways may cause the same problems of incompatibility with early open architecture computer products. Parks Associates predicts there will be a technology shakedown period, which could leave some users upset.

Parks Associates also points out that the tools necessary to build products and make CEBus networks are limited. Manufactures are hesitant to make product commitments for the pieces required to make CEBus products a standard.

LonWorks is a communications protocol contained in silicon sold by Motorola and Toshiba and licensed by Echelon Corp., in Palo Alto, CA. Over 150 companies are already offering commercial LonWorks-based products and 800 intend to have products on the market within the next year. According to Parks Associates, only 30% of the customers plan to deploy LonWorks products for the building automation market. The rest will be used by manufacturers in industries ranging from transportation to telecommunication and factory control.

Parks Associates says LonWorks' greatest strength is that it is unambiguous, straightforward and easy to incorporate into a product and has all the tools necessary to do so. In addition it scales well, from a small house network to a large factory. Furthermore it includes a complete communications protocol stack that supports such features as error correction.

LonWorks greatest weakness is the high cost of its developer kit, which can run into the $10,000+ range depending on the applications. Parks Associates points out that since Echelon's primary income is derived from the development system products, it is not likely to encourage competition in development products from other vendors.

At the moment the components to power these electronic networks are still too expensive for the average light bulb. It costs a minimum of $15 per appliance or device to create a complete node, which includes all of the supporting hardware, but this cost is expected to drop once volume deployment picks up.

But will it be easy to use?

How easy will it be for the average consumer to use this technology? After all, the majority of the population seems to have a blinking 12:00 on their VCRs, and how many of them would be thrilled with programming the rest of their house as well?

In Walnut Creek, CA, TCI is working with Microsoft and Pacific Gas & Electric to develop a bidirectional electric communications network over TCI's existing cable network.

Microsoft will be creating a TV-based interface for demand side management systems used in the Walnut Creek trial. Steve Phillips, the PG&E project manager for the trial, said, "The key is the absolute ease of use we will provide through the TV set. People don't like to program VCRs or thermostats. One of the reasons that Microsoft is a partner is its ability to provide the point and click interface. We are looking to market this as a basic package that gives customers demand side management, and we will set up a system in their home that will do home automation such as control lighting.

"It is a convenience thing. If we were just doing demand side management, we would not use broadband technology to deploy it. We feel that what will drive deployment of the infrastructure will be TV entertainment-based. We think it will be a rich environment and we want to add on top of that."

The participants are gambling $6.2 million that consumers will appreciate using the service because it saves them time and money. About 30 homes will be connected to the system later this year, and another 1,000-2,000 will be added in the first half of 1995. As Phillips pointed out, "We are looking at this as being something we would target market to consumers as a service. Verifying that this is a valid assumption is what it is all about."

Central & South West is deploying a customer-interface from Raytheon. It will be a paperback book-sized box that can be plugged into any outlet in the house. It will have several menus and be capable of programming the A/C, heater or the light. Central & South West also will be able to program it remotely from its headquarters or send messages like, "Summer is around the corner, we will send you $5 if you get your A/C maintained and send us the slip."

However, one must wonder how Joe Average will be able to use this thing, if he can't even program a VCR. Morrow replied, "There is no incentive to program a VCR. But there is an incentive to get money out of an ATM, and 100% of the market can use an ATM. That is the model we want to follow."

Who will pay for this stuff?

If the electrical utilities decide to hop on the information highway, it is going to have to come out of someone's pocket. Ideally, such a program would be implemented by the electric company out of the savings of not having to build a new power plant. But some feel that such a system could turn into a form of utility welfare, in which the rich are taxed to pay for the poor.

Johannes Pfeifenberger, a consultant at the Brattle Group in Cambridge, MA, said, "The problem with demand side management is that, because of regulatory policy, those programs are only evaluated based on total cost, not based on who pays. Utilities often pay most of the costs through rate increases. What misses the points is that if DSM programs are truly cost-effective the customer gets all the savings."

Pfeifenberger asks, "If these DSM programs only use 5% of the capacity of the line, should the DSM program pay 100% of the costs?"

Pfeifenberger found that most utilities pay too much for DSM programs. "A lot of environmental groups and regulators want energy saving stuff done by utilities. Then the utility gets money back through increased rates. It would just be as well to increase taxes and pay for it that way than have the utility do it."

Pfeifenberger cited the case of one utility that implemented a comprehensive DSM program in 1992 at a cost of about $60 million. The utility paid $57 million of this cost through customer rebates. Participating customers paid $3 million, but received $120 million in bill savings. However, those customers not participating in the program were upset because they had to pay for the utility's $57 million through higher rates, yet they received no benefit.

Pfeifenberger said the problem is that "utilities are very unsophisticated marketers. They want to penetrate the whole market within three years. Some of these projections are more ambitious than the VCR or fax machine. You can only reach that size if the product is free. But car manufacturers don't promote cars by giving them away below cost. If the customer has a cash flow problem, they offer financing."

PG&E is planning on letting the customer foot the bill. The utility already has a crude form of DSM implemented in homes. Between 12 noon and 6 p.m. electricity rates triple. This reduces demand during those peak times and they don't need a broadband network to do it. Phillips said the customer interest in the service may come from the fact that it will enable them to control appliances automatically and get up-to-the-minute information on their electricity bill.

Rivkin takes the view that installing telecommunications networks for demand side management will be to everyone's benefit. "I think that if you took the long view of telecommunications, you would not sweat the small points. There would be some adversary activity with environmental groups, but it would not be subject to an innate rip-off.

"The utilities have an average annual per house bill of $700, so we are talking about a lot of money to be saved in everyone's house. That is a windfall for the power companies. I think the power companies will be regulated or motivated by their own self-interest to put those boxes in everyone's houses."

Conclusion

It is not a question of if, but when the electrical utilities start putting their stake in the ubiquinetwork. They are all watching this first round of trials to see what happens and whether the technology is really cheap enough to save money over building new plants.

When the power companies are ready, it would behoove the cable industry to learn how to work with them or it may find itself working against a new competitor. Working with partners would be to the economic benefit of both the cable and utility industries. The approach taken by TCI in working with PG&E is exemplary of this strategy. Otherwise cable operators may find themselves struggling to survive much like TeleScripps' Glasgow operation. **CT**

Fiber-optic maintenance in the CATV headend

By Jeffrey L. Korkowski
Senior Market Manager
ADC Telecommunications Inc.

"Remember that connectors can pick up all sorts of 'invisible' substances — oil from touching a finger, lint from brushing a shirt, or metal dust from bumping another component — which will adversely affect service quality."

Mom may have told you to be careful as you ventured out into the big, scary world and she may have assured you that home would always be a haven when you needed it. But mom didn't know about headends.

In CATV networks, the outside world is in many ways the safest place for fiber-optic cable, because there the cable is usually isolated, buried and encased in a thick sheath. Sure, there's the occasional backhoe incident, but on the whole, fibers are more vulnerable "back home" in congested headends where there's a lot of activity.

Taking care of fiber always has been important, partly because the stuff is made of glass and partly because it can carry an incredible amount of traffic. Fibers are vital conduits, like bridges. (Why do you suppose they're always trying to blow up bridges in war movies?) Fibers represent a major component of a service provider's financial interest both in terms of investment and revenues.

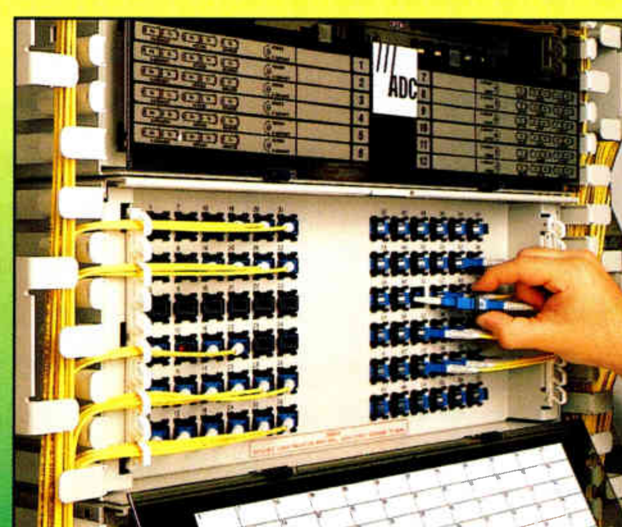
Now that networks are expanding rapidly and fiber is playing an increasingly important role, fiber-optic maintenance has become a priority. The old methods simply won't cut it anymore. An up-to-date, comprehensive scheme must be implemented to ensure the longevity and peak performance of a fiber-optic network. To see what the fundamentals of such a scheme might look like, let's follow the path of fiber-optic cable as it journeys through the headend.

Entering without breaking

Outside plant (OSP) cables should be terminated as soon as they enter the headend. Besides being gel-filled and messy to work with, they're neither flexible nor fire retardant. They should be terminated at a fiber-entrance cabinet (FEC)

Figure 1: Preinstalled factory-terminated connector module

Figure 2: Removable retainers detach from front of connector module

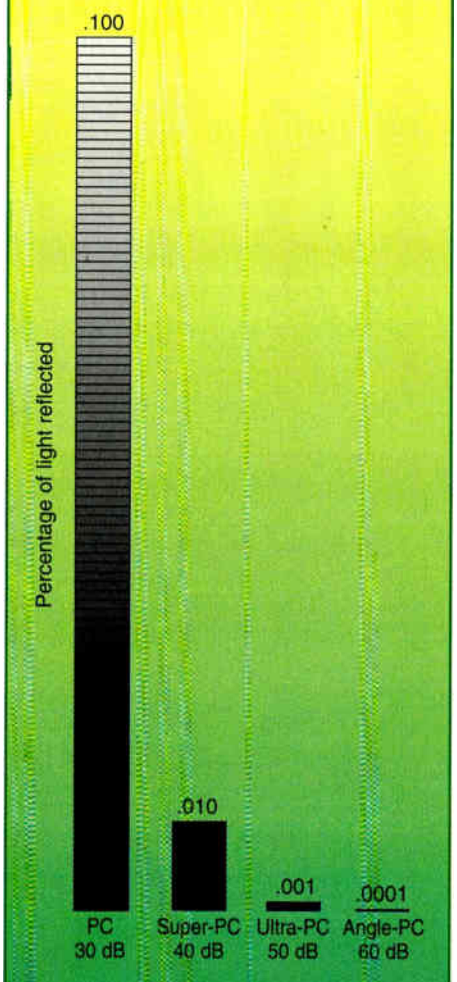


where fiber strands are spliced to intrafacility cables (IFCs). With connectors at one end and unterminated fibers at the other, an IFC can be seen as very long "pigtail."

Service providers are advised not to terminate OSP cables at splice cases, which are not designed for re-entry. An FEC, on the other hand, accommodates re-entry easily. It has a door, routing guides, protective drawers and other features to provide strain relief and ensure proper performance from the cable.

From the FEC, an IFC goes to the fiber distribution frame and is terminated on the back of a connector module. Service providers are urged to buy preinstalled, factory-terminated connector modules. This means that the manufacturer has already attached a connector to each of the 900 micron fibers and plugged them neatly into the back of the panel. Installers, therefore, are not required to handle any 900 micron fibers. Having been thoroughly tested, the entire module comes ready to use, with the tail-end length of IFC coiled around a spool. (See Figure 1 on page 86.)

Figure 3: Performance levels vary significantly with connector type



Run a clean operation

A basic element of infrastructure maintenance is testing and monitoring. This in itself is an extensive and complicated topic, but a few points are worth noting here. Test equipment like optical time domain reflectometers (OTDRs), power meters and optical return loss (ORL) meters can tap into the network through a patch cord link to the connector module. To make sure that test results are accurate, it's important to clean the fiber ends of the IFC and the patch cords terminated at the connector module. In fact, most connector-related problems are caused by dirt, but because the contaminants are often invisible to the human eye, many problems are misdiagnosed.

Cleaning IFC connectors is much easier if the connector module has removable retainers on the front panel. With this feature, the fixture holding the adapter into which you'd plug a patch cord can be pulled out from the front to reveal the connector of a 900 micron fiber. (See Figure 2 on page 86.) Using this method, only one connector is exposed at a time and the risk of accidental damage is reduced.

To clean connectors, adapters and attenuators, you'll need lint-free laboratory wipes, lint-free pipe cleaners, cotton-tipped swabs, isopropyl alcohol and a source of clean, dry, oil-free compressed air. When cleaning a connector, moisten a lint-free wipe with alcohol and rub vigorously around the ferrule or taper and several times across the tip. Repeat the process with a dry wipe and blow across the end of the ferrule with compressed air.

Once adapters are separated from connectors, they can be cleaned with an alcohol-moistened pipe cleaner. Simply pass the pipe cleaner through the opening, rotate to scrub the threads and grooves, and dry the housing with compressed air. Use an alcohol-moistened wipe wrapped around a cotton swab to clean biconic adapters. Again, rotate to clean the interior contours and dry with compressed air. When cleaning attenuators, use only a blast of compressed air.

For each component, it's best to use a separate wipe or pipe cleaner (or at least a fresh portion of one) so you don't just transfer dirt from one place to another. Also, be sure to inspect all components after cleaning them. Occasionally, the process must be repeated to remove lingering dirt. But remember that connectors can pick up all sorts of "invisible" substances — oil from touching a finger, lint from brushing a shirt, or metal dust from bumping another component — which will adversely affect service quality.

More than meets the eye

The connector itself plays an important but unsung role in ensuring reliable, high-quality performance. There are many styles of connectors available. They differ mainly in their fastening mechanisms and are chosen more or less according to individual preference. Once a style is selected, various models should be evaluated according to the performance, durability and reliability parameters required for a given application.

A connector's performance level is measured by insertion loss and return loss. Insertion loss describes the power lost from the circuit when a connector pair is installed. A maximum insertion loss of 0.2 dB is desirable. The amount of energy reflected from the connector back to the transmitter is expressed as the return loss.

Physical contact (PC) connectors, which physically press the fiber tips together, provide return losses of at least 30 dB with performance improving as better polishing methods are used on the fiber's end-face. Thus, super-PC connectors raise the level to 40 dB or better, ultra-PCs exceed 50 dB and angle-PCs top the list with return losses of 60 dB or better. Beyond this there is little need for improvement, since the fiber-optic cable itself has an internal reflection or return loss of around 60 to 65 dB. (See Figure 3. It's important to note that the scale in this figure is logarithmic. A return loss of 40 dB means that one photon is reflected for every 10,000 transmitted, while at 50 dB one photon is reflected for every 100,000 transmitted. The term reflectance, which is sometimes used in place of return loss, expresses the same magnitude but as a negative number. A reflectance of -35 dB is the same as a return loss of 35 dB. Lower reflectance or higher return loss means better performance.)

To ensure that a physical connection is maintained even when cables are bumped, use a "pull-proof" connector, which is one designed with internal springs, free-floating components, a strong but flexible casing and a resilient epoxy that keeps the connector attached to the cable.

Connectors may seem like simple devices, but making them is much harder than it looks. Expertise is required to en-

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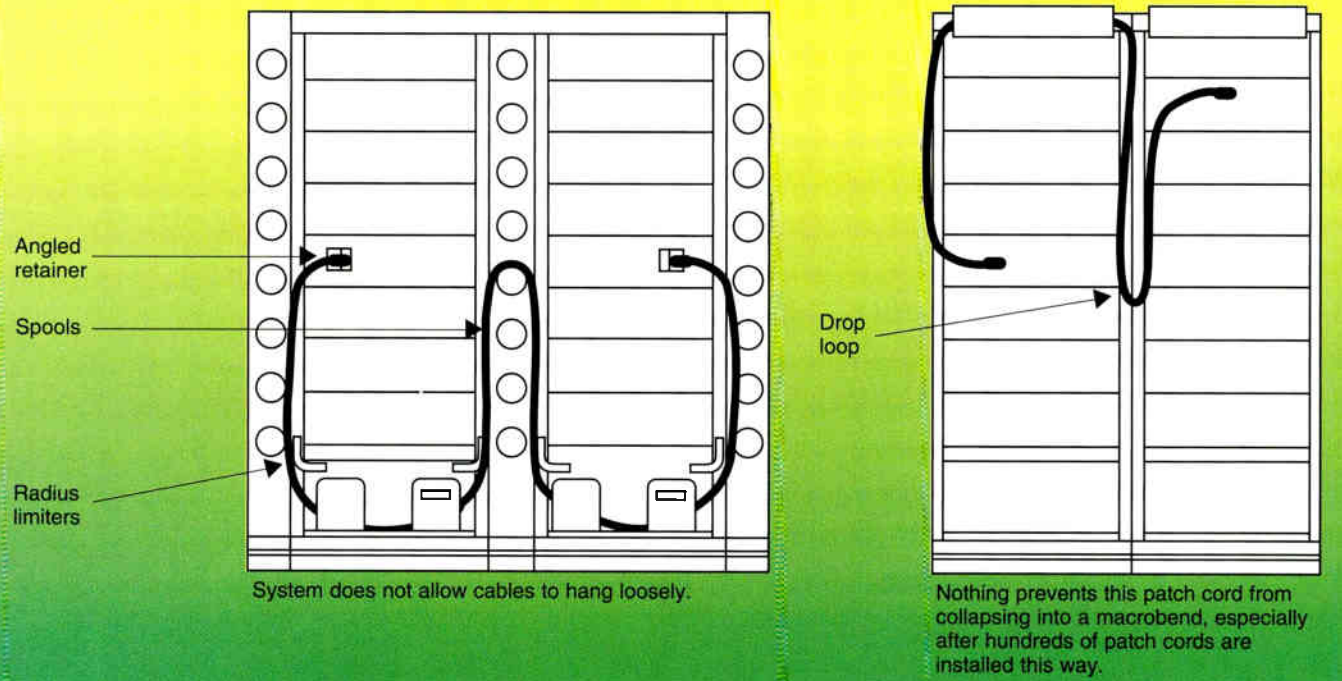
Figure 4: Cables protected (left) vs. cable drooping (right)



sure that the end-face is polished evenly, the fiber core is aligned properly and the glass core is prevented from withdrawing into the ferrule. Even minor production flaws will impair service quality. That's why it's important to work with an experienced manufacturer who can deliver reliable, factory-installed and tested connectors.

There has been a recent trend among service providers to consider installing high-performance connectors in the field. This activity appears to be premature. Field installations are often evaluated by testing insertion loss, which is the easiest performance requirement to meet. Return loss, however, is rarely measured in the field, yet it's a much more important parameter in a video network. In addition, many field installations may test well initially but because of epoxy creep, fiber withdrawal and other installation issues, they will not continue to produce acceptable results in the long run.

Handle with care

Everyone working in the headend must pay careful attention to all fiber cables. A fiber-optic cable is like a garden hose in the sense that bending it can reduce throughput. But of course it's not a hose, it's a thread of glass that will break if it's bent too far. A safe limit is defined by the cable's minimum bend radius, which is generally equal to 20 times its diameter.

A proper maintenance and management system will provide positive bend radius control to physically support the cable and prevent both "macrobending" (bending into an excessively small loop) and "microbending" (excessive pressing or squeezing). A fiber frame with positive bend-radius control carefully routes a patch cord between connector modules using spools, rings and troughs. Excess cable is kept neatly in storage.

Some systems allow cables to hang loosely. Not only do they leave cables more susceptible to damage, but they also allow cables to be squeezed and choked, resulting in partially dampened performance and a problem that's extremely difficult to track down. (See Figure 4.)

"For connections to the transmitter, CATV operators are urged to use angle-PC or ultra-PC connectors (for return losses of at least 50 dB) in order to minimize the amount of light reflected to the transmitter."

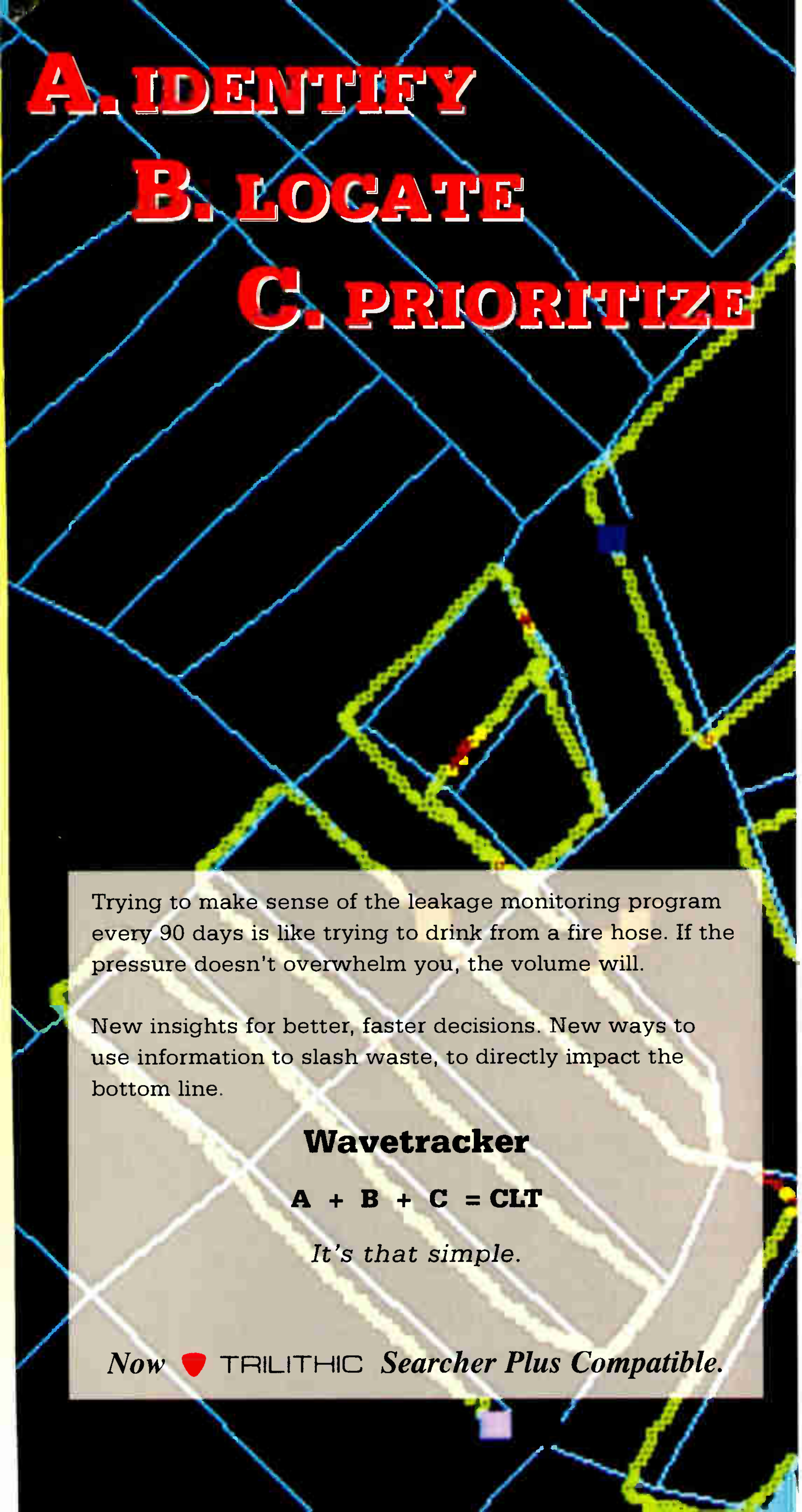
Splitter modules are another element of the fiber frame. The same design principles that apply to other points of connection apply to these components. They should provide thorough protection, support detailed record keeping and allow additional splitters to be added nonobtrusively.

From the splitter module, a patch cord leaves the fiber frame and makes its way to the transmitter through a trough routing system. The trough's job is to keep fibers organized and out of the way of technicians, prevent macrobends and microbends and remain visible and easy to identify amid the maze of equipment.

For connections to the transmitter, CATV operators are urged to use angle-PC or ultra-PC connectors (for return losses of at least 50 dB) in order to minimize the amount of light reflected to the transmitter. At all other locations within the headend, connectors with return losses of 45 dB or greater can be used.

Attention to detail

Because any weak link in the fiber infrastructure can lead to problems, make sure you pay attention to all the details of fiber-optic maintenance. Admittedly, it's not as interesting as trying out some cutting-edge piece of equipment or devising a new service strategy, but it's every bit as important. So be forewarned: If you choose to ignore basic maintenance, don't go crying to your mother when disaster strikes. **BTB**



Digital compression in an analog headend

By Robert E. Baker
Plant Manager, TCA Cable TV

The other day I placed my newly received digital integrated receiver decoder into service on my first incoming digitally compressed (and multiplexed) signal (Univision). And guess what? While I did get a picture, it had problems. I had intermittent tiling, freeze frames and some video drop out from time to time. While these symptoms were not extremely frequent, they were there making the quality less than desirable for sending to subscribers. Just what was causing this, I had no idea. Every other signal being received on the same polarity (all analog) looked great. Since I had no prior experience in handling digitally modulated (and multiplexed) signals, this was a learning experience for me. I hope this article will give others some hints in finding the gremlins that can cause problems in a digitally modulated compressed signal.

The receiver that I was using was a Scientific-Atlanta Model D9222 IRD. One nice feature that it has is that it will provide a direct readout of the bit error rate (BER), which is probably the most important vital sign in handling digital signals. My BER was terrible, coming in at about 2.5E-3 at its worst, but never better than about 4.5E-4 and changing. (With the D9222, the ideal BER is displayed as 0.0E-6. As the exponent, E-x, goes lower the BER worsens. Note that a BER in this notation is interpreted as follows: 5.6E-5 for example simply means 5.6 errors out of 100,000 bits.)

The task now was to find out the source of the BER. I made a few phone calls, both to the uplink and to the manufacturer of the receiver and I dug out the books to get smart quick. What follows is a brief summary of the things that can affect the BER. Any of these problems may contribute to interference or distortions that will, in turn, result in a higher BER.

Antenna alignment, polarization

Analog signals are very "forgiving" and a dish with less than perfect alignment and polarization will still produce acceptable pictures. However, in the digital domain, these parameters are much more important, especially the polarity. The azimuth (AZ) and elevation (EL) of TVROs should be set using conventional methods. Using any satellite receiver with either an analog or digital readout of carrier-to-noise ratio (C/N), or one that provides an AGC voltage at an external test point or barrier strip can be effective in "peaking" the dish. The polarity can be best adjusted using a spectrum analyzer. The polarity simply aligns the LNBs to minimize reception of signals of the opposite polarity. Having done all this, now we fine tune the AZ, EL and polarity using the digital IRD while receiving a digital carrier and monitoring the BER readout. These three adjustments should be fine tuned to produce the best BER.

Connectors, cables

Check all cable and connectors between the output of the LNB (or LNA) and the input to the digital IRD. Wherever possible, make sure the minimum number of connections exists (no splices or avoidable adapters). Use current connector technology, sticking with one-piece integral sleeve F-fittings and preferably pin-type and hardline to F-connectors. Many TVROs have been in service for a long time. In my case, I found the old feed-through hardline connectors used in lieu of the pin type. I found unneeded adapters in the RF path and I found some loose connections. Other things to look for are corroded or loose fittings, broken or damaged shields and dented or crushed hardline. Any or all of these problems may result in reflections (because of mismatches) that will contaminate the digital signal and result in a worse BER. They also may allow interference through ingress from outside signals such as local two-way radio paging, ham radio operation or military applications (radar, navaids, etc.)

Terminations

Most likely, after leaving the LNB (or LNA), the incoming RF signals are routed to a power splitter so more than one receiver may be used on this polarity. Make sure every port in use has a properly installed connector and that they are finger tight, plus a slight bit more using a small wrench. Further, ensure every unused port is terminated in its characteristic impedance (usually 75 ohms). Check the distant end of all cables connected to the splitter to make sure they also are properly terminated. An unterminated port or one with an improperly installed or loose connector can affect both the amplitude and phase response of the digital signals on an adjacent port while still looking transparent to the analog signals.

LNBs

If the dish you are using has been in service for quite a long time, it's possible that the LNB may be contributing to your BER problems. Older LNBs had much higher noise temperatures than those produced today and they have less stable oscillators in their circuitry. These oscillators drifted in both frequency and phase. Replacing the old LNB with a newer one may raise the BER by reducing the instability and giving a better C/N. I've heard various opinions on the "phase-locked" or "digital-ready" type of LNBs. They are probably a good investment for narrowband applications (digital radio for example), but most likely, not necessary for normal CATV digital video applications. If all else fails, try one.

In my case, the BER problems were resolved in the RF path from the dish to the receiver input. I moved the digital IRD out to the TVRO and connected it directly to the LNB bypassing all connectors, RF cable and passives. The BER was 0.0E-6. That ruled out the dish alignment and the LNB. I replaced old style connectors with today's technology, eliminated adapters by installing properly configured connectors, and replaced some questionable coaxial cable. The result for me was a BER 0.0E-6 in the headend rack. It's achievable, you just have to hunt for the gremlins. **BTB**

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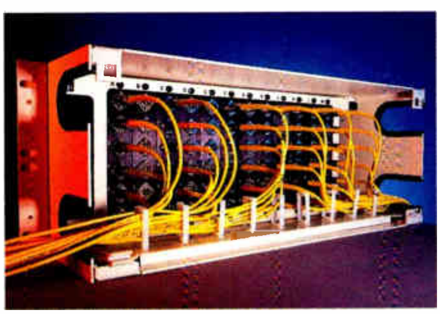

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sign, or shall wear eye protection that can be worn over the prescription lenses without disturbing the proper position of the prescription lenses or the protective lenses.

4) Eye and face PPE shall be distinctly marked to facilitate identification of the manufacturer.

5) Each affected employee shall use equipment with filter lenses that have a shade number appropriate for the work being performed for protection from injurious light radiation.

b) Criteria for protective eye and face devices.

1) Protective eye and face devices purchased after July 5, 1994, shall comply with American National Standards Institute (ANSI) Z87.1 — 1989, "American National Standard Practice for Occupational and Educational Eye and Face Protection," which is incorporated by reference, or shall be demonstrated by the employer to be equally effective.

§1910.135 — Head Protection

The new section on head protection is a considerable improvement over the one in the existing OSHA manual in that it provides guidelines relative to head protection use. This section also updates OSHA requirements concerning compliance with ANSI standards.

a) General requirements.

1) Each affected employee shall wear protective helmets when working in areas where there is the potential for injury to the head from falling objects.

2) Protective helmets designed to reduce electrical shock shall be worn by each such affected employee when near exposed electrical conductors that could contact the head.

b) Criteria for protective helmets.

1) Protective helmets purchased after July 5, 1994, shall comply with ANSI Z89.1 — 1986, "American National Standard for Personal Protection — Protective Head Wear for Industrial Workers Requirements," which is incorporated by reference, or shall be demonstrated to be equally effective.

2) Protective helmets purchased before July 5, 1994, shall comply with the ANSI Z89.1 — 1969, or shall be demonstrated by the employer to be equally effective.

§1910.136 — Foot Protection

This section has been expanded to include specific hazards or dangers to the foot. Perhaps the most significant change to this standard is the ANSI references. Note that the new ANSI reference is for "protective footwear" vs. the old reference to "safety-toed footwear."

a) General requirements. Each affected employee shall wear protective footwear when working in areas where there is a danger of foot injuries due to falling and rolling objects, or objects piercing the sole, and where such employee's feet are exposed to electrical hazards.

b) Criteria for protective footwear.

1) Protective footwear purchased after July 5, 1994, shall comply with ANSI Z41 — 1991, "American National Standard for Personal Protection — Protective Footwear," which is incorporated by reference, or shall be demonstrated by the employer to be equally effective.

2) Protective footwear purchased before July 5, 1994, shall comply with the ANSI standard "USA Standard for Men's Safety-Toed Footwear," Z41.1 — 1967, which is incorporated by reference or shall be demonstrated by the employer to be equally effective. →

Universal demodulator handles QAM, VSB and NTSC

This article was prepared for "Communications Technology" by the staff of Cable Television Laboratories Inc.

While set-top box developers are building quadrature amplitude modulation (QAM) demodulators for the emerging digital services market, Richard Prodan, CableLabs' vice president of engineering, has invented a device that could serve as the foundation for future generations of set-top boxes and TV sets.

Called the universal analog/digital demodulator, the device can demodulate QAM, vestigial sideband (VSB) and standard NTSC signal formats. Prodan has demonstrated a working prototype of the device, and CableLabs filed a U.S. patent application for it in April. In a recent interview Prodan described the universal demodulator as a cost-effective solution to the problem of multiple signal formats co-existing in the cable transmission environment.

"If you use this kind of approach, you can have different formats all being handled by the same physical equipment. It's a little more complex — but not three times as complex."

"We can expect three types of downstream signals for quite a few years," he said. "These are the well-established NTSC standard, the QAM formats for MPEG and European digital video, and VSB, which was recently selected over QAM by the FCC Advisory Committee for Advanced Television Service."

The idea for the universal demodulator came to Prodan as part of CableLabs' work to develop modulation equipment to produce QAM and VSB modulation formats for testing on cable systems. "Rather than build two modulators, I figured out a way to use one piece of hardware."

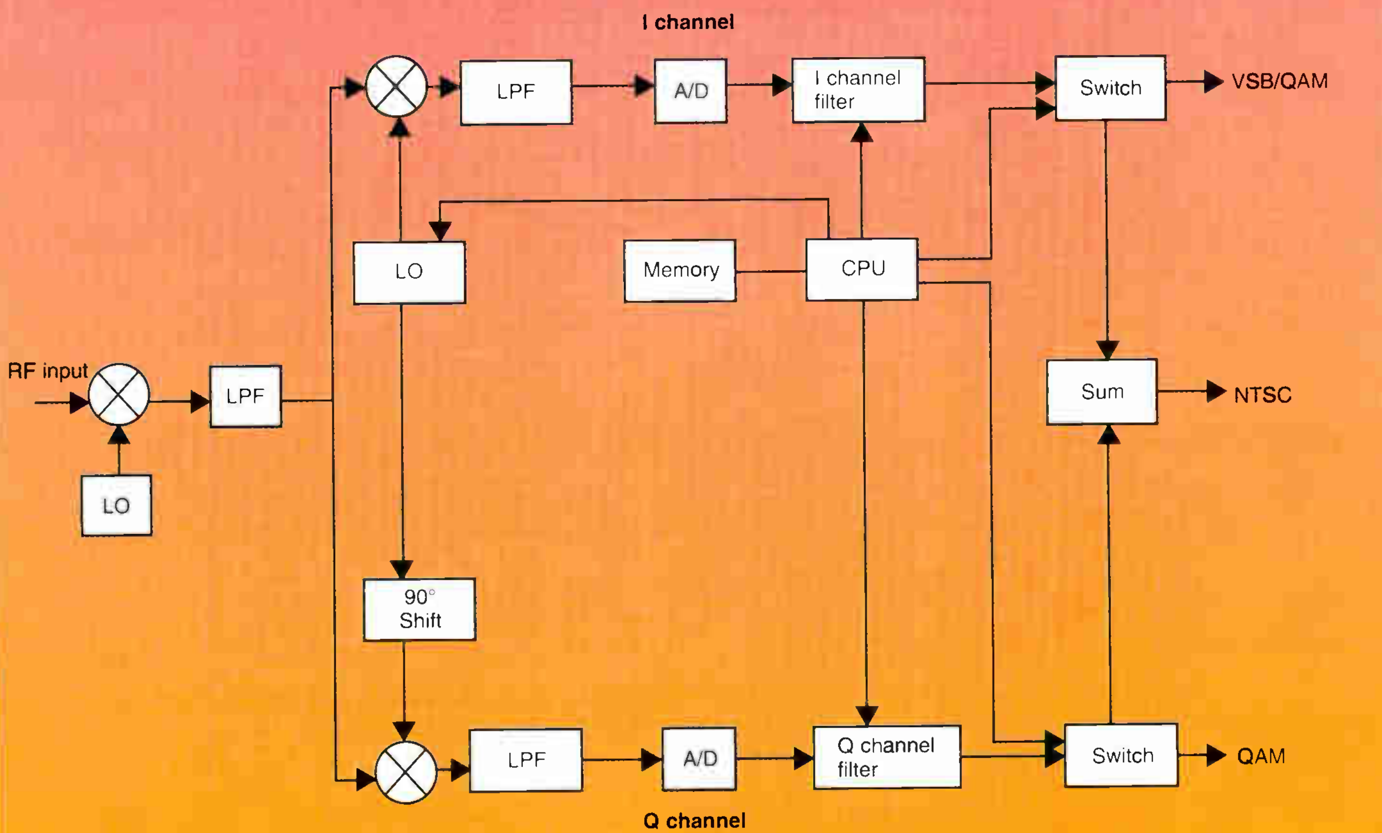
Having to accommodate both QAM and VSB proved to be a blessing in disguise, according to Prodan, because the same complex baseband signaling and quadrature amplitude multiplexing techniques he applied to QAM and VSB also can be used to demodulate NTSC's amplitude modulated form of the VSB format. "All these modulation formats are basically cousins," he said. "Everyone treats them as different species, and they're not. They're very closely related mathematically, which means you can attack them practically, from an engineering point of view, and find the common solution."

"The common solution is a little more complicated than doing each one individually," he continued. "However, if I do three for one, the slight additional complication will still result in an overall cost savings."

How it works

The universal demodulator uses a shared oscillator, CPU and digital filters. (See accompanying figure.) These components are programmable so that the correct position on the carrier band can be located and the proper digital filter

Universal analog/digital demodulator



This was invented by CableLabs researcher Richard Prodan.

coefficients may be selected to process QAM, VSB or NTSC using two "arms," the in-phase and quadrature channels. The 90° phase shift between the I and Q channels corresponds to the two multiplexed data signals used in QAM. For both VSB and NTSC, the I channel handles the signal itself, the Q channel the vestige. To produce NTSC, the I and Q channel outputs are summed. Complex baseband filtering and quadrature amplitude multiplexing are the techniques that let the universal demodulator flexibly derive all three signal formats from the same carrier input. "Conceptually, it's a simple idea," said Prodan. "The details are mathematically difficult, but tractable."

What's next?

Prodan does not expect his invention to have any immediate effect on set-top box or TV receiver design efforts. CableLabs does not manufacture equipment, so it will license the technology to companies that want to implement it. "We would like to talk with vendors of modem technology and system vendors who might be interested in incorporating this idea in their next generation of products," he said, noting that most set-top box vendors are currently focused on delivering a simple QAM digital demodulator, while TV makers are trying to do VSB for ATV. He expects that first-generation set-top boxes will be on the market next year. Then he predicts developers will turn their attention to integrated devices.

"I see this as a second- or third-generation set-top box, where you want to really cost-reduce and parts-reduce a box and simplify the design process. It requires a little more software programmability, but much less hardware redundancy. In addition to its economic advantages, Prodan stressed the importance of a universal demodulator in reducing the negative impact of multiple, standard signal formats. "If you use this kind of approach, you can have different formats all being handled by the same physical equipment. It's a little more complex — but not three times as complex." **CT**

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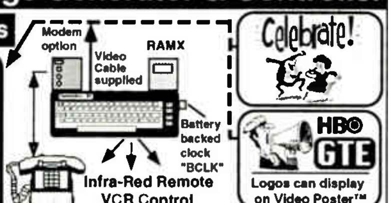

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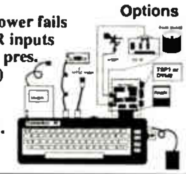

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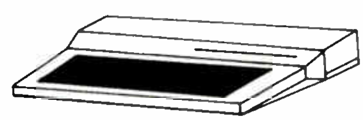

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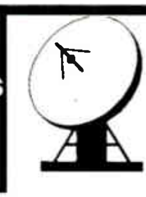

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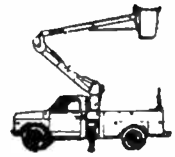

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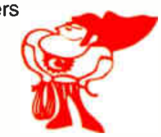

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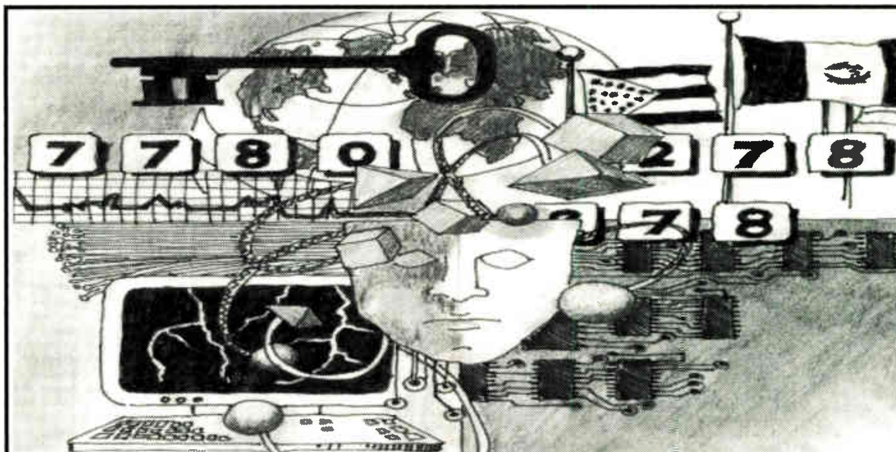

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35. ___ Commercial Insertion/ Character Generator
36. ___ Compression/Digital Equip.
37. ___ Computer Equipment
38. ___ Connectors/Splitters
39. ___ Fleet Management
40. ___ Headend Equipment
41. ___ Interactive Software
42. ___ Lightning Protection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

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

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

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

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

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

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

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

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

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

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December 1994 HM2

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(Signature and date required by U.S. Postal Service)

Circle Numbers for Free Information

1	27	53	79	105	131	157	183	209	235	261	287
2	28	54	80	106	132	156	184	210	236	262	288
3	29	55	81	107	133	159	185	211	237	263	289
4	30	56	82	108	134	160	186	212	238	264	290
5	31	57	83	109	135	161	187	213	239	265	291
6	32	58	84	110	136	162	188	214	240	266	292
7	33	59	85	111	137	163	189	125	241	267	293
8	34	60	86	112	138	164	190	216	242	268	294
9	35	61	87	113	139	165	191	217	243	269	295
10	36	62	88	114	140	166	192	218	244	270	296
11	37	63	89	115	141	167	193	219	245	271	927
12	38	64	90	116	142	168	194	220	248	272	298
13	39	65	91	117	143	169	195	221	247	273	299
14	40	66	92	118	144	170	196	222	248	274	300
15	41	67	93	119	145	171	197	223	249	275	301
16	42	68	94	120	148	172	198	224	250	276	302
17	43	69	95	121	147	173	199	225	251	277	303
18	44	70	96	122	148	174	200	226	252	278	304
19	45	71	97	123	149	175	201	227	253	279	305
20	46	72	98	124	150	176	202	228	254	280	306
21	47	73	99	125	151	177	203	229	255	281	307
22	48	74	100	126	152	178	204	230	256	282	308
23	49	75	101	127	153	179	205	231	257	283	309
24	50	76	102	128	154	180	206	232	258	284	310
25	51	77	103	129	155	181	207	233	259	285	311
26	52	78	104	130	156	182	208	234	260	286	312

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

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

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

C. Please check the category that best describes your job title:
19. ___ Corporate Management
20. ___ Management
21. ___ Programming

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

D. In the next 12 months, what cable equipment do you plan to buy?
30. ___ Amplifiers
31. ___ Antennas
32. ___ CATV Passive Equipment including Coaxial Cable
33. ___ Cable Tools
34. ___ CAD Software, Mapping
35. ___ Commercial Insertion/ Character Generator
36. ___ Compression/Digital Equip.
37. ___ Computer Equipment
38. ___ Connectors/Splitters
39. ___ Fleet Management
40. ___ Headend Equipment
41. ___ Interactive Software
42. ___ Lightning Protection
43. ___ Vaults/Pedestals
44. ___ MMDS Transmission Equipment
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96. ___ more than 2 years

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

Oscilloscope

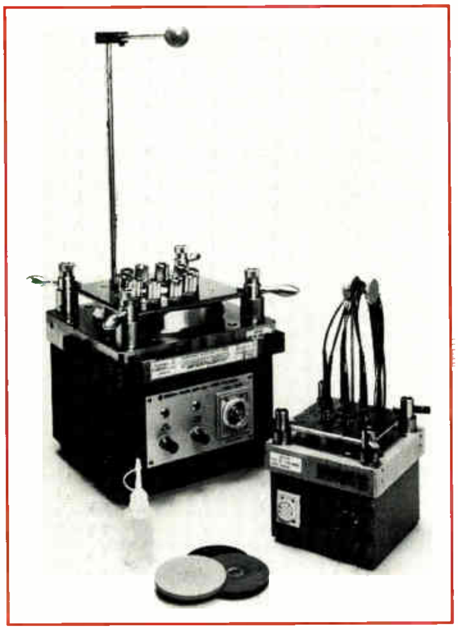
Leader Instrument Corp. added the Model 8063 60 MHz three-channel oscilloscope to its 8000 Series of analog scopes. The new model offers vertical sensitivity ranging from 1 mV/div to 5 V/div in 12 steps for Chs. 1 and 2. Bandwidth is automatically restricted to 20 MHz in the high sensitivity (1 and 2 mV/div) settings. V modes select display of Ch. 1-3 in any combination plus SUM (or difference with Ch. 1 inverted) waveform. Thus, four traces may be set up for simultaneous view (eight in the ALT sweep mode).

Alternate channel display is normal but CHOP may be selected from the front panel. X-Y operation is provided using Ch. 1 (Y) and Ch. 2 (X). Identical signal delay is provided in all channels to view fast trigger edges. Ch. 1 output is provided on the rear panel, allowing Ch. 1 to serve as a high-gain preamp to drive other instruments such as frequency counters.

Sweep facilities include delayed sweep with simultaneous display of the main and delayed traces in the alternate sweep mode. Main sweep times range from 50 ns/division to 0.5 s/division in 22 steps. The use of x10 sweep magnification raises the top sweep speed to 5 ns/division. Trigger facilities include source selection automatically keyed to V mode setup. That is, the trigger source is selected from the active channel, or Ch. 1 in dual mode operation.

The source may be manually selected between Chs. 1 to 3 plus the power line. Trigger modes feature auto, normal and fixed. The latter ensures stable triggering despite wide swings in signal amplitude by keeping the trigger point within the p-p span of the source signal. Dedicated H and V TV sync separators keep rock-steady video waveforms. Variable holdoff is provided to ensure correct display of long or complex wavetrains.

Reader service #206



Polishing machines

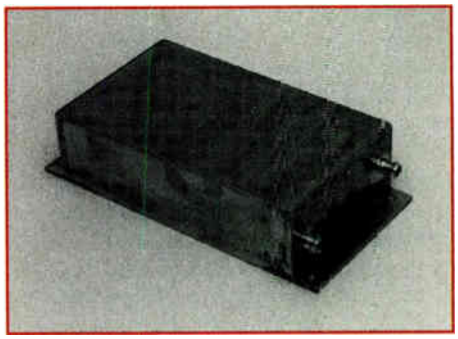
AMP unveiled fiber-optic connector polishing machines able to simultaneously polish up to 12 connectors in about five minutes, significantly reducing polishing time. Connector holders are available for a wide range of connector types, including FC, SC, ST, FSD and RSD styles.

The portable 70D PC & APC polishing machine is compact (230 x 230 x 144 cm) and lightweight (4.8 kg) for field use, yet rugged enough for factory applications. Depending on the holder accessory, it provides positive contact (PC) or angled positive contact (APC) fiber ends.

The unit features an automated polishing timer, with settings at six second increments, up to three minutes. It polishes up to six connectors simultaneously and operates from either a 12 volt battery or AC adapter. An optional connector cord also permits operation from an automobile cigarette lighter socket.

The larger AMP 550 PC & APC measures 230 x 230 x 255 cm and has the capacity to polish up to 12 connectors simultaneously. In both machines, the 8° APC achieves -68 dB average back reflection, while the PC achieves -47 dB. Standard accessories for the units include polishing pads and polishing film, spacers, tools and an AC/DC adapter.

Reader service #208



Amplitude equalizer

Communications & Energy Corp. announced the Model EQ(N) 2.5/2.7 amplitude equalizer that compensates for propagation anomalies that cause MMDS channels to be received at different amplitudes. The unit connects into the relay system between the low noise preamplifier and the power output amplifier.

The positive or negative equalization slope is factory tuned to customer specifications between 2.5 and 2.7 GHz. Positive or negative slope options are available up to 10 dB attenuation across the band. For example, with the -10 dB option, attenuation is 17 dB at 2.5 GHz and 7 dB at 2.7. The connectors are 50 ohm Type N. The unit measures 2 x 3 x 6 inches and weighs three pounds.

Reader service #207

Digital TV system

RCA-brand Digital Satellite System (DSS), the only all-digital TV receiving system, was rolled-out nationally. The three companies responsible for bringing DSS to market are RCA/Thomson Consumer Electronics, DirecTv (a unit of GM Hughes Electronics) and United States Satellite Broadcasting Co. (USSB), a division of Hubbard Broadcasting.

The system consists of a compact 18-inch satellite dish, dedicated digital receiver and interactive remote control. Two high-power direct broadcast satellites (DBS), built and operated by GM Hughes Electronics, beam approximately 175 TV channels with picture quality comparable to a video laser disc, and sound quality that rivals an audio compact disc, according to the companies.

More than 6,500 consumer electronics and satellite stores nationwide will sell both the DSS hardware and offer programming from USSB and DirecTv, which includes virtually every major basic and multichannel premium TV network, as well as first-run pay-per-view movies, sporting events, specialty programs, public service announcements and educational broadcasts. The programming packages are structured to be more flexible than cable to give customers more control over how much they pay for TV viewing. National retailers include Sears, Circuit City, Montgomery Ward, Best Buy and select Radio Shack locations.

The dish can be mounted on rooftops, in gardens or other out-of-the-way locations. Once installed, the dish remains in a fixed position. The lack of moving parts minimizes maintenance and provides reliability. The system can be professionally installed or with an RCA self-installation kit a handy do-it-yourselfer can put it together. In addition, the on-screen menu provides consumers with installation assistance.

The receiver is operated by a remote control that allows consumers to select programming using a simple "point and select" system to access the on-screen menu. The cursor is then moved through the on-screen program guide to select the desired channels. Also featured is a parental control system to lock out specific channels, establish rating limits and control pay-per-view spending.

Local network affiliate and independent channels are accessed through a broadcast antenna or, where available, cable feed. A special programming package from DirecTv offering one of each major broadcast network is available to customers in areas where they cannot receive local broadcast or cable service.

The system is "forward compatible," enabling consumers to take advantage of emerging video technologies and capabilities such as 16 x 9 widescreen, high definition TV (HDTV) broadcasts and interactive services.

Reader service #205

Data analysis

Wavetek introduced Windows-compatible StealthWare analysis, reporting and archiving software for cable TV managers, engineers and technicians. Designed for use with the Stealth SAM and Stealth Sweep System, the software makes it possible to upload field measurements such as waveforms and automated test results from a Stealth instrument. These are stored in a relational database, eliminating the need to maintain separate files. Measurement waveforms are displayed graphically (similar to how they appear on the instrument) and can be copied and pasted into other Windows-based applications or viewed in multiples.

Automated testing is achieved by downloading an automated test configuration from a computer to the Stealth instrument, performing the measurements in the field, and uploading the results to the software for viewing and analysis. Access test results through a spreadsheet format and easily sort by location, date, time, measurement type or channel. When warning or alarm limits are applied to the test results, color coding indicates out-of-limit measurements. Test results can be exported to other Windows applications or documentation can be generated with customized reports complete with your company logo.

Channel plans are maintained easily: Upload plans from a Stealth instrument, modify and archive them, then download the new plan to update several instruments. The software requires a 386 PC with Windows 3.1 and 2 Mb RAM.

Reader service #204

On-screen guide

TV Guide On Screen launched what it says is the first fully digital on-screen guide, the On Screen Channel, in two nonaffiliated cable systems. The service began operations recently at the Comcast system in Philadelphia with 161,000 subscribers and the TeleCable system in Radcliff, KY, with 11,500 subscribers.

Program listings for the channel are drawn from *TV Guide* and delivered digitally via satellite to the guide's on-screen format. While satellite delivery of listings data is not new, extending this technology to include promotional trailers for pay-per-view and premium programming has never been done before.

Digital TV technology allows the company to update video promotional material continuously, via satellite, unlike the slower laser disc method. Through the use of MPEG compression technology, the company reduces the satellite transmission time for the resulting video signals and allows for economical storage and decompression at the local headend.

The channel features video messaging, which utilizes the MPEG header information in front of each video packet to identify when a promotional trailer has been sent, and to automatically switch the on-screen presentation from full screen format to a half screen in real-time. Powerful multimedia computers placed at each headend allow for custom proportional fonts and color-keyed listings. The enhanced screen resolution enables the channel to display two hours of programming information for six channels.

The product is a composite of multiple digital images, each of which is independently programmable. A separate file is utilized for digitized backgrounds, allowing a daytime blue sky, a starry night, a sunset, landscape, cityscape or holiday scene. Digital logo files permit the system operator's logo to be displayed on every screen. High fidelity digital music can be provided by a computer file or as a live feed via an operator's pre-existing digital music service.

Also, downloadable messages can be displayed either from the system operator or *TV Guide's* editorial staff via satellite. These messages are transported as digital files that can be programmed into the channel in real-time. The digital satellite feed carries the program listings, PPV pricing, channel maps and promotional video updates on a daily basis.

Reader service #203

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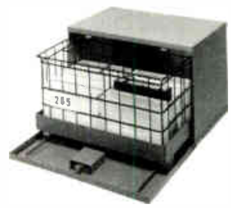

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Sales and Service

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

☛ *TV Your Primary Diagnostic Instrument* — Since SCTE began providing video training tapes to its members, *Diagnosing Common Cable Faults* (Order #T-1001) has consistently been the Society's most widely requested program. Since it was produced over 15 years ago, it could not demonstrate many of the picture impairments found in modern cable TV systems.

Although SCTE recognized that this tape was no longer current, the problems of arranging for laboratory facilities to isolate and demonstrate the various impairments was difficult, especially when you consider that baseband video impairments also would have to be included.

The new T-1001A, *TV Your Primary Diagnostic Instrument*, was introduced in SCTE's latest videotape and publication list. Since it is expected that this tape will become the most popular SCTE videotape of all time, making it the new "flagship" of the SCTE library, the SCTE chose to retain part of the old tape's number so it would be placed first in the new listing.

T-1001A clearly demonstrates the picture impairments found in modern cable TV systems by providing comparisons to unimpaired pictures, both before/after and split screens. It also discusses how to differentiate between the various impairments and the possible causes.

Impairments covered include: carrier-to-noise ratio, composite triple beat, low signal, excessive signal, hum, impulse noise, ghosting (reflective and ingress/direct pickup), cross-modulation and terrestrial interference.

Video impairments include: chroma/luma delay, low video modulation, excessive modulation and differential phase. Differential gain is discussed but not demonstrated, because it seldom appears by itself, and when isolated is difficult to see in a TV picture.

When the SCTE set out to produce this program, it wanted to develop a presentation that would be a primary reference tool. The Society hoped that it would enable technical personnel, both distribution and headend techs, to more accurately diagnose system problems. In addition, the SCTE wanted the illustrations to be a valuable training tool for customer service representatives (CSRs), helping them better advise their technical departments of potential system problems.

The production of T-1001A took approximately one year. Impairments were recorded on digital tape and mastered on 1-inch videotape. Every effort was made to maintain the highest quality, including having the VTRs go through a textbook alignment by manufacturer-trained personnel.

The development of this program truly was a "broadband" effort. It was produced with the participation of personnel from General Instrument's Jerrold division, Hewlett-Packard, CaLan, Jones Intercable, Malarkey-Taylor, Hickory Mountain Associates, Boettcher Video Services, Innovative Marketing and the SCTE national headquarters.

Since the intent was to develop a reference tape, and some of the low-level impairments can be difficult to see, the SCTE chose to distribute the tape on higher formats only. Copies in the 3/4-inch format have been produced directly from the edited master. In this way, the SCTE has minimized the effect of compound tape distortions contaminating the impairments being demonstrated.

Due to the rapid acceptance of this program as a training tool for CSRs, the SCTE decided to offer the tape in the VHS format as well. We do not recommend, however, that VHS copies be used by engineering and technical personnel. Every system engineering department should have an original 3/4-inch submaster copy for reference.

This 40-minute videotape is available in the 3/4-inch format for $59. VHS copies are $45. Please specify your preferred format when ordering. They are available in stock and will be delivered approximately three weeks after receipt of order with full payment.

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

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

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

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Reader Service Number 123

CALENDAR

1994

December

1: SCTE New Jersey Chapter seminar, training options, Wayne, NJ. Contact Linda Lotti, (908) 446-3612.

3: SCTE Cactus Chapter meeting, BCT/E and Installer exams to be administered, Tucson, AZ. Contact Harold Mackey, (602) 352-5860, ext. 135.

5: SCTE New Jersey Chapter meeting, Installer exams to be administered, RTK office, New Providence, NJ. Contact Linda Lotti, (908) 446-3612.

6-8: SCTE Wheat State Chapter meeting, BCT/E exams to be administered, Wichita, KS. Contact Jim Fronk, (316) 792-2574.

6-8: The Light Brigade fiber-optics course, installation, design and maintenance, Kent, WA. Contact (206) 251-1240.

7: SCTE Ark-La-Tex Chapter seminar, FCC proof-of-performance testing update, Shreveport, LA. Contact Randy Berry, (318) 238-1361.

7: SCTE Badger State Chapter seminar, color/RF/audio testing and standards, Holiday Inn, Fond du Lac, WI. Contact Brian Revak, (608) 372-2999.

7: SCTE Central Florida Chapter seminar, professionalism, Lakeland, FL. Contact Pam Kernodle, (813) 371-3444.

7: SCTE Delaware Valley Chapter seminar, advanced systems and competitive access, Williamson Restaurant, Willow Grove, PA. Contact Dave Jackson, (610) 256-8878.

7: SCTE Greater Chicago Chapter meeting, Installer exams to be administered, MetroVision office, Bellwood, IL. Contact Bill Whicher, (708) 362-6110.

7: SCTE Heart of America Chapter seminar, Washington update and FCC regulations, Kansas City, MO. Contact Dave Clark, (913) 599-5900.

8: Society of Cable Television Engineers Satellite Tele-Seminar Program, *Customer Service: Doing the Job Right the First Time, Part 2*, to be shown on Galaxy 1R, Transponder 14, 2:30-3:30 p.m. EST. Contact SCTE national headquarters, (610) 363-6888.

8: SCTE Central Indiana Chapter seminar, customer service, Holiday Inn North at Pyramids, Indianapolis. Contact Gordie McMillen (317) 353-2225.

8: SCTE Gateway Chapter meeting. Contact Duane Johnson, (314) 272-2020.

8-9: Probe Research seminar, making money in Tier 2 & 3 telecom markets, The Pointe Hilton, Phoenix. Contact (201) 285-1500.

10: SCTE Central Indiana Chapter meeting, BCT/E and Installer exams to be administered, Indianapolis. Contact Gordie McMillen, (317) 353-2225.

12-14: Society of Cable Television Engineers Technology for Technicians II seminar, Albuquerque, NM. Contact SCTE national headquarters, (610) 363-6888.

12-15: Siecor fiber-optic training course, Hickory, NC. Contact (800) 743-2671, ext. 5539 or 5560.

12: TeleStrategies conference, understanding cellular and PCS technology for nonengineers, Sheraton Crystal City Hotel, Arlington, VA. Contact (703) 734-7050.

13: SCTE Southeast Texas Chapter seminar, Installer and BCT/E exams to be administered, Warner Cable office, Houston. Contact Rosa Rosas, (409) 582-4855.

13-14: TeleStrategies conference, PCS auctions, Sheraton Crystal City Hotel, Arlington, VA. Contact (703) 734-7050.

14: SCTE Dakota Territories Chapter seminar, Watertown, SD. Contact Michael Schmit, (605) 229-1775.

14: SCTE Heart of America Chapter meeting, BCT/E exams to be administered, Kansas City, MO. Contact David Clark, (913) 599-5900.

15: SCTE Dakota Territories Chapter seminar, Fargo, ND. Contact Michael Schmit, (605) 229-1775.

15: Society of Cable Television Engineers OSHA/safety seminar, Hyatt Regency, Albuquerque, NM. Contact SCTE national headquarters, (610) 363-6888.

18: SCTE Great Plains Chapter meeting, BCT/E and Installer exams to be administered, Courtyard Cafe, Bellevue, NE. Contact Randy Parker, (402) 292-4049.

19: SCTE New Jersey Chapter meeting, Installer exams to be administered, RTK office, New Providence, NJ. Contact Linda Lotti, (908) 446-3612.

23: SCTE Wheat State Chapter meeting, BCT/E exams to be administered, Great Bend, KS. Contact Jim Fronk, (316) 792-2574.

28: SCTE Miss/Lou Chapter seminar, Ramada Inn, Slidell, LA. Contact Dave Matthews, (504) 923-0256, ext. 309.

Planning ahead

Feb. 26-Mar. 3: OFC '95, San Diego, CA. Contact (202) 223-0920.

Feb. 28-Mar. 3: Satellite '95, Washington, DC. Contact (301) 424-3338.

May 7-10: The National Show, Dallas. Contact (202) 775-3669.

June 14-17: Society of Cable Television Engineers Cable-Tec Expo, Las Vegas, NV. Contact (610) 393-6888.

Aug. 13-15: Great Lakes Cable Expo, Indianapolis. Contact (317) 845-8100.

January

4-6: Society of Cable Television Engineers Emerging Technologies conference, Stouffer Orlando Resort, Orlando, FL. Contact SCTE national headquarters, (610) 363-6888.

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

10: SCTE Central Indiana Chapter meeting, BCT/E and Installer exams to be administered, Connersville, IN. Contact Gordie McMillen, (317) 353-2225.

11-13: The Light Brigade fiber-optics training course, working with single-mode fiber, Kent, WA. Contact (206) 251-1240.

14: SCTE Cascade Range Chapter meeting, BCT/E exams to be administered, Portland, OR. Contact Cynthia Stokes, (503) 230-2099.

18: SCTE Dakota Territories Chapter seminar, annual elections to be held, Aberdeen, SD. Contact Michael Schmit, (605) 229-1775.

18: SCTE Piedmont Chapter seminar, safety training and fleet management, BCT/E and Installer exams to be administered, Greensboro, NC. Contact Mark Eagle (919) 477-3599.

18: SCTE South Florida Chapter seminar, data networking and architecture, Holiday Inn, Ft. Lauderdale, FL. Contact Jim Jones, (407) 478-5866.

19: SCTE Central Indiana Chapter seminar, baseband video and the new FCC tests, Holiday Inn North at Pyramids, Indianapolis. Contact Gordie McMillen (317) 353-2225.

19: SCTE Michiana Chapter meeting, BCT/E exams to be administered, LaPorte, IN. Contact Russ Stickney, (219) 259-8015.

19: SCTE Mount Rainier Chapter seminar, St. Andrew's Church, Seattle. Contact Art Hedstrom, (206) 745-8400, ext. 4112.

23-26: ComNet '95 conference and exhibition, Convention Center, Washington, DC. Contact (508) 879-6700.

27: SCTE Wheat State Chapter meeting, BCT/E exams to be administered, Great Bend, KS. Contact Jim Fronk, (316) 792-2574.

26: SCTE New Jersey Chapter seminar, digital video in CATV, Wayne, NJ. Contact Linda Lotti, (908) 446-3612.

Pros of dispersion-shifted fiber

This month our fiber expert answers questions on the benefits of dispersion-shifted fiber and how it differs from standard single-mode fiber. He'll also cover the splicing performance of dispersion-shifted fiber.

By Don C. Vassel
Senior Applications Engineer, Corning Inc.

☛ How does dispersion-shifted fiber fit into the cable TV market?

With the advent of new laser transmission technologies and erbium-doped fiber amplifiers (EDFAs), which use the 1,550 nanometer (nm) window, dispersion-shifted fiber is gaining acceptance in the cable TV industry. For applications such as the interconnection of headends, delivery of programming to remote node sites, high-speed communications networks, plus regional and metropolitan rings, dispersion-shifted fiber can improve reliability, increase system capacity and lower system costs.

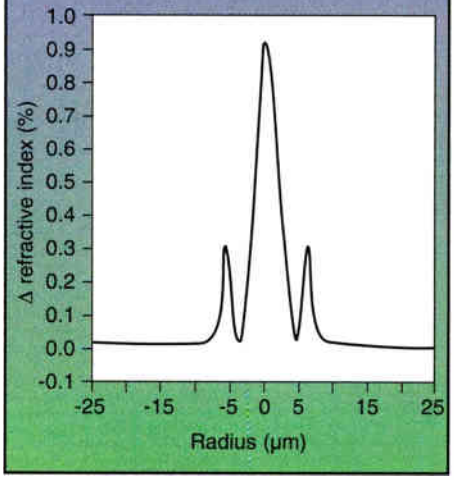
☛ What are the differences between standard single-mode fiber and dispersion-shifted fiber?

Dispersion-shifted fiber is designed to minimize dispersion in the 1,550 nm window as well as take advantage of the inherently low attenuation rate that silica-based fibers exhibit at higher wavelengths.

The ability to shift the zero-dispersion wavelength to the 1,550 nm window is achieved by designing the fiber with a segmented core profile. The accompanying figure represents Corning's single-mode dispersion-shifted fiber core profile.

In addition to its core design, dispersion-shifted fiber differs in two distinctive ways from standard single-mode fiber. The obvious first difference is in the shift of the zero dispersion wavelength from 1,310 nm to 1,550 nm. Because dispersion-shifted fiber can minimize dispersion in the 1,550 nm window, cable systems will be capable of higher bit rates and longer distances. The second difference is a decrease in the mode-field diameter (MFD) — the light carrying region of the fiber. The smaller mode field diameter improves the fiber resistance to induced attenuation from potential macrobending or microbending influences during cabling, installation and handling.

Refractive index profile (Corning DS fiber)



☛ What is the splicing performance of dispersion-shifted fiber?

As cable TV operators assess the benefits of dispersion-shifted fiber, particularly in new-builds, there are questions concerning that fiber type's compatibility with the existing fiber plant, in particular its handling and splicing performance characteristics.

To determine how efficiently dispersion-shifted fiber could be spliced using standard splicing equipment, Corning conducted a study. The first part of the splice study consisted of more than 250 separate dispersion-shifted to dispersion-shifted fiber splices using a commercially available profile alignment splicer.

Splice-loss measurements then were made using bidirectional averaging of two unidirectional optical time domain reflectometer (OTDR) readings. The resulting mean splice loss for the entire splice population was 0.04 dB at 1,550 nm. The mean splice loss measurement still was below the industry's typical maximum splice loss requirement of 0.05 dB per splice.

Dispersion-shifted fiber meets the handling and splice performance requirements of the industry. For more information on the dispersion-shifted fiber, contact your fiber manufacturer or optical cabler. **CT**

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MEMBER SCTE

Our engineering subcommittees need you!

By Bill Riker
President, Society of Cable Television Engineers

The SCTE has been involved in the development of standards for CATV technical hardware since 1990. To date, the Society has finalized standards addressing several interfaces, including the female F-connector and mainline connector-to-housing specifications. These standards were greatly needed in our industry, and have proven to be important to its continuing development.

However, if these efforts are to truly succeed, we need the involvement of cable operators nationwide. I do not need to tell you how important an impact the interoperability of broadband equipment has upon your system in terms of its quality and ease of operation. Your involvement in the development of these vitally important standards will help shape the way in which the products of the future will work together.

SCTE presently sponsors five engineering subcommittees that hold meetings on an average of four times per year. While participation in these groups does not require attendance at each subcommittee meeting, these should be convenient for many industry engineers to attend, since they are scheduled in conjunction with industry trade shows such as SCTE's Cable-Tec Expo and the Western Show.

Interface Practices Subcommittee

The first engineering subcommittee to be formed was the Interface Practices Subcommittee, which develops recommended procedures for the proper use of hardware, tools and test equipment by the cable TV industry. Its first accomplishment, an SCTE standard specification for the common female F-port, has been accepted by the U.S. cable industry and is currently being considered by CENELEC as a standard for broadband communications connectors throughout Europe. Recently merged with the In-Home Cabling Subcommittee, this subcommittee also promotes the development of residential wiring standards that specify acceptable hardware to be used within subscribers' homes by electrical contractors and home builders.

EBS Subcommittee

Following the extensive viewership of CNN (and cable TV in general) during the Gulf War and hurricanes here at home, the U.S. government decided that cable TV should play a major role in the country's Emergency Broadcast System. The FCC then called for the cable industry to become involved in upcoming rulemakings regarding a new system for emergency broadcasts. As a result, the EBS Subcommittee was created and has already filed comments with the commission on behalf of the Society. The focus of its effort has been to provide the FCC with a clear understanding of cable's capabilities and limitations, as well as the cost implications for cable from participating in the new system. This subcommittee is working to provide the FCC with all relevant information necessary for its consideration in creating a feasible, cost-effective system that will not be a burden to cable operators.

Maintenance Practices and Procedures Subcommittee

Over the past several years, we have become aware of a need for standardized guidelines for good engineering practices. The Maintenance Practices and Procedures Subcommittee was developed two years ago to provide recommended practices for the proper maintenance and operation of CATV systems. There are six working groups focusing on: headend issues, utility company interface, outages, damages, preventive measures (including signal leakage issues) and customer service.

Design and Construction Subcommittee

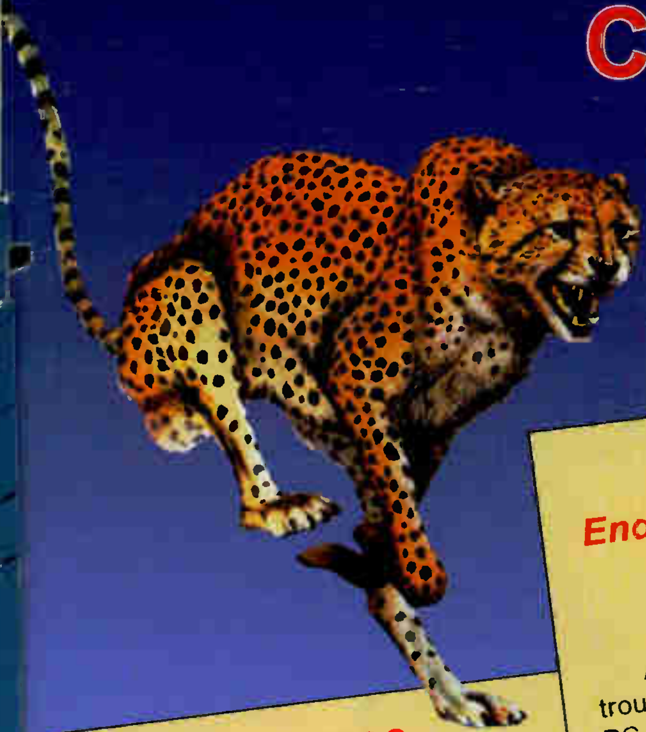
The Design and Construction Subcommittee develops standards for basic construction, fiber construction and design (including computer-aided drafting and engineering, makeready and mapping) of CATV systems, upgrades and rebuilds. Three of its working groups have made considerable progress recently. The Basic Construction group is focused on traditional cable TV outside plant construction. The Fiber Construction group is developing a manual covering all areas of fiber construction (overlash, new-build and underground) as they are instrumental to basic construction. The third group, working on design, is compiling traditional cable TV design specifications. Other areas receiving attention are design symbology and CAD layering standardization.

Material Management/ Inventory Subcommittee

Our newest subcommittee, the Material Management/Inventory Subcommittee, is focused on operational efficiency through the implementation of automated material management and inventory control systems. Just as all major retailers have utilized bar code scanning terminals connected to computerized real-time inventory management systems, industrial organizations are also implementing these systems. The nonconsumer members of the Electronics Industries Association (EIA) and the telecommunications industry, through an industry forum, have each prepared a specification that stipulates product and package marking bar codes for their industries. SCTE has undertaken this task for the cable TV industry. Once material is marked with a machine-readable part number, computer systems compatible with electronic data interchange (EDI) standards will allow the placement of purchase orders, exchange of shipping documents and the rendering of invoices through computer systems.

The development of technical standards and practices is opening the door to convergence with other telecommunications industries. It is vital to have leadership from all facets of the cable TV industry as we build the foundation for our future. Since the work of these subcommittees will change our industry — and therefore your future — you have a personal interest to become involved with them and help them shape the future of our business. If you are interested in being part of these exciting developments and would like more information regarding upcoming meetings, please contact Marv Nelson at SCTE national headquarters at (610) 363-6888. **CT**

Cheetah Introduces a New Family of 1 GHz Products



PC-1000
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Features Non-Interfering Distortion Measurements

A true end-of-line spectrum analyzer for trouble shooting and system diagnostics. The PC-1000 performs every RF test required by the FCC including non-interfering distortion measurements. And in the Cheetah™ tradition of automated systems, measurements at every test point are performed simultaneously.

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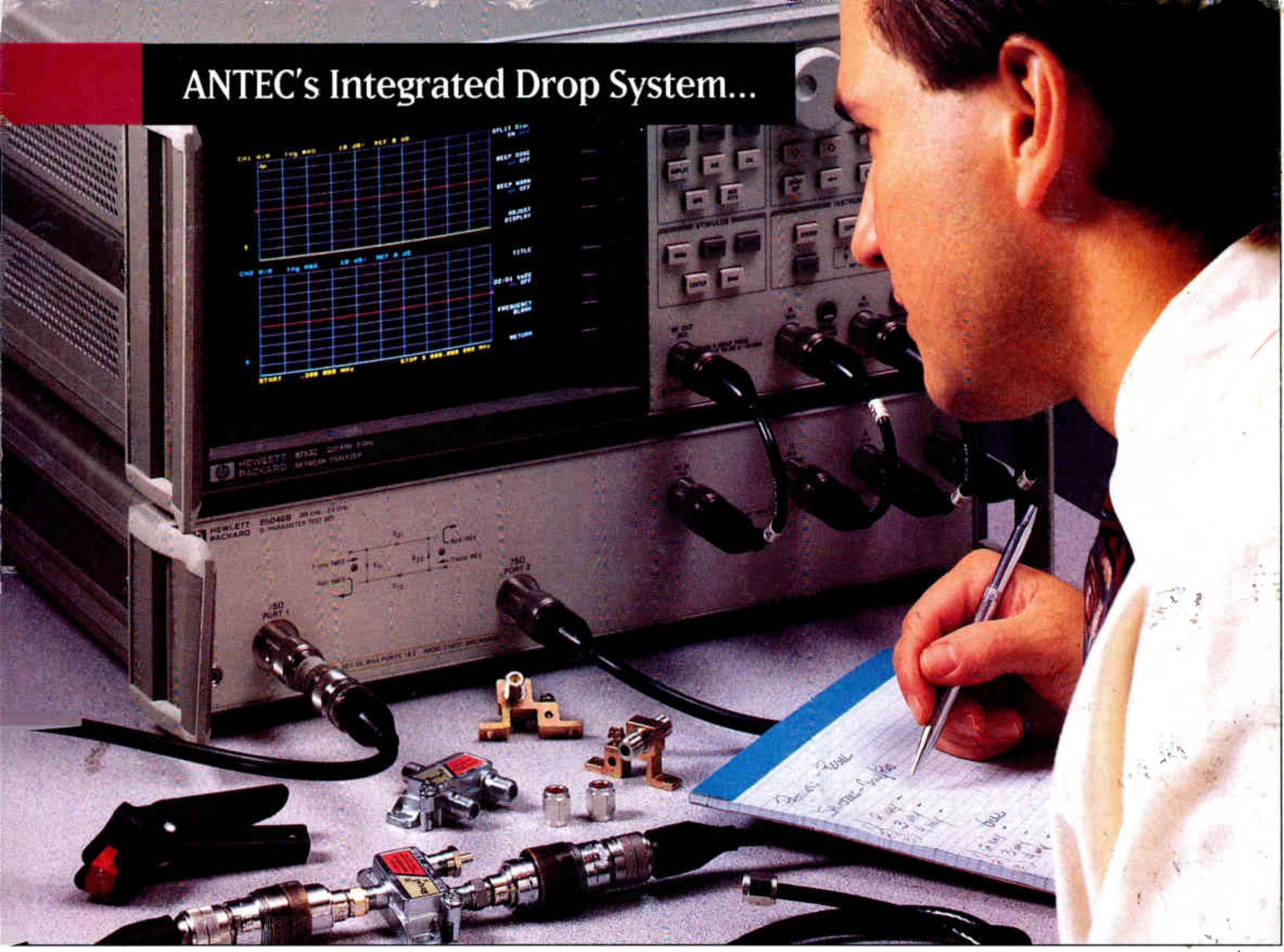

The System That's Certain...For a Future That Isn't.

Digital is a reality. Chances are, you're passing these signals through your network today, in the form of digital services. If you're like most broadband providers, you've already discovered the digital limitations of your drop – and so have some of your subscribers.

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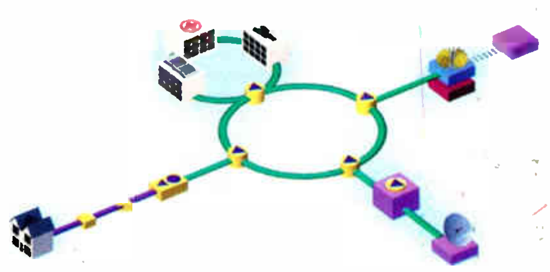
Ensure your pipeline to the home can deliver today's and tomorrow's services – call your local ANTEC consultant to learn more about the benefits of IDS.



Our Cable Integrated Services Network (CISN) provides a "blueprint" for building a broadband network that accommodates interactive services in a 1 GHz spectrum. IDS provides the solution to the final, critical link of the broadband network, the subscriber drop.

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