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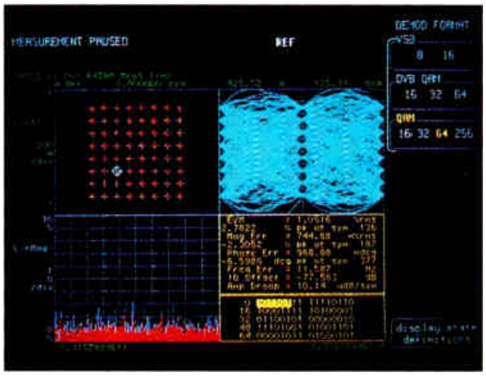

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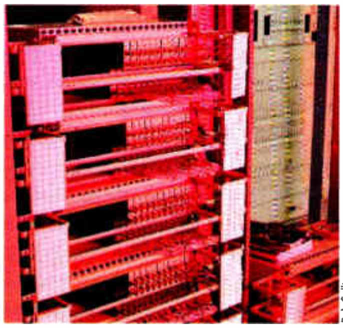

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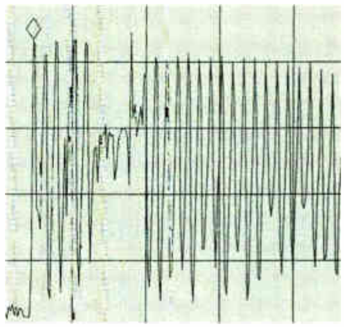

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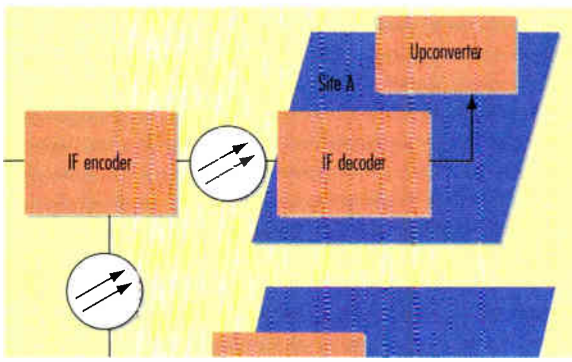

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FEATURES

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Two-way checklist

So you want to be in the (insert name of favorite new technology here — for example, telephony, interactive TV or data communications) business! This is going to require that your system be a fully functional two-way network. Unfortunately, you've heard that two-way brings a new level of complexity to system operation. I can guarantee there will be problems when you fire up the reverse, but the following checklist should help make the bumps a bit more manageable. Be sure to do all of this *before* you try to provide the new service(s) to subscribers. The first two on the list will be the hardest:

√ Stop thinking like a CATV operator.
√ Start thinking like a telecommunications provider.

Architecture:
√ Relatively small nodes fed via fiber (1,500 homes max, but smaller is better).

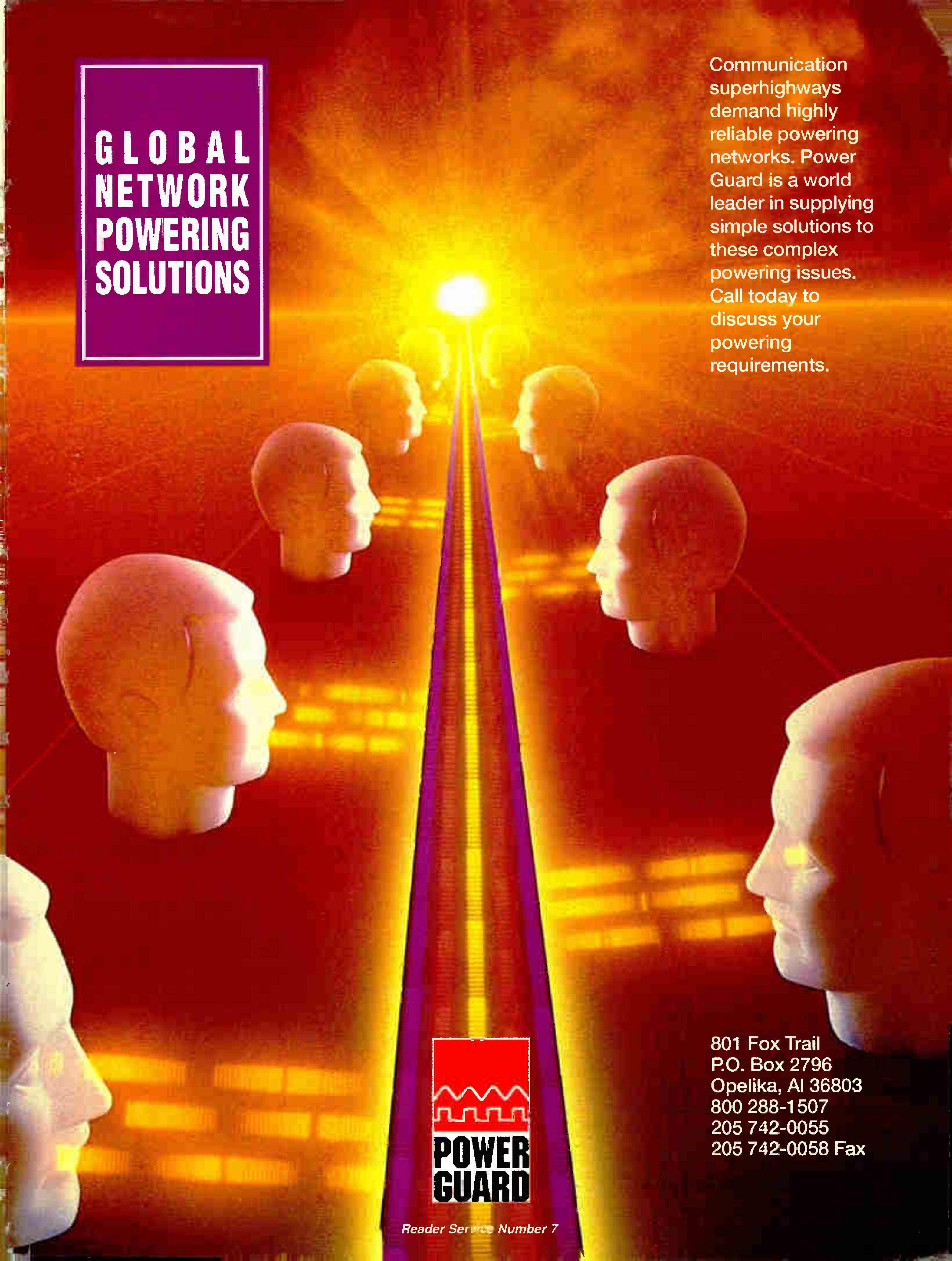
Downstream coax plant, electrical (and if you can't get this right, forget about two-way)
√ Correct amplifier setup (proper pads and equalizers, ALC/ASC operation, etc.).
√ Correct input and output operating levels.
√ Sweep and align all amplifiers for optimum flatness (even if amplifier cascades are only two or three deep).
√ No signal leakage greater than 10 μV/m at 3 meters. (The goal should be no measurable leakage from the distribution plant.)

Upstream coax plant, electrical
√ Correct amplifier setup (proper pads, equalizers, ALC operation, etc., as required).
√ Correct input and output operating levels.
√ Sweep and align reverse amplifiers for optimum flatness.
√ Fix distribution plant and headend related ingress problems. (Headends can have loose connectors, too.)

Coax plant, physical
√ Proper grounding and bonding.
√ Tight hardware.
√ No broken lashing wire.
√ No kinked/cracked cables.
√ Pin connectors only.
√ Good weatherproofing.
√ All passive and active device lids/closures properly torqued.
√ Unused 5/8-24 ports have port plugs installed and correctly tightened.

Subscriber drops
√ Use only messengered cable on aerial drops. (No exception, regardless of drop length.)
√ Use corrosion inhibitor type cable for all aerial drops and flooded cable for all underground drops.
√ Tri-shield or greater shielding on all drops
√ Good quality connectors, hardware and drop passives. (Forget the bargain stuff; you're in the telecommunications business, remember?)
√ Good installation practices.
√ Fix drop-related leakage and ingress problems.
√ Proper common-point grounding/bonding to minimize ground loops.
√ Keep some (OK, a lot) high pass filters handy.

Ronald J. Hranac
Senior Technical Editor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users want to be able to see similar performance growth in their networks. This is coupled with the expansion of networking from the business enterprise to the residential neighborhood. This "Law of Expanding Networks" equates to "More's Law Part II" (not to be confused with "Moore's Law of Shrinking Silicon"). More's Law Part II is "more data (graphics, voice, video) at more speed (needed to deliver to the desktop) to more locations (business, residence and remote locations)."

Perhaps even more pervasive is the increasing use of networking. As companies have acknowledged productivity gains from installing ATM networks, network nodes become more ubiquitous and location becomes irrelevant within the company. This is particularly attractive in telecommuting (work-at-home) environments, where some companies are growing their networks at 100% per year. Another example of network growth is the experience of the National Science Foundation Network. In 1988 NSFNET carried 200 million packets per month. In just five years, NSFNET saw growth to in excess of 32 billion packets per month. And the number of packets is increasing at a rate of about 10% per month!

Killer applications

In the past, analysts have asked what the "killer application" was that would drive a new technology, referring to a specific application such as word processing or spreadsheets. In the case of ATM, there are no killer applications of this type.

"The real value of ATM," explains John McQuillan, an expert in ATM networking, "is that new business strategies demand a new kind of network—one that enables new ways of working, collaborating and computing."

ATM will enable fundamental rethinking and radical redesign of the way in which networks are implemented and used. ATM's killer application is not any particular software, but its capability to support business re-engineering.

There also are some applications and requirements that are driving ATM. In the early phases

"ATM's killer application is not any particular software, but its capability to support business re-engineering."

of ATM adoption (1994-1995) these applications included the following:

- Movement to client/server architectures and flatter LANs
- Backbone replacement
- LAN simplification
- High-speed file transfer
- Disaster recovery
- 3-D visualization.

Applications driving ATM today are expected to include the following:

- High-resolution color document and image transfer
- Computer-aided drafting/mapping (CAD/CAM)
- Full-motion video
- High-speed interactive multimedia integrating data, voice and video
- Wide area collaborative computing

Aside from ATM's exponential increase in network power, ATM's architecture benefits include these applications:

- Backbone bandwidth is scalable so that users can grow networks as demand requires while protecting their investment.
- ATM's flatter topology than today's hierarchical LANs offers better management and lower latency. ATM has the ability to establish virtual LANs that emulate standard LAN operation. →

TCI, Cablevision to reimburse subs

TCI Communications Inc., a subsidiary of Tele-Communications Inc., and Cablevision, agreed to reimburse nearly $10 million to their customers, resolving more than 2,000 cable rate regulation complaints filed with the Federal Communications Commission against the two companies.

TCI will issue refunds in the amount of $1.90, including interest, per customer to 4.6 million customers in all franchise areas where a complaint was filed in connection with rates charged during the time period of Sept. 1, 1993, to Sept. 15, 1995. This will total about $8.7 million, which is anticipated to be issued as one-time bill credits during the first quarter of 1996. This proposed resolution will resolve all valid cable programming service rate complaints against TCI cable TV systems, according to both parties.

In a separate action, the FCC also accepted for comment a proposal whereby Cablevision will provide its customers with $625,000 in refunds. This would resolve 167 pending rate complaints against the company. The FCC's Cable Services Bureau, however, found no refund liability in 60% of those. According to the commission, subscribers in Columbia, SC, will get a significant portion of the refunds.

• • •

NOTE

• **Pioneer New Media Technologies** signed a contract with **Time Warner Cable** to supply 85,000 advanced-capability home terminals over a two-year period. Time Warner will install Pioneer's BA-6310CA addressable home terminal units in Houston-area homes to provide enhanced viewing and recording capabilities that simplify VCR programming and pay-per-view ordering procedures.

Rex Porter joins *CT* as editor

Phillips Business Information announced the addition of Rex Porter, former vice president of Times Fiber Communications and Senior Member of the Society of Cable Telecommunications Engineers, as editor of *Communications Technology*.

Porter's 30-year career in the cable industry, in positions from chief engineer, MSO general manager to vice president of sales and marketing, brings an even stronger technical engineering and communications focus to the magazine. Porter's technical expertise stems from 16 years of systems engineering and 14 years of manufacturing and vendor experience.

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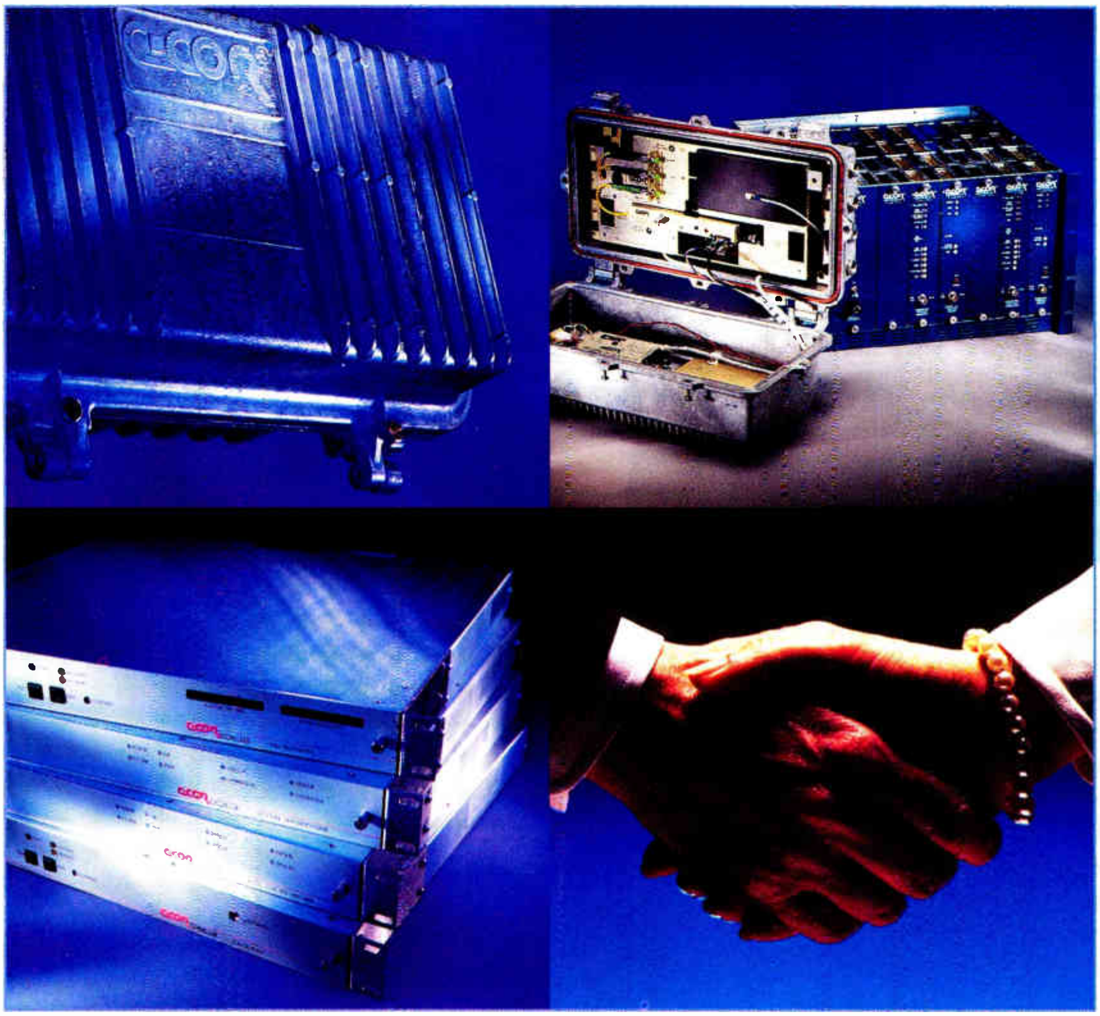

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ANSI proclaims SCTE standards body

The American National Standards Institute announced its recognition of the Society of Cable Telecommunications Engineers as a standards developing organization (SDO) for the broadband telecommunications industry. ANSI works with a variety of industries to determine that their proposed standards have been given due process and proper evaluation.

SCTE President Bill Riker comments, "The Society can now submit standards developed by our engineering subcommittees to ANSI for its approval. Essentially, ANSI will certify that our industry has had proper input in the development of SCTE-submitted technical standards. Upon their approval by ANSI, our standards will have increased credibility and visibility in the industry, assuring their adoption and utilization by broadband telecommunications companies nationwide.

"Working with ANSI will benefit our industry in other ways," Riker adds. "If a company manufactures equipment that conforms to ANSI-approved SCTE standards, they can promote the fact that it 'meets ANSI standard #...,' giving their product additional credibility."

SCTE plans to submit 16 standards developed by its Interface Practices Subcommittee to the institute for approval. These include drop cable and connector specifications, and a variety of test procedures. In this process, the SCTE will work to submit the proper forms and clarify any related issues to ensure prompt approval of standards.

Riker concludes, "This is a significant step for the Society, which notes standards development in its mission statement, 'Training, Certification, Standards.' We are confident that the standards developed by our engineering subcommittees will be properly recognized and used."

Program announced for Emerging Tech '96

The SCTE announced the program for the 1996 Conference on Emerging Technologies, to be held Jan. 8 -10 at the San Francisco Hilton and Towers. Optional preconference tutorials will be presented on Jan. 8 to give attendees additional background information on the technologies to be discussed during the conference.

- **Preconference tutorials:** *Digital Cryptography* — Dr. Harvey Gates, BDM Corp.; *Consumer Interface Issues* — Vito Brugliera, Zenith, and Walt Ciciora, Ph.D., consultant for NCTA; *Standards Activities: A Review of DAVIC Specifications* — Daljeet Singh, Harmonic Lightwaves Inc.; *IEEE 802.14* — Curtis Siller, AT&T Bell Labs; *SCTE Engineering Subcommittees* — Jim Haag, Time Warner Cable
- **Session A: Network Availability** — Moderator Nick Hamilton-Piercy, Rogers Engineering; *HFC Network*

Availability: The Real World — Jim Farmer, Antec, and Tony Werner, TCI; *Evolution of HFC Networks to a High-Reliability, Full-Service Network* — Raja Natarajan and Paul Vilmur, Motorola; *Integrating Residential Telephony into the HFC Network* — Andy Paff, Antec Corp.; *Analysis of the Capital, Operating Cost and Reliability Effects of Choices in Network Powering* — Dave Large, Media Connections Group; *Alternate Power Sources for Telecommunications Applications* — Peter LeBlanc, SatCon Technology; *Monitoring and Controlling HFC Network Devices* — Brett Price, Superior Electronics Group.

• **Session B: Cable Telecommunications Networks and Services Implementation** — Moderator Jack Terry, Nortel; *Cable Telecommunications Services Business Perspectives* — John Harrison, Sprint Telecommunications Venture, and Ken Wright, Intermedia Partners; *Modeling New Service Payback* — Carl Podlesny, Scientific-Atlanta; *Home Education and Telecommuting Services Implementation* — Don Sawyer, Bell Northern Research; *Customer Premises Equipment, Beyond Set-Tops* — Shawn Hayes, Digital Video; *Two-way Cable Plant Telephony and Data Experience* — Tony Werner, TCI, Jim Farmer, Antec, Paul Gemme, Time Warner, Charles Cerino, Comcast, and Mark Millett, Cox Cable; *Cable Telecommunication Digital Transmission Techniques* — Jack Terry, Nortel, and Edward Ganger, Charles Anderson and Lawrence Wang, ESP, and Kenneth Williams, Cox Cable; *ATM in MPEG-2 Transport, or Vice Versa?* — Itzhak Gurantz, Comstream Corp., Mike Maslaney, Digital Video, and Adrian Jones, Nortel.

• **Session C: Data Transmission** — Moderator Mark Laubach, Com 21; *Considerations for Deploying Packet-Switched Data Services on Broadband Hybrid Fiber/Coax Networks: An Overview of Frame Relay and SMDS* — Gaylord Hart, XEL Communications Inc.; *Broadband Data: More Than a Cable Modem* — Ilja Bedner and Daniel Pitt, Hewlett-Packard; *HFC Return System: Management of Subscriber-Induced Noise* — Bob Chamberlin, Brian Johanson and Aravanan Gurusami, Philips Broadband; *Broadband Interactive Networks for Full Digital Services* — William Beck, David Brown and Dean Stoneback, General Instrument; *Field Evaluation of Reverse Band Channel Impairments* — Majid Chelehemal, Richard Prodan and Tom Williams, CableLabs; *The Design and Operation of the Reverse Path* — Henry Kallina, Broadband Engineering Solutions and Technology.

• **Session D: Digital Television Transmission** — Moderator Brian James, CableLabs; *An End-to-End Digital Services Delivery System for EPA and VOD* — Thomas duBreuil and Cecil Dean, AT&T Bell Laboratories, and Wilt Hildenbrand, Cablevision Systems; *End-to-End Integration and Delivery of MPEG-2 Digital Video in a HFC Environment* — Keith Bechard and Jim Wood, US West Technologies; *Overcoming Problems in the CATV Return Path* — John Barsellotti and Brian Langlais, West End Systems; *Performance of Multichannel AM/256-QAM Video Transmission Systems for Hybrid Fiber/Coax* — Hongxing Dai, Chinlon Lin and Shlomo Ovadia, Bellcore; *Employing the OFDM Technique in Hybrid Multichannel Analog/Digital Transmission over the HFC Network* — Qun Shi, Panasonic Technologies; *Using Frequency Domain Digital Techniques for De-Ghosting and Demodulating VSB Transmission* — Majid Chelehemal and Tom Williams, CableLabs.

By Lawrence W. Lockwood

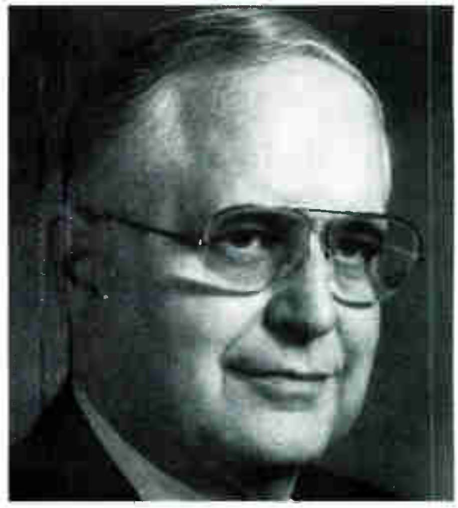
VSB and QAM

What kind of modulation for digital video on CATV? There has been some controversy over two proposed modulations — VSB (vestigial sideband modulation) and QAM (quadrature amplitude modulation). VSB has been accepted for high definition TV (HDTV) by the Grand Alliance and thus many expect the Federal Communications Commission to specify VSB for HDTV transmission. QAM has been endorsed for digital video transmission by both the International Telecommunications Union (ITU) and the Digital Audio-Visual Council (DAVIC). Neither is a new technology. VSB has been around since at least the 1960s when the 9.6 kbps AT&T 203 telephone modem incorporated a VSB form of modulation. However, the current telephone data modems use QAM.

RF transmission of digital data

In RF transmission, information can be carried by changing the properties such as amplitude, frequency and phase of the transmitted signal in some defined way. Examples are shown in Figure 1.

The baseband bit stream to be modulated is the PCM code (pulse-code modulation) in the nonreturn to zero (NRZ) format. One choice of modulation is that of amplitude-shift keying (ASK) in which the amplitude of a CW carrier is switched between two values of the PCM code — in the case illustrated the CW carrier is on or off also known as OOK. Figure 2 shows amplitude modulation where the carrier is not cut off when the PCM is at zero value. Another choice is to shift the frequency of the CW carrier and this is called frequency-shift keying (FSK). A third possibility is that of shifting the phase of the CW carrier in response to the amplitude of the PCM code. The two points



"In each corresponding group of VSB and QAM, performance characteristics are essentially identical."

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

Figure 1: Idealized ASK, FSK and PSK waveforms

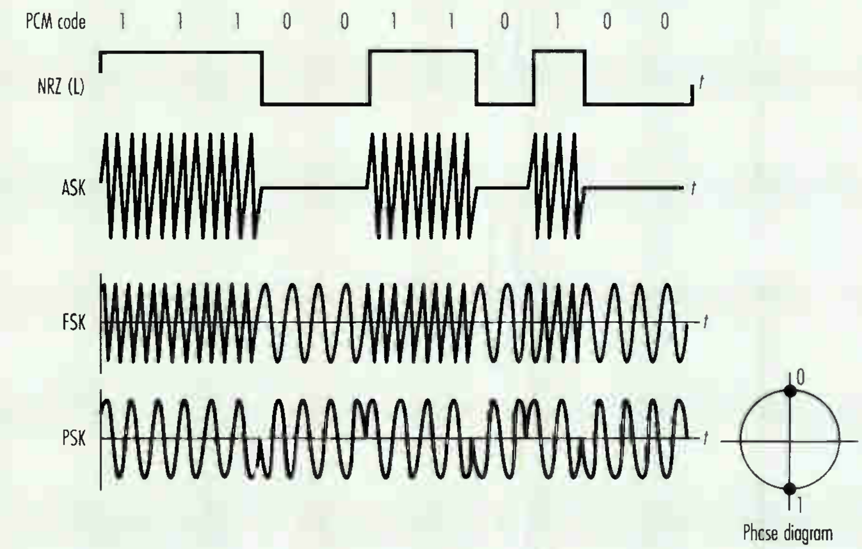


Figure 2: Digital binary amplitude modulation

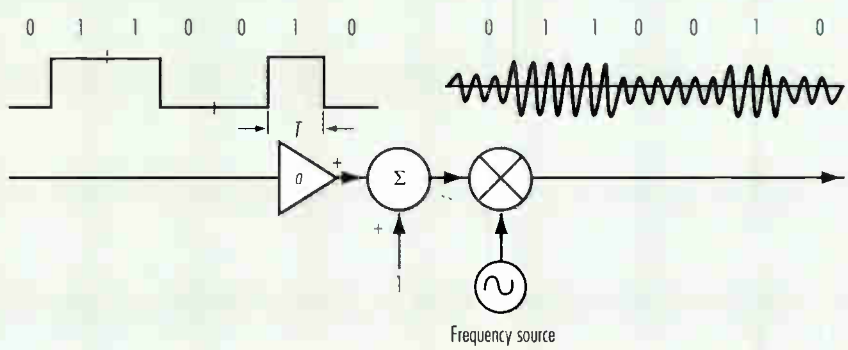


Figure 3: Four-level coding

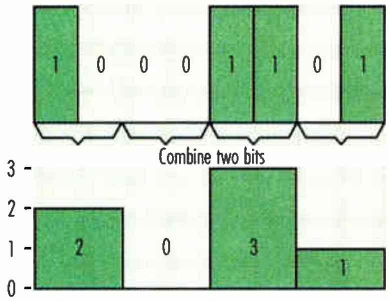
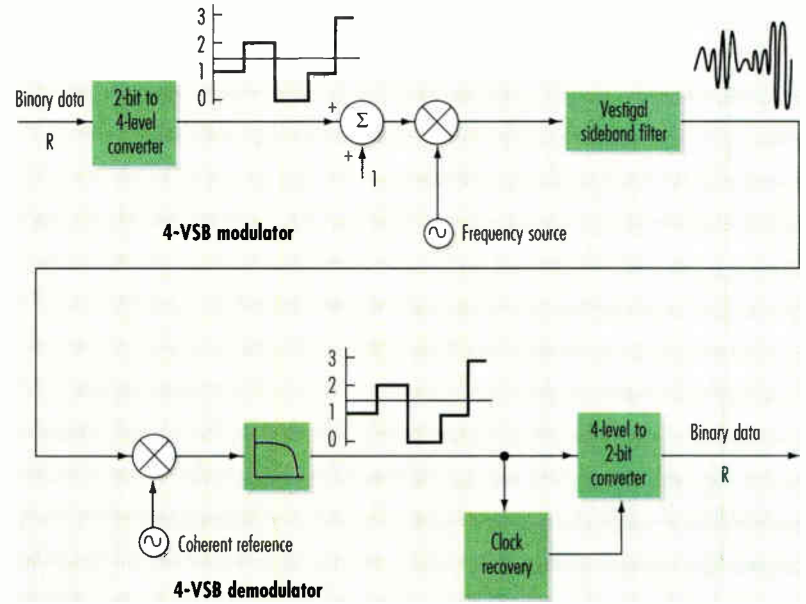


Figure 4: 4-VSB modulator and demodulator



in the phase diagram of the binary PSK signal are called the signal constellation.

Multilevel signaling

MPEG compression of digital video reduces the digital data rate generated of the imagery. Uncompressed, the data rate of HDTV is about 1.2 Gbps. MPEG compresses this to about 20 Mbps. However that is still too high to fit in a 6 MHz channel. Multilevel signaling can be used as a means of compressing the bandwidth required for transmission. In a simple binary scheme, two single symbols, usually two voltage levels, are used to represent a 1 and a 0. The symbol rate is therefore equal to the bit rate. The principle of multilevel signaling is to use a larger alphabet of m symbols to represent data, so that each symbol can represent more than one bit of data. As a result, the number of symbols that needs to be transmitted is less that the bit rate and hence the bandwidth is compressed. The alphabet of symbols may be constructed from a number of different voltage levels. Figure 3 shows an example of a four-level scheme.

In this figure, two data bits are mapped to one of four voltage levels each equal to the digital value of the binary bits (00 = 0, 01 = 1, 10 = 2, 11 = 3). Only one symbol need be transmitted for each pair of data bits, so the symbol rate is half the bit rate.

VSB modulation

VSB is amplitude modulation of the data in the 6 MHz channel. An explanation of the system's bit capacity is as follows. The theoretical Nyquist rate for a 6 MHz channel is 12 megasymbols/second. This is an unobtainable maximum; 10.7 megasymbols/second is possible in practice. If each symbol represented two bits then the transmitted data rate would be 10.7 x 2 = 21.4 Mbps. A simplified block diagram of a 4-VSB modulator and demodulator is shown in Figure 4. Expressed in bits/Hz, 4-VSB carries 21.4/6 = 3.57 bits/Hz.

16-VSB has been field tested (see my column "Washington demo of an improved DSC-HDTV," April 1993) and its transmission capacity is 43 Mbps in a 6 MHz channel — *two* HDTVs in 6 MHz! To transmit 43 Mbps each symbol must carry 43/10.6 = 4 bits. To carry 4 bits each symbol must have 16 different levels ($2^4 = 16$). Expressed in bits/Hz, 16-VSB in a 6 MHz channels carries 43/6 = 7.17 bits/Hz. Using the customary maximum channel capacity, 16-VSB has 8 bits/Hz and 4-VSB has 4 bits/Hz.

QAM modulation

QAM is a modulation having both PSK and amplitude modulation. QAM modulation is having multilevel amplitude modulation applied independently on each of two quadrature carriers. See Figure 5 (page 20). The bit stream to be modulated is split into two parallel bit streams that are then converted into a four-level amplitude signal. One of the signals is mixed with a carrier from a local oscillator (LO) while the other is mixed with the same LO after having undergone a 90° phase shift. The two signals are then added. The result is a 16-QAM signal. Figure 6 (page 20) shows the constellation diagram for 16-QAM.

64-QAM is the format commonly recommended by QAM proponents for CATV. In a 30 Mbps 64-QAM system, the input data bits are grouped into 6 bit symbols ($2^6 = 64$) that are applied to the QAM modulator at a symbol rate of 30/6 = 5 Mbaud.

Error rates

Probability of error as a function of baseband digital signal-to-noise

Comparison of VSB and QAM modulation

Modulation method	4-VSB	16-QAM	8-VSB	64-QAM	16-VSB	256-QAM
Total data rate (Mbps)	21.5	21.5	32.5	32.5	43	43
Number of data levels	4	4	8	8	16	16
Information density (bits/Hz)	4	4	6	6	8	8
S/N (dB) for error rate 10^{-6} (without error correction)	20.5	20.5	26.6	26.6	33	33
S/N (dB) for error rate 10^{-6} (with error correction Reed Solomon 207,187, t = 10)	16.3	16.3	22.3	22.3	28.3	28.3

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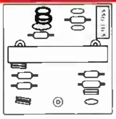

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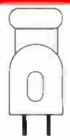

SXP-T-Top Pads for Scientific Atlanta & Augat

SXP-T (Blue) 600 MHz, $1.75
0 to 20 dB in 1 dB steps.

SXP-TY (Yellow) 860 MHz
0 to 13 dB in 1 dB steps, $2.14

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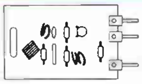
QSYL

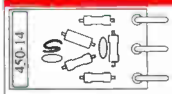


Pathmaker EQ's $10.00
300, 330, 400 & 450 MHz
Nominal Values are:
4, 7, 10, 13, 16, 19, 22 and 25 dB

QSYL - P

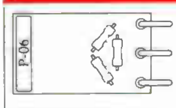
Pathmaker Pad $4.50
0, 1, 2, 3, 4, 5, 6 dB
9, 12 and 15 dB

QTEX



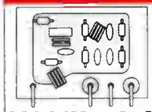
TEXSCAN "T-SERIES" EQUALIZERS
$10.00
Bandwidths are 330, 400, 450 & 475 MHz
330-400 MHz values: 4, 8, 12, 15, 18 dB
450 MHz - 4, 6, 8, 10, 12, 14, 16, 18, 20 dB
475 MHz - 4, 6, 8, 10, 12, 15 dB

QTEX-P



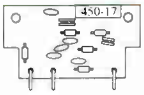
TEXSCAN "T-SERIES" PADS - $5.00
0, 1, 2, 3, 4, 5, 6 dB
9, 12 and 15 dB

QMAG



QMAG - 62E Series
Replacement EQ's for Philips
(330, 400, 450 and 550 MHz)
$10.00
330 MHz - 2, 5, 8, 11, 14, 17, 20, 23 dB
400 MHz - 2, 5, 8, 11, 14, 17, 20, 23, 26 dB
450 MHz - 2, 5, 8, 11, 14, 17, 20, 23, 26 dB
550 MHz - 2, 5, 8, 11, 14, 17, 20, 23, 26, 29 dB

QMAGRE Response EQ - $21.00
600 MHz response EQ with 4 or 7 dB slope.
Useful in 6-series tapped trunk and feeders.

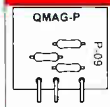


QMAG - 5EE Series
Fixed EQ's for Magnavox
(330, 400 and 450 MHz)
$10.00
5, 8, 11, 14, 17, 20 dB values - All frequencies
Return Loss ≥ -16 dB, Insertion Loss ≈ 1 dB

QMAGV

QMAGV - 5CE Series
Variable EQ's for Magnavox
(330 and 450 MHz) **$14.00**
5, 8, 11, 14, 17, 20, 23 dB Values
Return Loss ≥ -16 dB, Insertion Loss ≈ 1 dB

QMAG-P



4-A Pad (0, 3, 6, 9, 12 dB) **$4.50**
6-A Pad (0-20 dB, 1 dB steps) **$1.75**
7-A & 9A Pad (0-20 dB) **$2.90**

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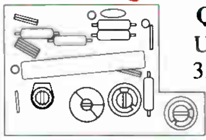
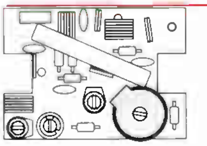
NEW EQs for Jerrold X, N & JN



QXFE-554 FIXED EQ
Use QXFE-554 for XFE
3, 6, 9, 12, 15, 18, 21 dB

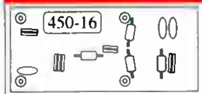
Fixed EQ's - **$18.00**



Use QXE-454 for XE
TL, L, M, H, ST EQ's
Variable EQ's - **$19.50**!
Both of these models include a handle.

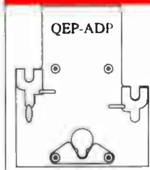
Other frequencies are available on request. The QXE board can also substitute for the older JE-series. Minimum order quantities may apply to non-stocked models.

QLX



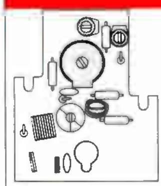
Equalizer for Jerrold JLX
(Replaces EQ & SEA)
ALL in 2 dB increments.
ONLY 1 dB insertion loss for all models!
(330, 350, 400, 450, 500 and 550 MHz)
330-450 - 0-30 dB 500 MHz - 2-22 dB
550 MHz - 0-24 dB **$6.75 each**
600 MHz $7.50 750 MHz $11.00
600 & 750 MHz in 2 dB steps, 0-24 dB

QEP-ADP



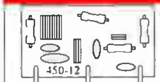
Fixed value equalizer adapter allows QLX to replace SEP-*.
NO alignment! Lower Cost!
Lower Insertion Losses!
EASY installation.
QEP-ADP **$7.00**
Plus QLX - **$6.75** Total is only $13.75

QEP

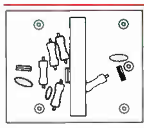


Variable trunk equalizer same as Jerrold SEP. Available in 1 & 2-way versions ... 4's, 5's
TL - 5 thru 11 dB
L - 10 thru 16 dB
H - 16 thru 22 dB
ST - 20 thru 25 db
(300 through 450 MHz Bandwidths)
$15.00 all values

QEE & New QXEE



Line Extender Equalizers
(Replaces SEE by Jerrold)
270, 300, 330 & 400 MHz
All values $5.00 each!
450 MHz - **$6.75** 550 MHz - **$7.00**
QEE values: 6, 12, 18 & 24 dB



QXEE replaces Jerrold XEE
550 MHz - $8.25
Used in XQLE Line Extender
Values: 3, 6, 9, 12, 15, 18 dB
Also available in 630 MHz

Jerrold pads, 0 to 20 dB in 1 dB Steps

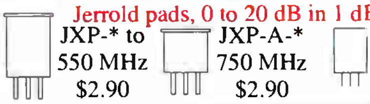


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Figure 5: 16-QAM modulator and demodulator

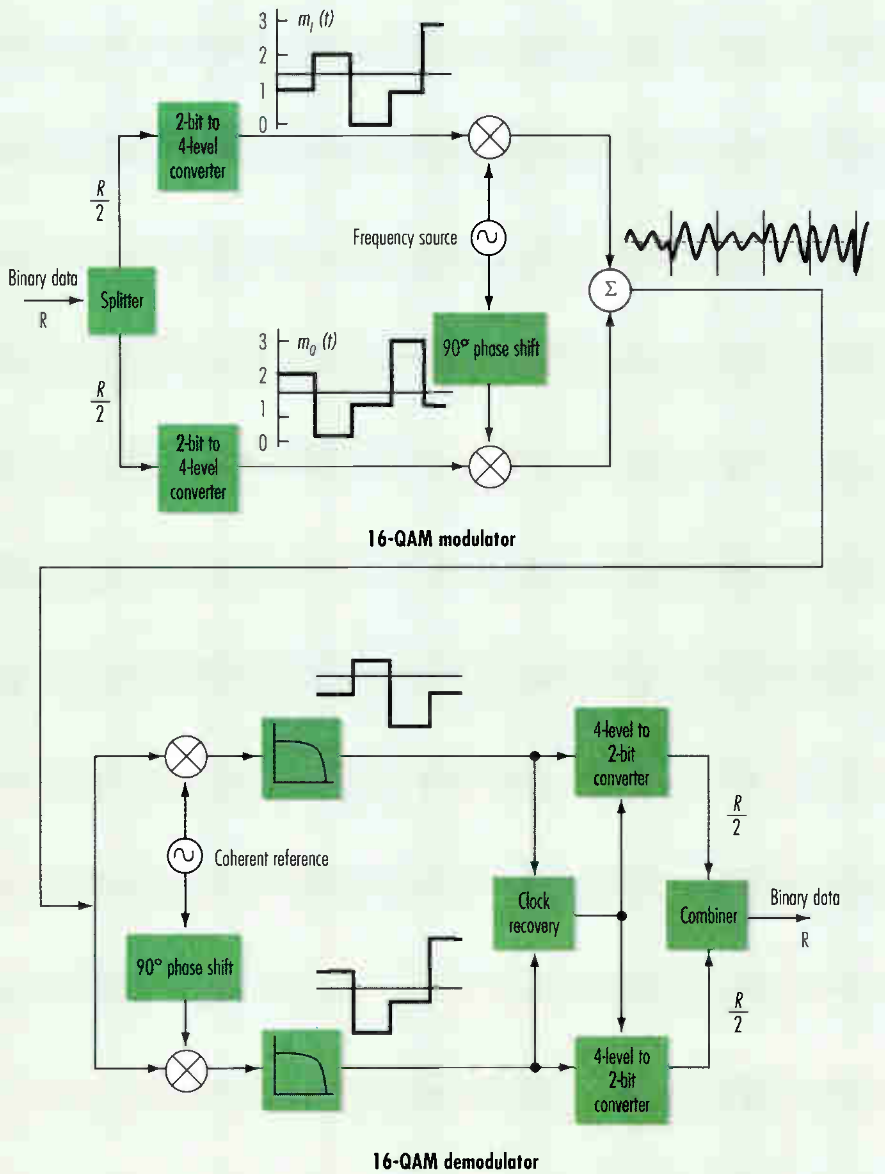
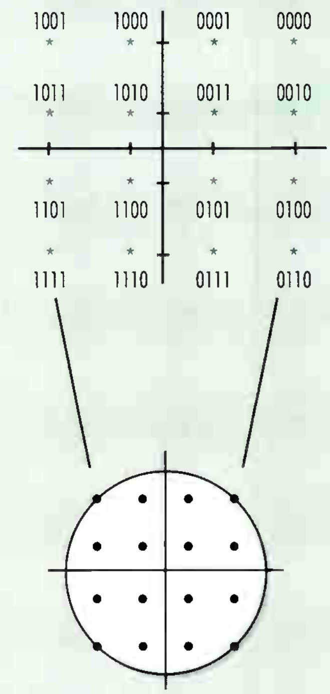


Figure 6: Constellation diagram for 16-QAM



ratio is shown in Figure 7 (page 23). Two curves are presented for each modulation type — the steep one is for an error-protected case and the curve that rolls off more gradually is for an unprotected case. When the probability of error equals 10^{-6} or lower, visible artifacts occur so rarely that they go unnoticed, which is why that value was chosen in the accompanying table (page 18) giving comparisons of VSB and QAM modulation.

Digital TV analyzer

Hewlett-Packard has just introduced a new analyzer that is the first commercial unit to characterize advanced digital TV signals and to characterize digital RF modulation. The HP 89400 demodulates most of the proposed signal formats. The analyzer downconverts and digitizes input signals to 2.6 GHz. It can be key stroke-configured for 16-QAM, 32-QAM, 64-QAM and 256-QAM formats. Also handled are 8-VSB and 16-VSB as well as support for QPSK, BPSK, FSK and MSK. Besides offering demodulation information, traditional displays show eye and constellation diagrams characterizing them quantitatively. A photo of the HP 89440A display is shown in Figure 8 (page 23). Close examination shows a display of a 64-QAM constellation diagram. Configured HP 89440 vector signal analyzers are priced from $59,200.

Conclusions

Theoretical analysis and extensive laboratory testing confirm that in each corresponding group of VSB and QAM, performance characteristics are essentially identical. Some critics of QAM complain that there are too many different "flavors" or versions of QAM. Most of the differences are different error coding techniques (e.g., Reed Solomon, Trellis, interleaving, etc.).

Since the FCC decision on specifying the modulation standard for HDTV is likely to come soon, the only sensible avenue to take regarding a prediction is refuge in an old predictors dodge — "never make a prediction on a decision that will be made so soon that people will remember the prediction." **CT**

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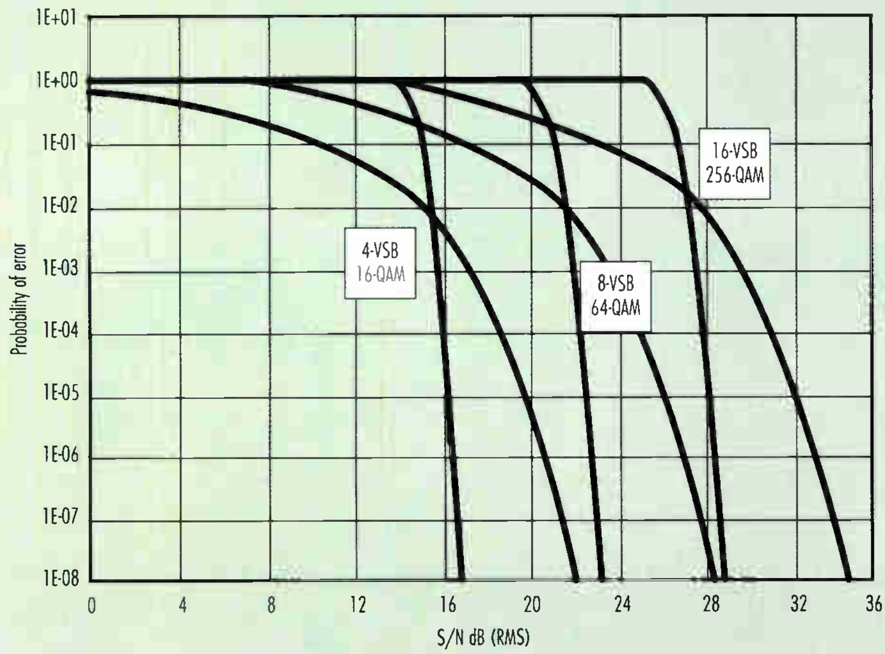
3) *Digital Telephony,* J. Bellamy, John Wiley & Sons, 1982.

4) *Introduction to Communication Systems,* F. Stremeler, Addison Wesley, 1982.

5) *Telecommunication Transmission Systems,* R. Winch, McGraw-

Figure 7: Error probabilities of VSB and QAM systems

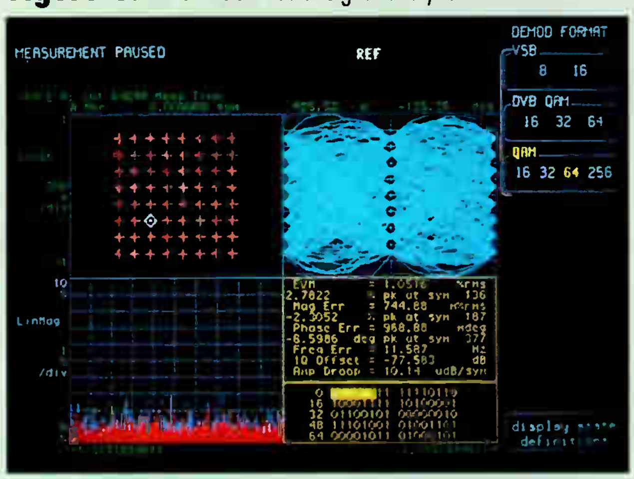


Hill, 1993.

6) "Practical Implementation of a 43 Mb/sec (8 bit/Hz) Digital Modem for Cable Television," R. Citta, R. Lee, *1993 NCTA Technical Papers.*

7) "Performance Results of a 64/256-QAM CATV Receiver Chip Set," H. Samueli et al, IEEE 802.6 meeting, May 1994.

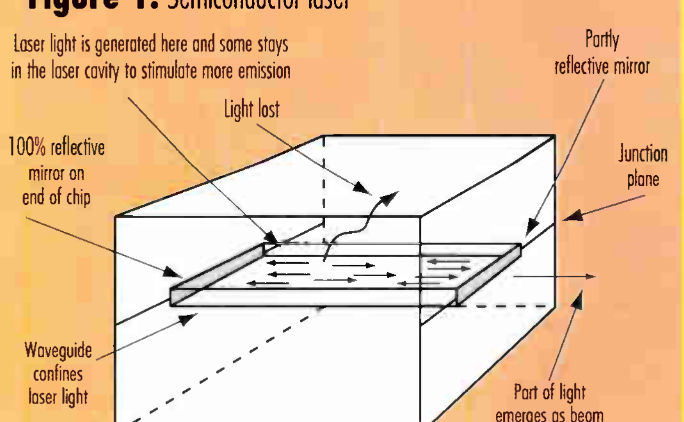
Figure 8: HP 89400A vector signal analyzer



Correction

In October's "Correspondent's Report" on page 20 the arrows in Figure 1 were incomplete. The figure should have run as shown on the right.

Figure 1: Semiconductor laser



By David Bross

Cable, satellites and DBS — The (tenuous) ties that bind

The following is the first installment of a new department that will deal with convergence issues in the cable, telecommunications and other communications industries. This particular column considers cable from a satellite perspective.

The relationship between the cable TV industry and the domestic commercial communications satellite industry often has been characterized not only by pitched, often nasty, competitive battles but also by periods of relative calm and cooperation.

From the satellite industry's perspective, the cable TV industry was an abusive, vertically integrated monopoly that exercised its market power from 1984-1992 in order to crush any hopes of launching competitive, national direct broadcast satellite (DBS) systems.

During that same period, cable programmers were some of the best customers for the United States' bevy of satellite fleet operators — Hughes Communications, GE American Communications and AT&T Skynet Satellite Services — spending hundreds of millions of dollars on long-term transponder lease agreements.

Even so, if you listen closely, you still

can hear a segment of the satellite industry, "the true DBS believers," rejoicing (sometimes not so quietly) over the spectacular early success of Thomson

David Bross is the managing editor of "Satellite News," a Phillips Business Information newsletter. He can be reached at (301) 340-7788, ext. 2580, or via e-mail at dbross@phillips.com.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Consumer Electronics' Digital Satellite System (DSS) hardware effort and the DirecTv/USSB programming ventures.

Indeed, during satellite industry confabs, it is almost impossible to last a day and not hear the words, "We told you so," spoken again and again. The public posture of DBS proponents long has been that DBS will complement and not compete with cable's installed 62 million customer base. Devotees say the service primarily will serve rural customers and will act as a gap-filler throughout the rest of the country. But those words belie the reality of the marketplace. Due to the stunning, first-year sales (more than 800,000 units moved in only a year) the DBS companies have changed their strategy and decided to compete with cable head-on.

But even the most bullish industry projections claim that the DBS industry, at its apex, will have only 18.5 million customers nationally — a scant 30% of what cable already has today. But the salient question remains: Can any entrenched media business (cable) afford to lose up to 30% of its installed base? Or even half that amount?

The satellite industry is banking billions that the answer is an unqualified, "No." Indeed, at least three of the seven Baby Bells also believe that the time is right to swoop in and take customers away from cable as well, only this time embracing the wireless/satellite option instead of ill-conceived partnerships and joint ventures based solely on the hybrid fiber/coax (HFC) solution.

In early October, the previously unthinkable happened on Capitol Hill when the full Senate, on a 98-0 vote, approved the first-ever auctions for DBS spectrum — or for any satellite spectrum — setting the stage for a full-court lobbying campaign (by both satellite and cable interests) at the Federal Communications Commission to try to avoid auctions for the 27 channels at the coveted 110°W orbital slot. The approval was in the form of an amendment calling for the FCC to auction off the 27 frequencies at 110°W. However, it grants the commission some wiggle room. If the FCC can determine a way to raise more money for the slots, thereby avoiding auctions, it may do so.

The news also was a setback for cable-owned Primestar, the medium-powered direct-to-home (DTH) service that is under the gun to migrate to high power in less than a year. Its current satellite, Satcom K1, is due to "go dark" in less than a year.

But the DBS action by the full Senate is both a defeat and a victory for the beleaguered Primestar, which had spent many weeks and millions of dollars lobbying the Senate and the five FCC commissioners to avoid costly auctions, claiming bidding for spectrum would place Primestar at an unfair disadvantage in the marketplace. Regardless of the outcome, the regulatory developments in Washington, DC, have been a bitter pill for Primestar to swallow.

Primestar: Best of the worst-case

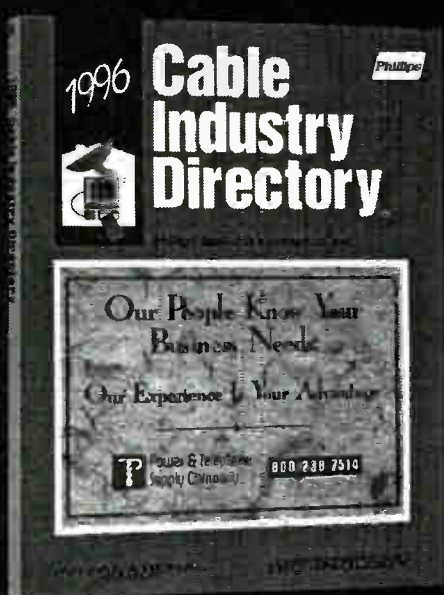
While it is virtually certain Primestar will have to pay between $45 million and $100 million for its high-powered spectrum, Primestar is lobbying the commission to adopt a plan whereby Primestar ultimately could receive the 27 channels at 110°W without an auction at that orbital spot for those channels. Here's the proposal: The FCC, in an effort to uphold the April International Bureau decision, would reclaim a total of 46 DBS channels allocated to TCI-controlled Tempo Satellite Corp. (TCI's DBS arm), and Advanced Communications Corp.'s old frequencies.

The commission then would issue a notice of proposed rule making to auction the 11 Tempo frequencies at the 119°W slot as well as the 24 Advanced-controlled channels at 148°W and Tempo's 11 channels at its far western slot at 166°W. The auction would be held as soon as possible.

Primestar is advocating the International Bureau then take the average price paid for the 46 channels at auction and multiply that price by the 27 channels available at 110°W slot to determine the "market value" of those channels — thereby avoiding auctions for those frequencies.

FCC sources said there already is a proposal circulating at the International Bureau and on the 8th floor of the FCC that would take the average per-channel value for the 11 full-CONUS channels at 119°W and apply that amount to the 27 full-CONUS channels at 110°W to get an accurate valuation. Regardless of how the spectrum is disposed, Primestar's break-even point and profit benchmark will need to be pushed back.

Also waiting in the wings to bid for any DBS spectrum is MCI Communications (with its partner Rupert Murdoch's News Corp. Ltd.), Pacific Telesis Group, Bell Atlantic Corp. and DirecTv (backed by GM Hughes Electronics). **CT**



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• ATM supports centralized control that increases network intelligence and simplifies network maintenance, resulting in lower costs and less down time.

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• High-resolution color document and image transfer
• CAD/CAM
• Full-motion video
• High-speed interactive multimedia including voice and video, and collaboration over the WAN.

ATM forum

As the primary advocacy group for ATM technologies, the ATM Forum is made up of over 700 companies ranging from component manufacturers to carriers. This diverse group has a common goal: global interoperability of ATM products. High-speed LAN product vendors have experienced many delays in the growth of the FDDI market. These delays were attributable to the fact that FDDI developers followed an old model of network development similar to that used when Ethernet was developed a decade ago. Today's users will not tolerate similar delays in ATM development.

The ATM Forum's charter is simple: "To accelerate the use of ATM products and services through the rapid convergence of interoperability specifications, promotion of industry cooperation and other activities."

As a consequence, the ATM Forum is acting as the de facto standards body for ATM LANs to speed standards development. Unlike traditional standards-making bodies, the ATM Forum's bylaws are designed to avoid bottlenecks delaying application of ATM technology. Specifically, rather than emerging at a consensus that considers every company's position, standards recommendations are passed by a two-thirds vote. This voting procedure makes it impossible for a handful of companies to hold up the standard as they wage various political and marketing wars.

Additionally, the ATM Forum recognizes that standards development must occur in parallel with early product introductions, interoperability testing and user feedback at the same time as early products are introduced, interoperability is supported, and user feedback is sought.

Conclusion

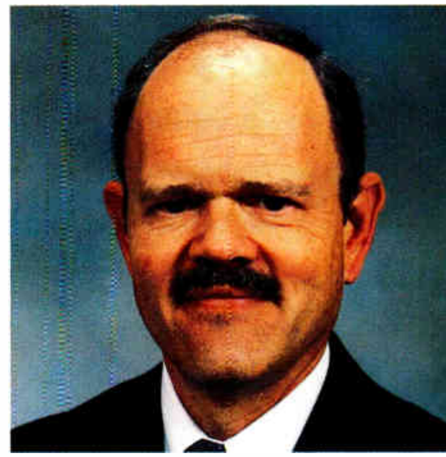
In order to cost-effectively add on incremental revenue streams, today's network infrastructure choices cannot be based upon shortsighted needs. Technology and products must be selected that can handle today's bandwidth requirements and tomorrow's seamless migration to new applications like telephony and video. **CT**

By Justin J. Junkus

What is TCOM Talk?

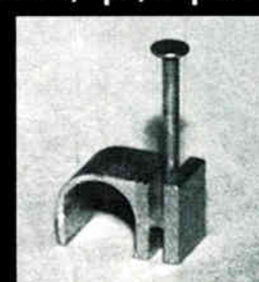
It's no secret that technology in the world of cable TV is changing. The word television in cable's working vocabulary is being replaced by another tele — telecommunications. No longer is it just CATV, but television, telephones and computers. What this means is that there is a whole new environment to learn about just to keep up with your industry and your job. This column is being created as your guide to new acronyms, new technology, new tools, new customers and new services.

Learning new technology can be intimidating and time-consuming — or challenging and fun — depending on how it's approached. It sometimes helps to look at new material in layers, like peeling an onion. Start by scratching the surface to get a general view of a subject, delve deeper into areas that are immediate needs for your job and really knuckle down when your job demands an expert view that can only be found by going to the core of your material.



This column is based on that approach. Each month it will introduce a new topic, usually at the overview

Justin J. Junkus has over 25 years experience in the telecommunications industry. He serves on the Telecommunications Advisory Board of DeVry Institute and is a member of adjunct faculty at DePaul University and DeVry for the telecommunications curriculum. His papers on telecommunications have been published in issues of the "National Engineering Consortium Annual Review of Communications" and the Cable-Tec Expo proceedings of the Society of Telecommunications Engineers. He is currently the AT&T Cable Television Market Manager for the 5ESS switch. Reach him by e-mail: JJunkus@aol.com.



level. Hopefully, you'll learn the key concepts and the "buzzwords" to make you conversant enough to go to the next level of learning, when you need it — and receive enough depth to understand your colleagues, vendors and customers who need to communicate with you in these new areas. What you see here won't replace traditional training, but it will begin your education and help you identify further training needs.

As I stated earlier, this is a technology column. Its main purpose is to educate and keep its readers current in technological areas related to telecommunications in the cable TV industry. But technology does not, and cannot, stand by itself. A good example is the announcement by AT&T in September that it will restructure itself into three separate companies — one that manufactures and distributes telecommunications products, one that provides telecommunications services and one that is a computer company. While you may be a technologist in the cable industry, you still need to understand that a business announcement like this from a major telco player will affect you as an engineer in cable. You will, at minimum, be called upon to analyze the technology interfaces between each new business and your own, and explain to others in your company how they have changed from your present method of operation.

What we'll cover

With this in mind, most of the time we'll be covering technology, but sometimes we'll be looking at issues behind the technology to understand why certain solutions may have advantages over others. Your education in the technology of the "other tele" begins with the following grocery list of topics we'll be exploring in detail in future columns.

• *Types of information moving through a network.* Cable TV traditionally transports analog video programming from a headend to subscribers. Under the new paradigm of telecommunications, not only analog video, but digital video, voice and data will move across your networks. What are the characteristics of this new information, how does it differ from traditional cable TV signals, and how will it change future cable TV networks?

• *Telecommunications switch types, choices to be made and consequences.* Telecommunications switching systems come in many flavors. There's electromechanical (for history!), electronic, analog, digital, central office-based and customer premises systems. Which type of systems will your company need for new business operations and with what systems will they interact? Why do your customers prefer service offered on a particular platform? What are important technological and business considerations in choosing a switching platform for your company? Once chosen, what is involved in maintenance?

• *Signaling between network elements.* You have a switch and you need to connect to a network. What types of signaling and associated equipment will you be installing and maintaining? What is a loop trunk, MF signaling, Feature Group B and Feature Group D? When are they used?

• *Traffic theory.* How do you choose the quantities of equipment you need, both in the switch and for the peripherals attached to end users and the public switched network (PSN)? How does probability theory fit into telecommunications? What are Poisson tables, erlangs and CCS?

• *Multiplexing and its role in a telecommunications network.* Frequency division multiplexing is the dominant form used today in cable TV. Telecommunications technology is based on time division multiplexing. What are the characteristics of T-1, T-3, the North American Digital Hierarchy and SONET? How will your networks adapt to accommodate these schemes in wide use today in the telecommunications industry?

• *Intelligent networks.* Distributed processing and data bases are critical to delivering new capabilities that will help your company compete for telecommunications customers. Where are these data bases, what do they contain and who owns them? What role do they have in industry issues such as number portability?

• *Wireless communications.* Cable competes with the traditional telephone company wireline offerings. Wireless, on the other hand, is a completely new business that appears to be synergistic with cable company operations. What types of wireless communications could be delivered by a cable TV company and what are the potential interfaces with cable company plant?

• *The information superhighway.* Where is cable delivering the promise of high-speed data access and what is the potential for the future? Where does cable TV meet the Internet?

• *Telecommunications reliability.* We'll start with this in the next column. Why is it important? What are the methods used in telecommunications networks to ensure reliable performance? How is reliability measured?

Certainly, these topics are not the entire spectrum of what you'll want discussed. I hope this column also will become a forum where you can tell me where you want more information. I invite you to join me monthly on this page and at my e-mail address, JJunkus@aol.com, to continue our journey into the new world of telecommunications! **CT**

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Electro-Optical Engineering

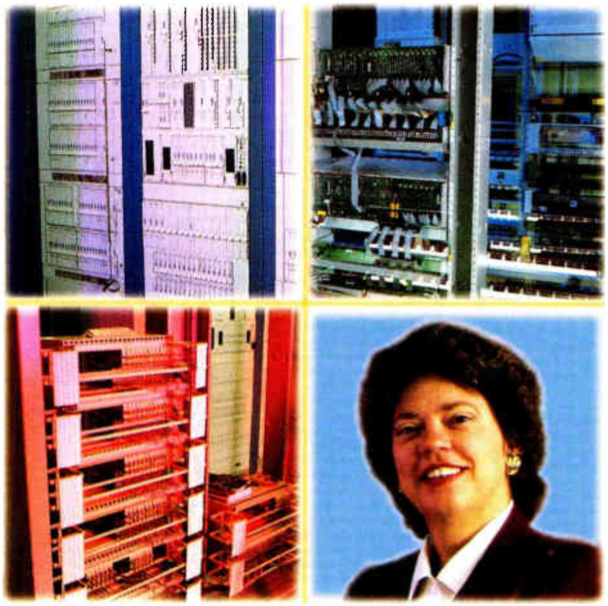
By Laura Hamilton

CONGRATULATIONS, PAM ARMENT

There's more to turning the plain old cable TV industry into "cable telecommunications" than just throwing all those strange telco and computer acronyms into our industry's alphabet soup. New systems, new equipment and new marketplaces are demanding a new type of engineer. However, no matter how much the technology changes, it seems you still earn the respect and recognition of your peers the old-fashioned way — experience, proven engineering expertise and the ability to share your knowledge.

It's for embodying these standards of excellence that Pam Arment, director of broadband engineering for Tele-Communications Inc., was chosen as the first Woman in Technology Award recipient.

Created this year, the accolade is co-sponsored by the Society of Cable Telecommunications Engineers, Women in Cable & Telecommunications and Phillips Business Information's *Communications Technology*. On the selection committee were SCTE's Bill Riker, WICT's Margot Botelho, and *CT*'s Paul Levine.



Bob Sullivan

"We had quite a few very strong candidates when we were selecting the winner. But in the end we were unanimous in our choice," said Riker, SCTE president.

Riker, who said that this was perhaps the largest pool of nominees he has ever seen in his experience with similar industry awards, explained the factors the committee focused on in the picking the winner: Contributions to technical excellence in cable telecommunications — not only by displaying knowledge and professionalism, but expressing willingness to share that knowledge; membership and participation in industry organizations; proven commitment to furthering one's technical education; and commitment to the community at large in a way that enhances the public's perception of cable and women in technology.

Margot Botelho, national board member of WICT and market development manager of cable TV for Corning, said Arment is a role model for the industry and a mentor for other women in technical positions. She added, "Pam Arment has a very strong technical background and is on the technical cutting edge."

Arment brought an extensive telco background with her when she moved over to the cable side of cable telecommunications in February 1993. She has 15 years of experience at US West, spending time in the switch and transmission engineering department and also managing a group of engineers responsible for providing technical solutions to meet large customers' telecommunications requirements in the areas of voice, video and data.

In her first position with TCI, she acted as a cable/telecommunications "bridger" of sorts by developing interfaces and relationships with Teleport Communications Group, of which TCI is a part owner. TCG is the nation's largest competitive access provider, and you might remember the company being mentioned in the Sprint/TCI/Comcast/Cox venture back in October 1994. (The companies announced their intention to create a communications alternative by packaging local telephone, long distance and wireless communications with cable service into a single offering for consumers and businesses. TCG's contribution to the venture was to provide local access for long distance service.)

In her present position at TCI, Arment continued to offer "technical bridges" by providing support to the company's new telephony services organizations until internal resources were established. At that point her duties involved providing an interface between this new organization and the CATV operations side of the business.

Arment's technical expertise was a huge factor in choosing her for the Woman in Technology Award, but her outside activities were the clincher.

"You don't have to be a big name in the industry to win this award," said *CT*'s Paul Levine, "We were really looking at what the nominees gave back to their industry as well as their community."

Arment's "giving back" to the industry has included extensive participation in professional organizations. She's been a member of the Institute of Electrical and Electronic Engineers since 1978, a Society of Women Engineers member since 1980, and she joined the SCTE and WICT when she started with TCI. At WICT, she was a board member and newsletter chair in 1994 and 1995 for the Rocky Mountain Chapter.

Arment said, "With so few women in the engineering discipline, WICT gives me the opportunity to interface with other professional women that is invaluable."

Arment has made many personal commitments to assist and encourage women to enter technical fields. Her emphasis is in making school-age women aware of the opportunities in the sciences and particularly in the cable and telecommunications field. She has spoken at Career Day forums and panels, judged essay contests, presented awards and been involved in speaking engagements at the University of Colorado and the Colorado School of Mines.

Along with all her professional commitments and educational pursuits (she earned her masters of engineering in engineering management in 1991 at the University of Colorado, Boulder), Arment finds time for her husband and two young sons. She enjoys supporting her children's activities, which included assistant coaching in a local youth soccer association.

For everything she's contributed to the industry and her community, Arment will be honored at this year's Western Cable Show in Anaheim, CA, with the Woman in Technology Award. She'll receive a crystal trophy as well as a scholarship for use at Mind Extension Institute donated by Jones Intercable.

Join us during the Western Show on Wednesday, Nov. 29 at the end of the first technical session (1-2:15 p.m. in Room AR-1) in thanking Pam Arment for her commitment to cable telecommunications. **CT**

By Michael Adams

ATM and MPEG-2 — Part 1

This is the first in a two-part article describing asynchronous transfer mode (ATM) and MPEG-2 networking in cable TV systems. Observations are based on Time Warner Cable's Full Service Network in Orlando, FL.

The Time Warner Orlando FSN was constructed with available technology a little over a year ago. It is a sophisticated system, capable of satisfying Time Warner's stated goals: To understand the technical, operational, marketing and business issues surrounding interactive TV systems. Today, the FSN is serving over 1,000 paying subscribers and this number is expected to grow rapidly to 4,000 by the end of 1995.

As we move toward large-scale FSN deployment, we need to re-examine our options in every aspect of the system in light of technical developments and our experience in the implementation of the Orlando system. One important aspect is the digital transport mechanism from the headend to the set-top.

Orlando uses ATM all the way to the home. This is a logical decision in a purely interactive system because ATM is the switching technology used to interconnect media servers with the network. But with the advent of direct satellite broadcast systems (such as the DSS one), another technology, MPEG-2 transport, has been developed. (MPEG-2 transport is well-suited to the delivery of compressed TV channels in broadcast networks). Mechanisms for mapping switched, interactive channels into MPEG-2 transport have been developed and are now close to standardization. Thus MPEG-2 transport has emerged as the common transport mechanism that can be shared in an integrated broadcast and interactive network.

Of course, using ATM to the home is still an option that must be carefully considered. What follows is a study of the pros and cons of ATM to the home. This article will show that for television, ATM is not the best option. Also, it will show that this is not a short-sighted observation but a fundamental reality that comes from the understanding that FSNs must deliver a range of entertainment programming. These cover every mode of delivery from broadcast, through narrowcast to unicast. Broadcast TV programming will not become extinct, in my opinion, in five, 10 or even 50 years! (This may be likened to the growth in print publishing during the rise of the personal computer.)

An architecture for future FSNs that takes advantage of today's digital broadcast architecture and gracefully extends it to an interactive system will be shown. In this way we get "the best of both worlds" by combining ATM and MPEG-2 transport technologies. MPEG-2 transport provides a uniform, efficient distribution mechanism to the set-top while ATM provides the necessary switching and load balancing functions required by interactive services.

In December 1994, the first subs were connected to the Orlando FSN. It was (and is) the most advanced, interactive TV service in the world and unique in its use of ATM to deliver digital TV service all the way to the home. (ATM had mainly been used in communications networks to provide private local area network — LAN — or public wide area network — WAN — service.)

During the same period, DSS providers have been supplying broadcast digital TV services to subs without the use of ATM. In both FSN and DSS systems, the TV channel is digitally compressed using standards established by the Moving Pictures Experts Group.

What is the difference between these systems? Where is ATM cost-effective in digital TV systems? This article will attempt to answer these questions and show that the primary difference is that the FSN is an interactive system whereas DSS is a broadcast system.

What is MPEG compression?

The Moving Pictures Experts Group is the standards body that developed the MPEG compression standards. Initially, MPEG was concerned with how to compress video and audio so that it would take less space for storage and less bandwidth for delivery. In more recent times, the MPEG group also has addressed how to deliver the MPEG compressed streams (elementary streams in MPEG parlance) from A to B. This has put them head to head with the communications world (in particular ATM developers) who believe that is their job! However, the MPEG and ATM development communities have collaborated on the mapping of MPEG-2 transport packets into ATM connections. More on this later.

The important thing about MPEG in TW's view is that it can take 140 Mbps of broadcast NTSC video and squeeze it down to 3.5 Mbps and still maintain a very acceptable picture. How is this remarkable achievement possible?

Fortunately, there is a lot of redundancy in most video signals — areas with little detail — sky, walls, etc., can be coded with relatively few bits. MPEG uses a discrete cosine transform (DCT) to convert blocks of 8x8 pixels and then discards coefficients that are close to zero and quantitizes the remaining coefficients to a discrete set of values. Huffman coding, which uses short codes to send common values and longer codes to send uncommon values, further reduces the data rate. All this applies to a single frame, but when we look at the next frame there is often much that hasn't changed significantly. By encoding only the changes we can save more bits. Objects will have moved but changed relatively little from one frame to the next and a motion vector can be sent instead of re-encoding the entire block, saving yet more bandwidth.

If this all sounds horribly complicated — it is! Custom hardware is required to encode and decode the MPEG syntax in real-time. The algorithm is deliberately designed to put the majority of the work into the encoder and less into the decoder. Hence the decoder can now be implemented in a single chip (plus memory), while the encoder is a board with typically 8 or 16 special-purpose RISC processors.

What is ATM ?

ATM is actually a type of fast-packet

Michael Adams is a senior project engineer with Time Warner Cable responsible for ATM networking in the Time Warner Full Service Network. Previously, he was manager of ATM switch software development for Bell Northern Research in Canada.

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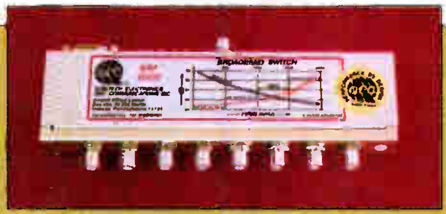

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service. ATM defines short packets, called cells, which are all the same length (53 bytes). Fixed-length cells make it possible to build high-capacity cell switches in hardware. The advantage is that very fast switches can be built at low cost. High-speed VLSI has made 10 Gbps switches on a single circuit-pack possible. Soon, a 10 Gbps switch will cost less than $100,000. That is a switching cost of only $10 per Mbps! Compare this with a telephone switch, which costs about $100 per 64 kbps line or about $1,500 per Mbps! (Of course one reason a telephone switch is more expensive is because it has a lot of narrowband interfaces where an ATM switch has a smaller number of broadband interfaces.)

Can we use ATM to carry MPEG?

Using ATM to transport MPEG compressed audio and video streams has been discussed for some time. ATM is an obvious candidate because it is capable of delivering the quality of service (QOS) required by MPEG and because ATM makes high-capacity switching networks practical and cost-effective.

A key advantage of ATM is that it can transport video, audio or data with equal ease and this makes it ideal for multimedia applications. This is achieved by adapting the higher layer protocols to the common, underlying ATM layer. The small size of ATM cells supports low packetization delay, which is an important MPEG requirement. In a well-engineered network, the possibility of a cell being lost or dropped can be reduced to a very low probability. This is another important MPEG requirement.

Another advantage of using ATM is "bandwidth-on-demand." By allocating a certain number of cells per second, a "virtual channel" of almost any bandwidth can be dynamically created when it is needed and then destroyed when it is no longer required. This supports flexible and efficient use of bandwidth in a well-designed network.

ATM doesn't provide for timing distribution, a key requirement for audio and video delivery. Timing distribution is normally considered a physical layer function. In ATM networks, all the physical links are run asynchronously. In other words there is no timing relationship between them. This can be a problem. For example, when a video playback in a set-top must be synchronized with a playback from a server. But the MPEG standard includes procedures to support synchronization by sending regular time-stamps from the server to the set-top.

Alternatives to ATM

Another candidate for the delivery of MPEG compressed material is MPEG-2 transport. This was specifically designed for this purpose. MPEG-2 transport was designed for broadcast systems and includes a number of mechanisms to multiplex video and audio into a single bit stream together with information to allow their synchronized playback.

MPEG-2 transport also is a fast-packet service. Fixed-length packets of 188 bytes are defined that carry compressed audio, video or other data. In many ways MPEG-2 transport is very similar to ATM. They both use fixed-length packets and can allocate sub-channels of any bandwidth. However, ATM was developed as a networking protocol and has hooks designed to allow it to work well over large, general topology networks. In contrast, MPEG-2 transport was designed to support transfer over a single link. ATM was designed for bidirectional operation in two-way communication networks whereas MPEG-2 transport was designed for unidirectional, broadcast networks. Finally, ATM switches are readily available from many vendors but no MPEG-2 transport switches are available to this author's knowledge.

DSS providers are using MPEG-2 transport or very similar schemes and have added information that allows the receiver to identify and select the desired program. These are known as system information (SI) tables.

Best of both worlds

MPEG-2 transport and ATM are not incompatible. In fact, MPEG-2 transport can be encapsulated into an ATM virtual channel (VC). This gives the best of both worlds. MPEG-2 transport provides timing and system information about the program structure while ATM provides the ability to switch the channel to the appropriate subscriber.

MPEG to ATM mapping

ATM is an effective switching and transmission technology. But to deliver MPEG-compressed material, certain QOS characteristics must be observed:

- *Cell loss rate* — MPEG is extremely susceptible to lost data. To deliver good quality MPEG video, the cell loss rate must be very low — about 1 in 10 billion. This can be achieved in carefully designed ATM networks.
- *Cell error rate* — MPEG is equally susceptible to errored data. Cells with payload errors must be discarded or flagged to the decoder. ATM includes a powerful CRC-32 check on AAL-5 SDUs, which supports this requirement.
- *Cell delay variation* — MPEG is susceptible to network-induced timing jitter. In particular, the set-top must be synchronized to the server's time reference. MPEG-2 transport contains program clock reference (PCR) time-stamps to provide this synchronization. PCR jitter must be kept to a minimum by correctly designing the ATM network and by avoiding excessive packetization delays when adapting the MPEG stream to ATM.

There are several approaches proposed to adapt MPEG-2 transport streams into an ATM VC. Two alternative ATM adaptation layers (AALs) have been proposed — AAL-1 and AAL-5. The ATM Forum has considered these and favors an AAL-5 mapping.

Why use ATM to carry MPEG?

Previously, we established it is technically feasible to use an ATM network to deliver MPEG compressed audio and video. But does it make sense to do so? After all, the MPEG data must be first mapped into ATM at the source and then unmapped at the destination. This seems like a lot of work when we could just use MPEG-2 transport.

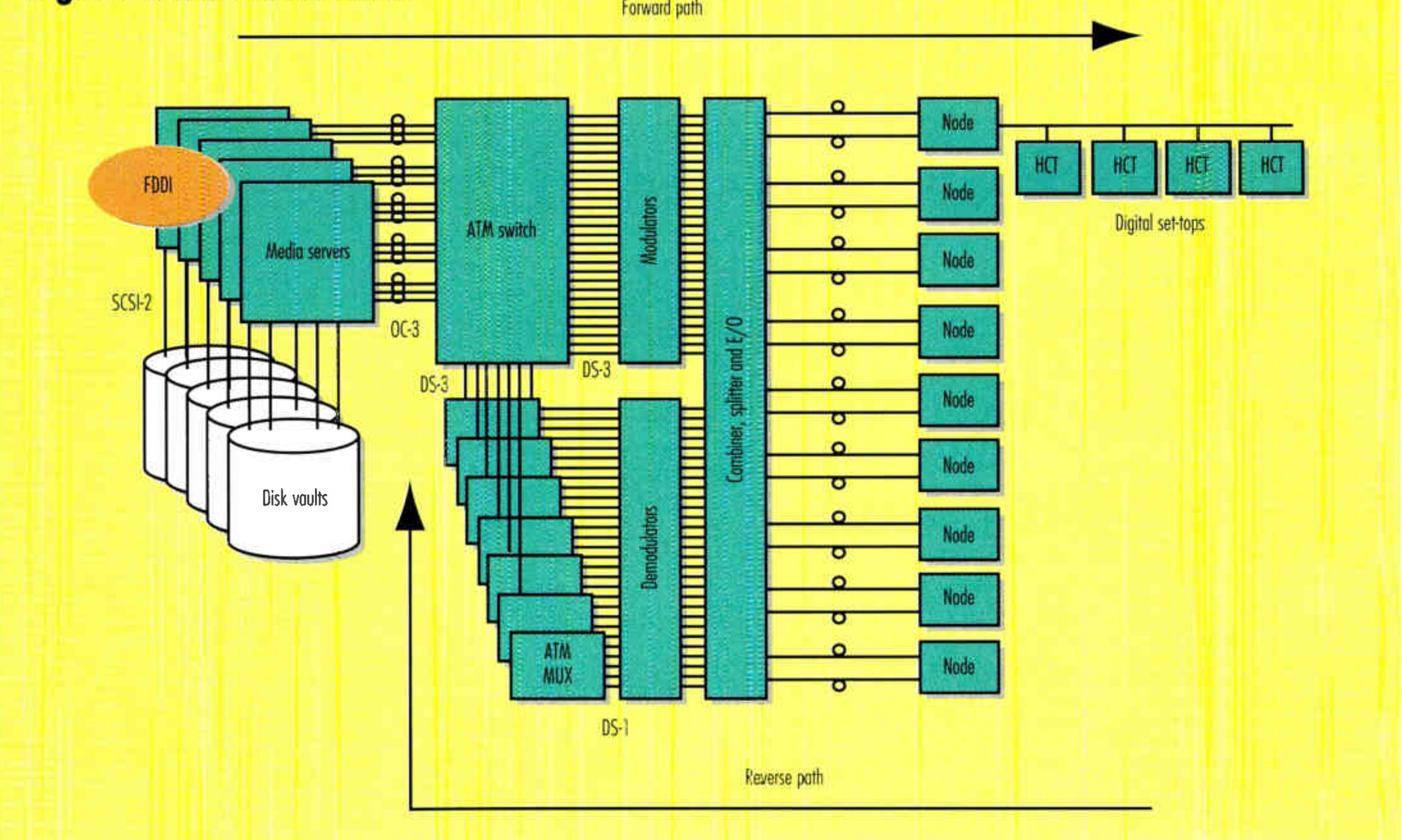
To provide "on-demand" access, the assets in an interactive system must be stored and then delivered when requested to the subscriber. As an interactive system grows, the library of assets becomes very large. (In Orlando there are currently 82 full-length movies, a number of home-shopping catalogs each containing extensive product information and a series of interactive games.) Storing all of these assets on a single media server or even in a single location is not cost-effective and soon becomes impractical.

The solution is to interconnect the media servers using a switched network to allow any server to provide service to any subscriber. The only available technology capable of providing the required quality of service and throughput is ATM switching.

FSN technical overview

The Orlando FSN uses ATM to send

Figure 1: Overview of FSN network



MPEG-compressed video and audio to the subscriber residence. The subscriber is provided with a digital set-top, called an HCT (home communications terminal), which translates the compressed signal back into standard NTSC video and stereo audio. Figure 1 gives an overview of the FSN network. The description is divided into forward (from server to HCT), and reverse (from HCT to server) paths for clarity.

Forward path

Eight media servers (SGI Challenge XLs) are connected to disk vaults using fast and wide SCSI-2 interfaces. The vaults can be configured to provide a total of 3,000 gigabytes of media storage capacity, enough for about 500 movies.

The media servers are connected to an AT&T GCNS-2000 ATM switch. Each server is connected to the switch with six SONET OC-3 connections. A total of 48 OC-3s provide 5,184 Mbps of usable payload bandwidth.

The media servers also are interconnected with an FDDI ring, which is used to transfer media content to the disk vaults and to collect billing records from the servers. A separate FDDI ring was used to expedite development, and in the future ATM switching will support all communications.

The ATM switch is connected to a bank of 64-QAM modulators (supplied by Scientific-Atlanta). Unidirectional DS-3 links (152 of them) provide a total of 5,600 Mbps of payload capacity from the ATM switch to the neighborhoods.

The QAM modulator outputs can be tuned to 500-735 MHz, spaced at 12 MHz. This allows the outputs to each neighborhood to be combined into a broadband RF signal. Conventional analog TV channels (spaced at 6 MHz) also are combined. The spectral frequency diagram is shown in Figure 2 on page 41.

The composite RF signal from 50-735 MHz is then used to amplitude modulate a laser. The laser is coupled to a single-mode fiber that takes the signal out to the neighborhood about 10 miles away. At the neighborhood the optical signal is converted back into the RF domain by the fiber node and used to feed a coaxial feeder network that passes about 500 subscribers.

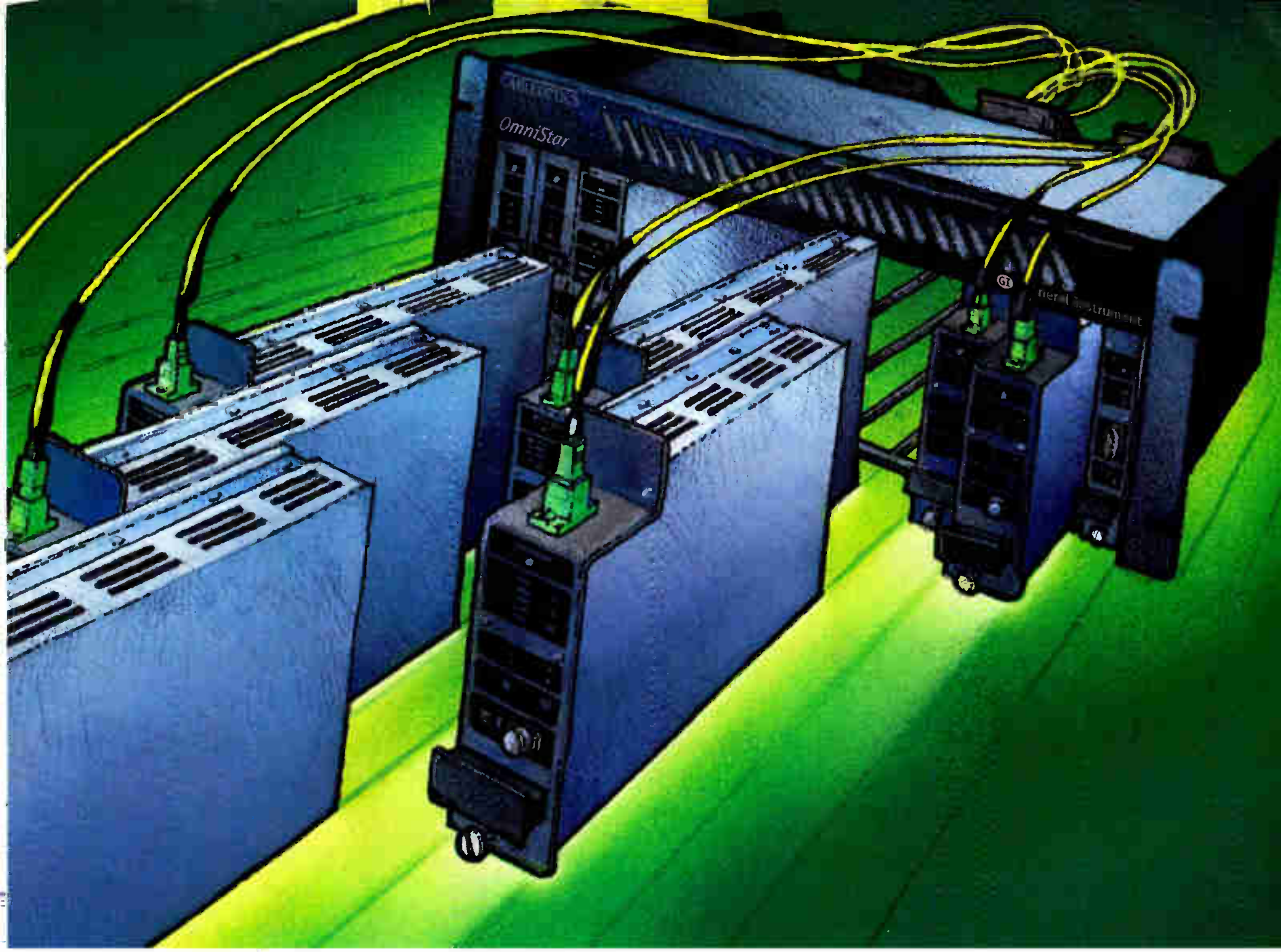
The RF signal enters the subscriber residence and feeds the HCT. The HCT is actually a powerful RISC-based multimedia computing engine with video and audio decompression and extensive graphics capabilities. An ATM addressing scheme is designed to allow any server to send data to any HCT.

Reverse path

The HCT transmits a QPSK-modulated signal in the 900-1,000 MHz band. Reverse carrier frequencies are defined at a spacing of 2.3 MHz. The QPSK channel supports a data rate of 1.152 Mbps (after accounting for ATM overhead). Each reverse channel is slotted using a time division multiple access (TDMA) scheme. This allows a single reverse channel to be shared among a number of HCTs. The time-slot assignments are made at the headend and sent to the HCT over a forward channel such that only one HCT is enabled to transmit in any given time-slot. By default, each HCT has access to a constant bit-rate ATM connection with a bandwidth of 46 kbps. More importantly, the access latency of a typical packet is 25 ms worst-case.

The reverse channels from a neighborhood are transported by the coax plant back to the fiber node. At this point, the reverse spectrum is used to modulate a laser, which is coupled to a single-mode fiber. Separate fibers (in the same sheath) are used for the forward and reverse directions.

At the headend, the optical signal is first converted back into the RF domain and then fed to a bank of QPSK demodulators. These convert the cell-stream



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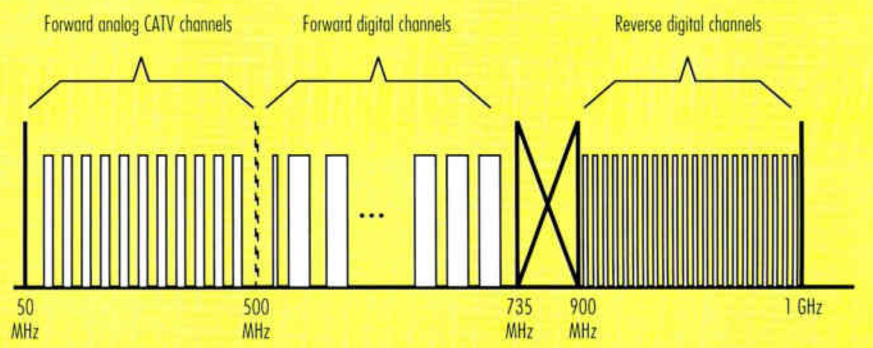
into a ATM-format DS-1. The mapping is standard but the DS-1 is a unidirectional link. The outputs of the demodulators are combined by seven (Hitachi AMS5000) ATM multiplexers. A standard, bidirectional ATM-format DS-3 is used to connect each multiplexer to the ATM switch. The ATM switch passes the reverse data to the media servers. An ATM addressing scheme is designed to allow any HCT to send data to any server.

The ATM switch and multiplexers are configured with a mesh of permanent virtual connections (PVCs).

In the forward path, ATM virtual paths (VPs) are configured from each OC-3 port to each DS-3 port. This allows the server to address any forward application channel (FAC) by selecting the appropriate virtual path identifier (VPI). The HCTs tuned to an FAC ignore the VPI and reassemble connections based on virtual channel identifier (VCI). Thus we have a two-level switching hierarchy, VP switching in the ATM switch and VC switching in the neighborhood. This allows any media server to send data to any HCT. In the reverse path, the ATM multiplexers perform a traffic aggregation function from DS-1 to DS-3 rates. A mesh of virtual paths is provisioned from the multiplexer DS-1 ports to the server OC-3 ports. This allows any HCT to send cells to any server by using the appropriate VPI.

Figure 2: Spectral frequency



Connection management

Allocation of VP and VC identifiers and of network bandwidth is performed by the connection manager. The connection manager is a distributed set of processes that run on the media servers. In response to an application request for a connection with a given quality of service, the connection manager determines a route, allocates connection identifiers and reserves link bandwidth. The connection identifiers are returned to the server and client applications at the media server and HCT respectively.

Integrating broadcast, interactive services

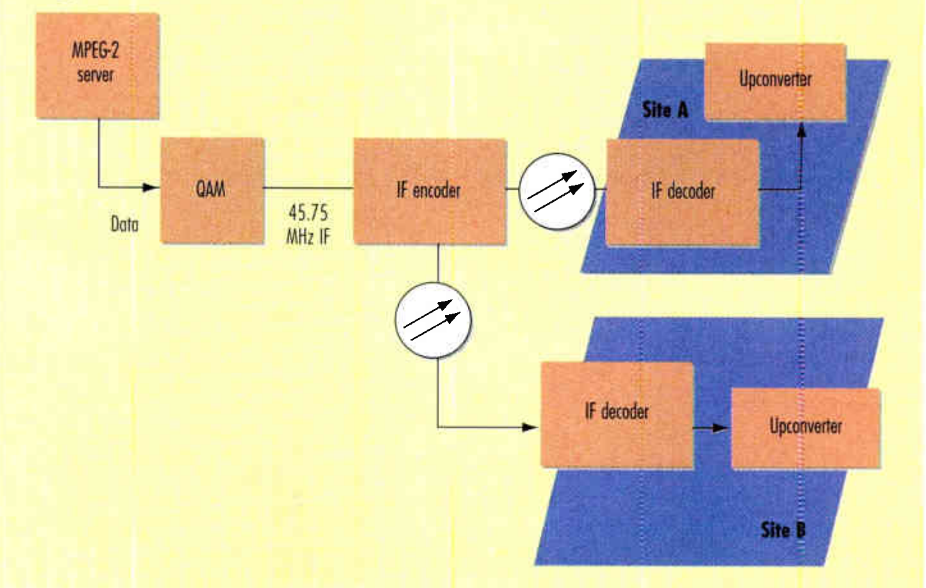
The Orlando FSN was designed specifically to provide interactive digital service in addition to existing analog broadcast services. The next logical step is to integrate digital broadcast services in a single network. This will be covered in Part 2 of this article. **CT**

By Wesley D. Simpson

Flexibility in new service rollout: Choose uncompressed digital backbone

With service providers struggling to keep up with the constant flow of new service requirements — many of which require a large capital investment and have a poor payback during their initial rollout — today's networks must provide maximum flexibility to prevent obsolescence of their digital network backbones. In order to balance the need for new services with the need to provide a positive return on investment under low penetration conditions, unique equipment should be centralized and shared over a large service area. This can be accomplished by using one of the flexible digital backbones available on the market today to support the constantly evolving mix of CATV services, both old and new. Uncompressed digital backbones offer greater flexibility than any other network alternative, including synchronous optical network (SONET), and offer the widest array of service transport alternatives of any system on the market today.

Figure 1: Transport Model 1 — IF interface



SONET vs. uncompressed

A digital fiber transmission backbone provides transparent transport of signals over hundreds of kilometers with superior signal quality. Collection (gathering signals from multiple sources) and delivery (combining and delivering multiple signals to multiple locations) is supported, as are redundancy, reliability and complete flexibility. Additionally, the digital backbone is repeatable — capable of sending the same signal to one site after another. In contrast, analog systems will suffer degradation after each signal regeneration.

There are two main ways of implementing a digital backbone. The first uses SONET equipment where video signals are encoded and compressed onto high-speed digital streams (typically DS-3), transported via SONET and then decoded into a baseband video signal. The other method uses uncompressed video and features a much higher bit rate per video channel (typically 135 Mbps or higher) than commonly used with SONET.

Wesley Simpson is senior product line manager of digital video systems at ADC Video Systems in Meriden, CT.

An uncompressed digital backbone offers large networks as great as a 40% advantage in equipment costs over SONET, which requires a codec at each site for each channel. (For scrambled signals, a SONET-based system also must provide a scrambler at each site for each channel.) The uncompressed video transport system requires less equipment and allows all key components such as encoders, scramblers, etc., to be centralized at the headend.

In a SONET solution, very little equipment can be centralized at the headend and most must be replicated at every node. The cost of a SONET headend is roughly the same as the cost of an uncompressed digital headend, but the SONET price tag will rise dramatically at the hub level.

Comparing service transport: Analog

• *Baseband video (broadcast-quality)* is typically NTSC video with a signal-to-noise ratio (S/N) of 57-60 dB. Uncompressed digital systems can easily transport this service using 8-bit resolution encoders and decoders. SONET systems use DS-3 rate compressed video to transport the same signal.

• *Baseband video (studio-quality)* is NTSC video with an S/N of 65-70 dB. Uncompressed systems use 10-bit resolution encoders and decoders for transport, while SONET systems must use OC-3 (155 Mbps) signals to achieve this level

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of quality, forcing an OC-48 to carry only 16 video channels. In many networks, studio-quality links are used to backhaul signals from remote locations to a central headend, or to provide transport services for studios and production houses that can be reached from a digital backbone network.

• *Scrambled baseband video* is broadcast-quality video that has been scrambled to prevent TV sets without the proper decoder from receiving the signals. Uncompressed systems can transport scrambled signals easily because they operate on "pure bandwidth" and do not require picture information recovery. SONET systems rely on compression algorithms that must identify and process video picture information (using discrete cosine transform — DCT — or other methods), and therefore cannot operate on a signal in its scrambled state.

• *IF modulated video* is a video signal that has been modulated from baseband to the intermediate frequency (IF) common to most conventional modulators. Current compression techniques do not operate directly on modulated signals. Therefore, SONET systems are not capable of transporting an IF modulated signal. Uncompressed digital systems on the market today can accept an IF modulated source, transport it digitally and provide an IF output. This allows the far-end equipment for each channel to consist of a simple upconverter at half the cost of the $1,500 modulator needed to make SONET baseband signals ready for distribution.

• *RF scrambled video* is a signal that has been IF modulated and then scrambled to deter unauthorized reception. This is one of the more common forms of scrambling used in set-tops today. RF scrambled video uses the same interface as IF modulation in uncompressed digital systems and allows additional cost savings through centralization of the scrambling equipment. Needless to say, SONET systems are not suited to transport this type of signal.

Comparing service transport: Digital

In ever-growing numbers, today's CATV service providers are taking advantage of the ability of digital video to increase the total number of video signals carried without the traditional corresponding increase in analog channel capacity. Source video is preprocessed using MPEG-2 encoding equipment and stored in a server, with bit rates per video channel ranging from 2 to 6 Mbps, depending on the amount of compression employed. Several of these digital video signals can then be combined and transported in place of a single analog video channel. Use of a 256-QAM modulator allows over 30 Mbps of program material to be transported in one 6 MHz video channel.

• *256-QAM encoded MPEG-2 video* is a digital video stream that has been modulated using a QAM modulator. The signal is typically 5-6 MHz wide, with a middle frequency of 43-44 MHz. This signal fits into the acceptance window of an uncompressed digital system's IF interface, and can therefore be easily transported. SONET-based compression algorithms cannot accept these types of signals and must employ other transport mechanisms. (See Figure 1 on page 42.)

• *Pure digital MPEG-2 video* is the digital video stream as it exists before entering the QAM modulator. In many instances, this signal is formatted as a DS-3 (telephony) signal, because one 45 Mbps DS-3 can easily carry one 30 Mbps multiplexed MPEG-2 signal. Uncompressed digital and SONET systems can both be equipped to carry this type of signal by using a DS-3 interface. While SONET can carry 48 DS-3s on a single fiber at a single wavelength, an uncompressed digital system with dual DS-3 encoders can carry 32 DS-3s per fiber per wavelength — more than enough to carry a 30-channel (180 MHz) tier of compressed digital services. (See Figure 2 on page 47.)

Comparing service transport: The rest

• *Videotex and set-top control codes* are just two examples of vertical blanking interval (VBI)-based services that can be used by modern CATV systems to carry additional revenue-generating services such as news or advertising data. Uncompressed digital video transport allows service providers to take advantage of the VBI, transporting every video channel's entire VBI unaltered along with the rest of the video signal. SONET compression systems generally strip away the VBI to conserve space. Some manufacturers allow system operators to select a few lines of the VBI to be transported along with the video signals. However, these selections are typically fixed at the time the equipment is ordered and cannot be easily changed once the equipment is installed and in service.

• *Video game services* require a modulated digital signal to be supplied to properly equipped customers, very much like the QAM MPEG-2 services described before. SONET systems can be configured to transport these signals digitally by placing a digital modulator at each destination location. In contrast, an uncompressed digital system can use an IF interface, allowing a single digital modulator to service an entire network.

• *Digital music services* are virtually identical to video game services. Again, the trade-off is between one centralized modulator (uncompressed digital systems) or multiple distributed modulators (SONET systems).

• *Interactive data services* can take many forms, ranging from set-top-based audience participation systems to full Internet access. One feature common to these services is that they are highly asymmetrical. That is, considerably more data flows from the hub to the subscriber than from the subscriber to the hub. Uncompressed digital systems are well-suited to this architecture because many of them are fundamentally asymmetrical by nature. SONET systems, on the other hand, were originally designed for voice services and are therefore symmetrical by nature. This design can end up wasting bandwidth in the return direction.

• *Voice services* based on DS-3 signals are well-suited for transport on SONET systems. Uncompressed digital systems are available with both DS-3 and DS-1 interfaces. For low-density applications such as headend-to-headend communications, a direct DS-1 interface (available on some uncompressed systems today) can eliminate the need for a DS-1-to-DS-3 multiplexer at each location where voice services are required.

Still more to consider

There are a great many things that service providers must consider when planning their networks, not the least of which is whether to go with proprietary or nonproprietary systems. SONET-based systems claim superiority based on the fact that they use standardized equipment interfaces. However, under close scrutiny, this claim falls apart in at least two places. First, all of the cost-effective DS-3 codecs currently on the market use proprietary algorithms, thus forcing users to buy all of their codecs for the entire system from the same manu-

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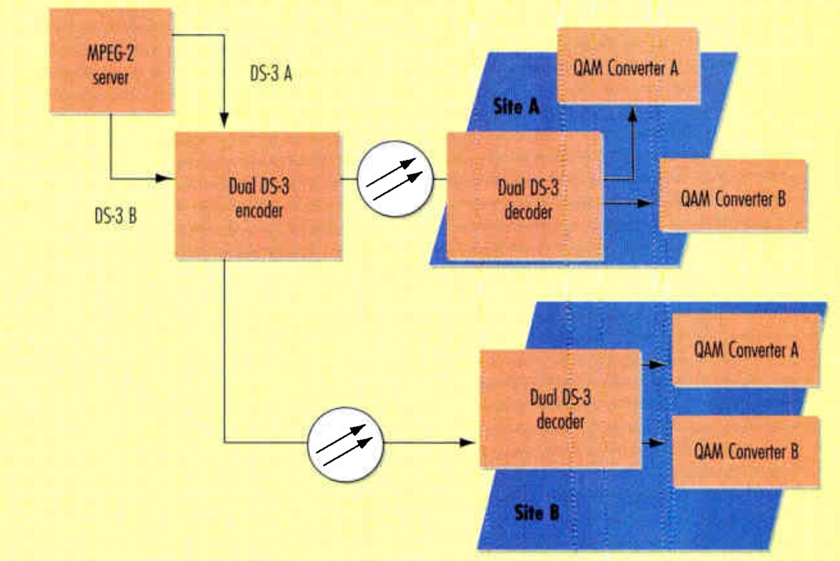
facturer. Thus, universal transport of video channels between carriers is not guaranteed with SONET. Second, the intermingling of operations channels embedded in SONET systems is just beginning to become feasible with equipment from competing manufacturers. Even now, some of the most advanced operational features of many SONET systems require all network equipment to be purchased from a single supplier.

Service providers also must pay close attention to the architectural flexibility of their network backbone. Current SONET systems require symmetrical, counter-rotating rings to provide protection against single points of failure. The SONET network also must be threaded through each node on a network, and does not support spurs or subtending nodes. In contrast, uncompressed digital systems support both symmetrical and asymmetrical networks, including a variety of mixed ring/star networks and optically switched protection systems. With uncompressed digital systems, CATV operators can choose full redundancy, partial redundancy for critical nodes only, or protection exclusively against fiber cuts to minimize equipment capital expenses.

Figure 2: Transport Model 2 — Dual DS-3 interface



Conclusion

Although SONET has become the prevalent mode of transport for voice signals today, its original goal — simultaneous transmission of all signal types, regardless of signal content — still has not been met. The weaknesses of SONET for transport of video are most glaring. In contrast, an uncompressed digital transport system is a universal transport mechanism that can carry any type of video signal, whether in baseband, modulated (either analog or digital) or IF format, uncompressed or compressed, clear channel or scrambled, or any other kind of video signal, plus telephony signals. This ability to simultaneously transport numerous types of signals greatly increases the options available to the service provider.

Uncompressed digital backbones provide both increased cost-effectiveness and improved signal quality compared to SONET video networks. SONET provides two-way (full-duplex) transport at all times. Uncompressed transport systems are more cost-effective than SONET because they can be full- or half-duplex, thereby optimizing video signal transport costs and permitting multiple architectures. By centralizing and sharing unique equipment over a large service area, uncompressed digital backbones provide greater flexibility than any other network alternative, including SONET, and offer the widest and most cost-effective array of service transport alternatives of any system on the market today. For these reasons, CATV service providers should seriously consider the benefits of implementing an uncompressed digital backbone before they jump on the current SONET bandwagon. **CT**

By Jim Chartre and Mac Frick

Planning your 750 MHz build

As we move forward into higher bandwidths, the range of acceptable variances becomes narrower. In the past, the need for accurate and reliable customer count information for determining service areas and future growth was not as great as it is with today's hybrid fiber/coax (HFC) designs, which employ shorter cascades and customer count restrictions. When considering your fiber needs, gathering information about future customer demands for data, telephony or intercompany fiber connections is more important today than ever before.

Because many plant managers find it difficult to find enough time to operate their system while they oversee a major upgrade, we have listed some of the items that need to be addressed while planning and scheduling a 750 MHz upgrade project.

Plant maps

The single factor that can have the largest negative effect on a project is providing the design house with inaccurate or outdated as-built maps. This is not to say that each system should be remapped from scratch, but the necessary time and money should be spent to have your maps field-checked prior to starting design.

In many cases the existing system maps are the original design maps from the last build and have never been updated to show what changes actually took place during construction. Many times when the system maps were prepared, long drops were not an issue unless they were 300 or 400 feet, while with 750 MHz design, drops in excess of 250 feet require special attention.

It also is important that future growth areas projecting customer counts and estimated mileage be noted on the maps prior to sending them out for design. This information should be as accurate as possible. However, discretion should be used when including 100- or 200-home subdivisions that may not be built for five or 10 years.

Rapid signal tilt change

RG-6 drop length (in feet)	Attenuation at 750 MHz	Attenuation at 54 MHz	Attenuation variance
100	5.65	1.6	4.05
150	8.48	2.4	6.08
200	11.3	3.2	8.1
250	14.13	4	10.13
300	16.96	4.8	12.16
400	22.6	6.4	16.2

Long drops

In many older systems, 400-foot, 500-foot or even longer drops are not uncommon. This becomes a problem when upgrading to 750 MHz. The higher attenuation of drop cable not only results in a rapid decrease in signal level, but also results in a rapid change in signal tilt. (See the accompanying table.) Placing hotter and hotter taps in the system will help alleviate the signal level problem, but will only make the tilt problem worse.

Before system design begins, the plant manager should decide upon a maximum drop length for normal drops, and a maximum drop length for long drops to be fed with hot taps. Then he should either have them identified when the system is walked off, or he should identify them himself for the design house so that these areas can be fed with feeder cable and proper signal levels can be maintained across the entire bandwidth.

Serving MDUs

Multiple dwelling units (MDUs) may be fed in a variety of ways. For example, they may be fed from hot taps, with an assortment of taps in a lockbox or with an in-house amplifier. Therefore, it is not always possible to come up with a blanket rule for feeding MDUs unless you are prepared to do a lot of field work changing feeds so they are all uniform.

It is most effective to handle MDUs on a case-by-case basis prior to beginning the system design phase of your project. Unless you are fortunate enough to have as-built drawings (or even sketches) of your MDUs, gathering this information will require a field check. The method of feeding each MDU should be documented on the maps supplied to the design house prior to the start of design.

Limitations

While much has been discussed and written about the benefits of going to 750 MHz, there also are some limitations of this architecture that should be considered.

First, manufacturers have chosen a Bode network as their method of level control rather

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By Stephen H. Lampen

Coax vs. unshielded twisted-pair

As we enter the "information age," technological crossovers are occurring. These are software or hardware designed for one industry now being used in another. Computers used to manipulate video or audio is one example. Using CATV cable to provide data or phone services is another.

One barrier rapidly falling is the delivery medium. Almost everyone in the delivery industry (CATV, regional Bell operating companies, utilities) admits that the choices in the delivery mediums available are becoming as chaotic as the services that will be supplied.

There are three basic delivery media: twisted-pair (the original phone company medium), coaxial cable (the original CATV medium) and fiber. All three members of the delivery industry have standardized on single-mode fiber for long-haul high-bandwidth delivery.

At the curb, fiber ceases to be as cost-effective. Sages a decade ago were predicting fiber in the home, something that has yet to happen and may not happen for some time.

One of the key reasons behind this failure to "fiberize" is vast improvements in the other two delivery mediums, coax and twisted-pairs. In fact, the CATV industry has standardized on fiber backbones with coax drops to the home or business while the phone company is fiber and twisted-pair drop. Within a home, business or school, the economical choice is still coax or twisted-pairs.

Stephen Lampen is technology development manager for Belden Wire & Cable.

Coax and UTP

Coax has made tremendous technical advances, and these have been dictated by the rise in bandwidth of CATV. Gone are the 10- or 20- channel systems. Now we're into the 150-channel, even 500-channel world. The coax cable of yesteryear was not designed or tested to these extreme bandwidths. But today's modern CATV cable can do this with a cost/performance ratio that would have been unthinkable only 10 years ago.

Twisted-pair technology has made even greater advances than coax, mostly because telcos started with the lowly twisted-pair to the home for phone service. Good for only the lowest data rates or lowest voice quality, the last 10 years have seen a series of leaps into what are now called "category cables." Category 3, 4 and 5 are quality grades of twisted-pairs originally formulated for the computer industry. Category 5 is rated up to 100 MHz bandwidth, and there are enhanced Category 5 cables with performance up to 350 MHz bandwidth. While less impressive than the 2 GHz coax cable, one must remember that twisted-pair performance is over 14,000 times better than it was when it was plain old telephone service (POTS).

By comparison, CATV cable has "only" quadrupled in performance in the same period. I put "only" in quotes because even that increase is an amazing technological feat. Coax is still the winner where long runs are concerned. Twisted-pair cable is specified in the data world up to 100 meters (328 feet). Certain types of coax can go many hundreds, even thousands of feet. The actual working distance for any cable, unshielded twisted-pair (UTP) or coax, is based more on the level that can be recovered by the equipment used. The lower the recoverable signal level, the farther one can go with any particular cable. The stability of specifications (called structural return loss or SRL in the CATV world) is vastly superior in coax compared to even the finest UTP.

Table 1 shows the basic specifications for Category 3, 4 and 5.

Those who have spent their lives isolated on one side of the fence have a

Table 1: Basic specs for Categories 3, 4, 5

Category	Bandwidth	NEXT (near-end crosstalk) minimum per 1,000 feet	Attenuation maximum per 1,000 feet
3	16 MHz	32 dB @ 4 MHz 26 dB @ 10 MHz 23 dB @ 16 MHz	17 dB @ 4 MHz 30 dB @ 10 MHz 40 dB @ 16 MHz
4	20 MHz	47 dB @ 4 MHz 41 dB @ 10 MHz 38 dB @ 16 MHz	13 dB @ 4 MHz 22 dB @ 10 MHz 27 dB @ 16 MHz
5	100 MHz	53 dB @ 4 MHz 47 dB @ 10 MHz 44 dB @ 16 MHz 40 dB @ 31.25 MHz 32 dB @ 100 MHz	13 dB @ 4 MHz 20 dB @ 10 MHz 25 dB @ 16 MHz 36 dB @ 31.25 MHz 67 dB @ 100 MHz
Extended 5	350 MHz	Same specs as Category 5 but actual performance much improved	Same specs as Category 5 but actual performance much improved

Table 2: Extended Category 5 vs. RG-6 "report card"

Attribute	Extended Category 5	RG-6 CATV drop cable
Cost per foot per circuit	B	D
Installation time	A	D
Bandwidth (i.e., number of channels)	C	A
Availability	A	A
Support equipment	D	A
Run length	C	A
Average grade	*B*	*B*

Note: A is excellent, B is good, C is average, D is poor

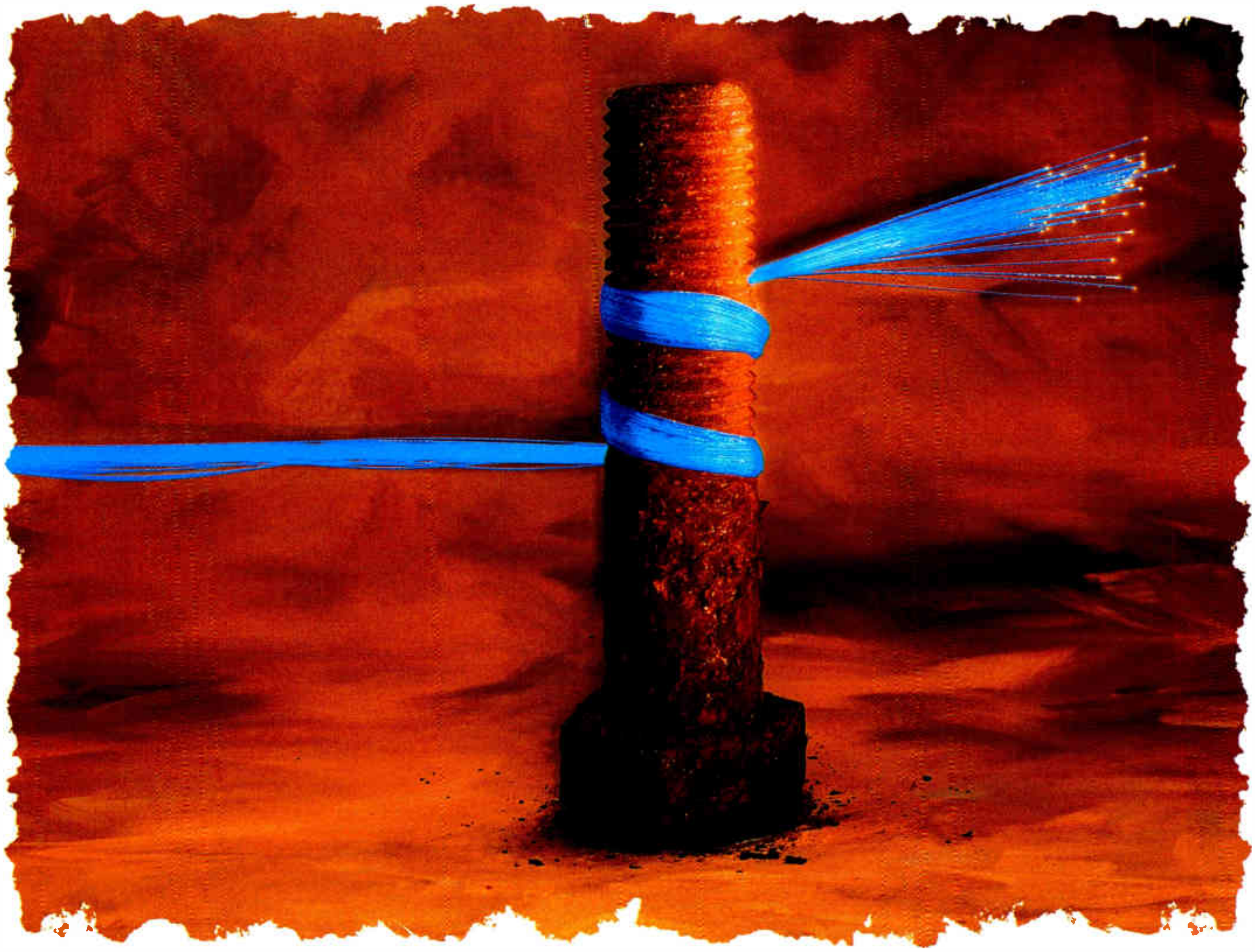

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Table 3: Balun manufacturers

Manufacturer	Model/ part number	Passive or active	Category	Maximum distance	Picture quality
NVT 365 Iris Way Palo Alto, CA 94303 (800) 959-9870	202A NV-1702A (PC-mount module) 314A 418A 518A	Passive Passive Passive Passive Active	Category 2, 3, 4 or 5	500 feet 500 feet 500 feet 500 feet 2,000 feet	Capable Capable Passable Receive Receive
Signature Multimedia 13506 W. 72nd St. Shawnee, KS 66216 (913) 631-9979	Premiset SMM5000VT SMM5000VR SMM5000SWPT SMM5000SWPR	Active	Any UTP Any UTP Category 3 Any UTP Belden 1456A (Category 4)	5,000 feet 4,000 feet 3,000 feet 2,500 feet 3,000 feet	Capable Passable Receive Broadcast Broadcast
Cal-Tech Associates 1711 Arbor St. Omaha, NE 68144 (402) 330-3970	Vida 200AV 200AV-HUB12 (12 feeds, each requires 200AV)	Passive Active	Any UTP Any UTP Category 3 Category 3	1,200 feet 1,700 feet 1,400 feet 3,000 feet	Color Black and white Color Black and white
Spacecards P.O. Box 58249 Louisville, KY 40268 (502) 935-5107	Video Twist VTW6080 (60 sources/80 users)	Active	Any UTP "High-quality" UTP	812 feet 1,300 feet	Receive Receive
C-C-CGroup Ltd. 13 Farnborough Business Center Eelmoore Rd. Farnborough Hampshire GU14 7XA England	Freeview	Active (Signal split RGB to separate pairs)	Category 5	650 feet	1,024x768 resolution 100 MHz bandwidth >60 dB

hard time believing what they are hearing from the other side: UTP can come close to coaxial performance or coax can carry telephone audio or computer data as well as video signals.

Where we are left is in a very interesting world where, against all odds, twisted-pair performance is beginning to rival coax performance. While still many times better in bandwidth, coax cable in more expensive (comparing it to twisted-pairs on a circuit-by-circuit basis) and takes much more time to install. In fact, one could compare extended Category 5 to RG-6 coaxial cable and come up with the "report card" shown in Table 2 (page 48). This compares unshielded Category 5 and coax cable in the same application, multiplexed analog video. Note than when the bandwidth or the support equipment improves, twisted-pairs will be more than just a cost-effective alternative! One other significant advantage to UTP is the fact that many installations use it already as computer network cable, for wiring phones, faxes and modems. In fact, it can be the "wire-that-does-everything" when used for CATV as well.

There is currently only one manufacturer that makes broadband multiplexed analog video adapters for UTP — AT&T. Its Model 384A claims to accomplish 28 analog channels per pair, still a far cry from 150 channels of coax.

As to the support equipment, no current CATV equipment is made that accepts twisted-pairs (or RJ-45, the connector most commonly used), so adapters called baluns are necessary. These baluns are made to run only one channel per pair, not multiple channels. In some installations such as schools, hospitals or businesses, one channel to each desk is really all you need and the selection of that channel can be easily made at the desk to a remote equipment closet where the switch is. Table 3 is a list of those balun manufacturers.

There is one other aspect to coax vs. UTP — in the field of digital video. Digital video is different from analog. It is already data, 1s and 0s. It is very robust (like data) and is much more immune to interference. It can be easily broken up, transmitted and reassembled. The thousandth copy of a digital signal is identical to the original, making digital the ideal medium for recording, duplication and playback. The only real stumbling block is data rates. The data rate for true broadcast-quality video is hundreds of megabits (actually 143 Mbps to 270 Mbps) and even more for high definition TV (HDTV). These data rates are far beyond the standards of networking twisted-pairs today.

The cutting edge in the network world is ATM at a data speed of 155 Mbps, and even this is extremely hard to handle. This pushes cable, connectors and hardware to their limit, and the word size (how the data is arranged) for ATM is not compatible with standards already set for digital video. However, some extended Category 5 cables available today can theoretically handle data rates up to 270 Mbps and beyond, probably even HDTV. But only now are baluns being made that will go from BNCs (still the connector of choice for digital video) to RJ-45s. When these are perfected, only then will the key questions be answered: "How far can you go with these high data rates?"

For lower data rates, the lower the rate the easier it is to ship signals around. Anything below 100 Mbps can easily be handled by today's cable, connectors and hardware. Table 4 (page 52) shows the (very few) manufacturers who make baluns for digital video.

Category cables are specified to run up to 100 meters (328 feet) at their maximum data rate. At T-1 or lower data rates, high-quality twisted-pairs could go much farther. It should be emphasized that these are single-channel-only schemes, or at best, they


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Table 4: Balun manufacturers for digital video

Manufacturer	Model/ part number	Cable	Data rate	Distance	Image quality
ETS 1394 Willow Rd. Menlo Park, CA 94025 (415) 324-4949	PV101 (Passive)	Belden Datatwist 350	270 Mbps	250+ feet	In-studio broadcast
Gyyr 1515 S. Manchester Anaheim, CA 92802 (800) 854-6853	FasTrans 2000 (Active)	Any UTP	Variable 8 fps "low-quality" 20 seconds/frame "high-quality"	Unlimited	Poor
NVT 365 Iris Way Palo Alto, CA 94303 (800) 959-9870	VideoExpress (Active)	Any UTP	T-1 1.544 Mbps	Unlimited	Home-reception quality
Pairgain 14402 Franklin Ave. Tustin, CA 92680 (714) 832-9922	Campus-TI Campus E-1	Any UTP	784 kbps per pair (1.544 Mbps for 2-pair) 1 Mbps per pair (2.048 Mbps for 2-pair)	2.3 miles 2.2 miles based on 24 AWG copper, further with larger size	Below standard received picture quality

could be configured to do a few very low-quality channels simultaneously. Currently, the equipment to support such digital multichannel uses is not available although the technology is inherent in a standard network scheme.

Twisted-pair cables are making significant inroads in bandwidth and already surpass coax in cable cost and installation time. Where single-channel or small numbers of multiplexed channels are required, twisted-pair cable can be a cost-effective solution, especially when integrated into a twisted-pair computer and phone network.

On the other hand, for large numbers of channels, for long runs and for existing hardware support, coax is currently superior. **CT**

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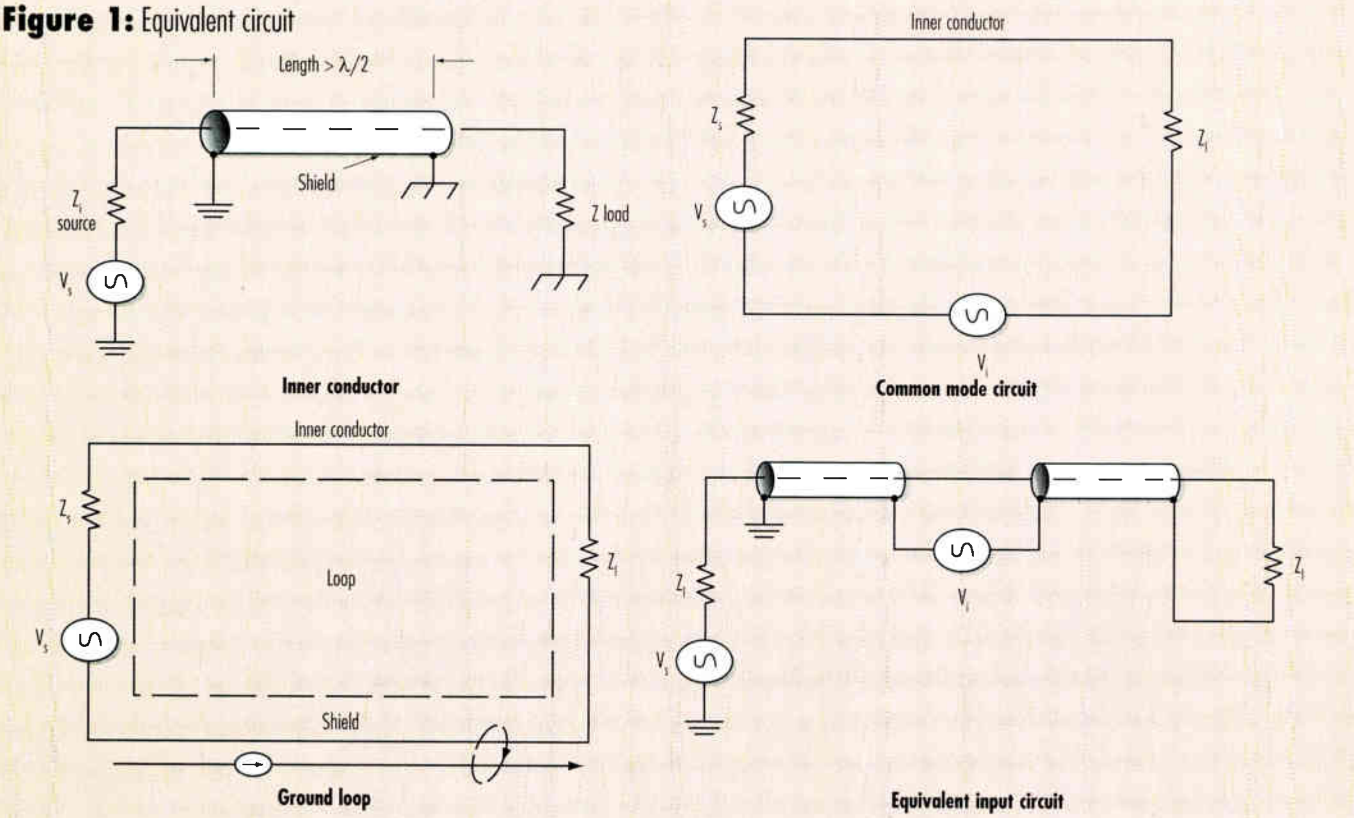
By Glyn Bostick, Ronald E. Mohar and Vince Cupples

Figure 1: Equivalent circuit



Suppressing direct pickup interference — Part 1

This the first in a three-part series of articles that examines the problem of direct pickup interference (DPI/DPU). This part defines DPI and discusses its the history. It also explains its theoretical causes and cures.

With the introduction of "cable-compatible" TV receivers an increasing number of subscribers are becoming victims of DPI. The problem also affects master antenna TV (MATV) systems. Virtually all TV receivers currently on the market suffer from DPI when strong ambient RF fields are present. Computer studies undertaken by Stern Telecommunications Inc. in 1992 indicate that perhaps 48% of TV households could be subject to DPI from VHF/UHF TV stations operating below 550 MHz.[1] Given the large number of non-TV transmitters operating between 18 MHz and 550 MHz, the total potential for DPI is probably above 48%. Further, a growing number of LPTV stations and transmitters in other radio services continue to be licensed every year. Fiber-optic systems will not alleviate the problem as long as coaxial drop lines are used.

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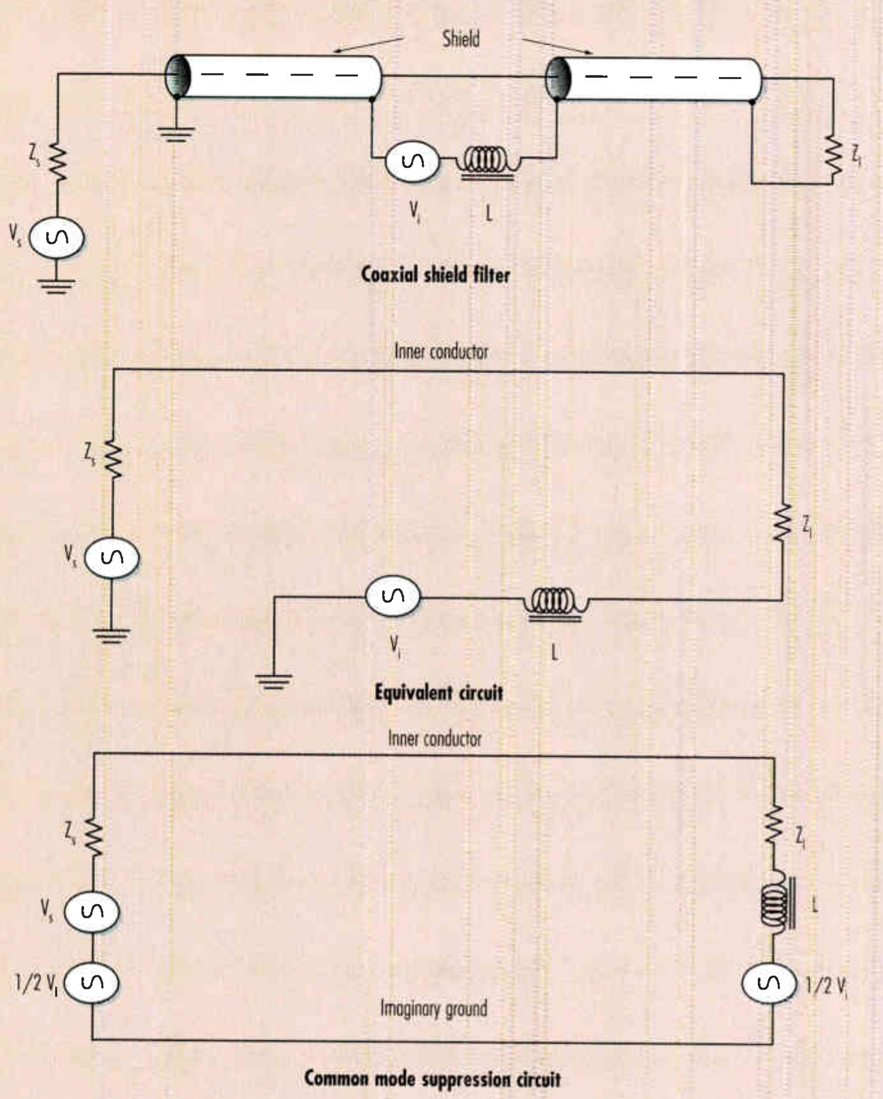
Definitions

It is sometimes said that definition of a problem represents most of its solution. Hence, definitions of DPI and related terms are prerequisites for working with DPI.

- *Direct pickup interference* (for the purposes of this article) may be defined as a form of ingress interference that enters a TV tuner on the shield of a coax input cable. DPI symptoms may be broadly classified as either *coherent* interference or *noncoherent* interference.
- *Coherent interference* is defined as any form of interference that results in the simultaneous display of two pictures at the same time. Typically an unwanted picture is superimposed faintly in the background of a stronger desired picture. Examples of coherent interference include "same picture" ghosting (like multiple reflections on an antenna system) and co-channel interference (when a different picture is superimposed in the background). →

Figure 2: Coaxial shield filter



• *Noncoherent interference* is defined as any unintelligible interference pattern in a TV picture. Some examples of noncoherent patterns include horizontal, vertical or diagonal lines. Other patterns include rolling lines, a rolling picture, "barber pole lines," "bars," tearing, "wavy lines," "herringbone," "venetian blinds," "sparklies," "snow" in the picture, color distortion, audio buzz, pale colors or a "windshield wiper effect."

DPI problems first appeared when cable-compatible TV sets were introduced. (*Editor's note: Some older systems that carried local broadcast stations "on-channel" also experienced DPI problems prior to the introduction of cable-compatible TV sets.*) ost of the standards originally established for television assumed semi-adjacent channel reception in a relatively interference-free environment. With the exception of some large metropolitan areas, few cities had more than three or four VHF stations. Tuner selectivity was not too important. With the exception of a few rural areas, co-channel interference was rarely a problem. Because of channel "offsets" (±10.5 kHz) and careful geographic distribution of stations (150 miles) operating on the same frequency, co-channel interference was minimized for most viewers.

When the "cable TV revolution" began, cable systems used specially designed set-top converter boxes. TV sets received only 12 VHF channels. Set-top converters were necessary to adapt existing receivers for 35-channel reception. These rugged commercial-grade products were specially designed for CATV applications. They had highly selective tuners with shielded input circuits and sealed construction. Frequently they employed more sophisticated bypass circuits, balanced decoupling networks and power line filtering. As a result, cable converters could discriminate against DPI.

When cable-compatible TV sets and VCRs were introduced, many of the cable converters became unnecessary. But as the converters were taken off, DPI problems started to appear. While the manufacturers added channels, they neglected to upgrade critical tuner circuitry. Inadequate tuner shielding and circuitry made these cable-compatible receivers susceptible to DPI. Further, stiff price competition discouraged improvements that were not obvious to buyers. Sometimes open holes in the tuner chassis (used for frequency alignment at the factory) allowed signals to radiate into the tuner.

As a result, some cable operators started to deny that TV sets and VCRs were *truly* "cable-compatible." Even presuming Federal Communications Commission-mandated design requirements, a large number of these receivers will continue to be operated for years to come. Meanwhile, more potential interference sources continue to be licensed.

Causes

DPI occurs when unwanted signals leak into a receiver and penetrate the tuner. It is one of several ground ingress problems that degrades reception. Many kinds of "grounds" are used with electronic equipment for a variety of purposes. The primary purpose of grounding is safety against lightning and shock hazards. At radio frequencies, grounds provide a common return path for radio frequency (RF) signals. Chassis grounds shield internal circuitry from electromagnetic fields. But at high frequencies power lines, ground wires and coaxial cable shields can "look like" antennas to RF signals.

VHF grounds

As RF wavelengths become smaller, it becomes increasingly difficult to establish an earth ground. Meaningful single-point grounding cannot be implemented at high frequencies. Multipoint grounding risks creating ground loops. Table 1 (page 58) illustrates the wavelengths of various representative frequencies. At 54 MHz, a 5-foot ground lead looks like an antenna to VHF signals. A lead only 6.96 inches long looks like a quarter wave antenna at 400 MHz. For this reason "floating grounds" or "local

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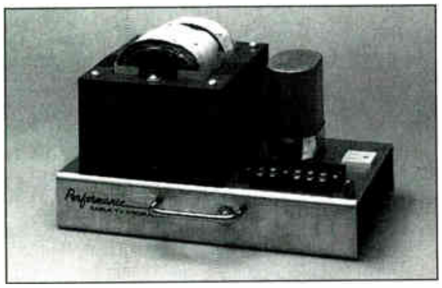

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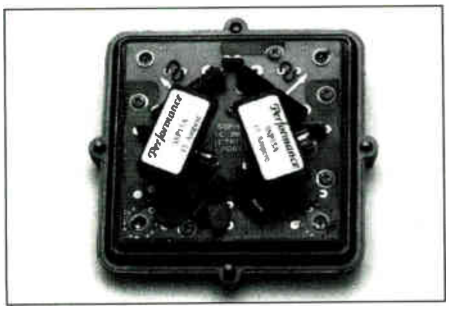

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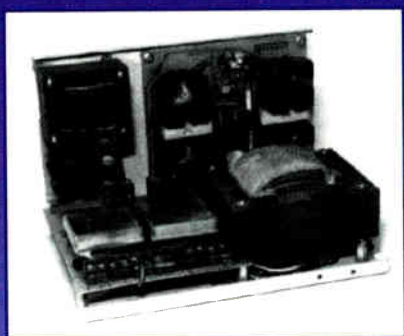

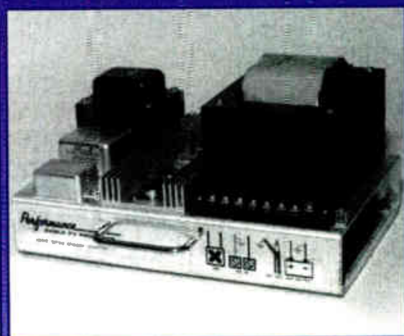

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grounds" are frequently used at VHF. Single-point grounds are used purely for safety with VHF. But power grounds can create a variety of ingress problems. DPI is one of several types of ingress problems that can degrade reception. It is caused by coaxial ground loops and common mode interference.

Ground loops

Figure 1 (page 54) shows a simplified equivalent receiver input circuit connected to a coaxial cable and a ground block. While coaxial cables are intentionally used to prevent ground loops, under certain circumstances a ground loop can still be formed by the inner conductor and the outer shield.

Common mode interference

Whenever a long coaxial cable is in a strong ambient RF field, RF currents can be induced on the shield. The resulting ground loop acts like a loop antenna. The loop picks up any signals that happen to be around. Once on the shield, signals can be conducted into the tuner. Emissions from the shield can be radiated into the tuner though any openings in the tuner chassis. Studies indicate that whenever the ambient field strength exceeds 100 mV/meter, there is risk of DPI.[1] The interference signal induced on the shield (V_i) will be in series with the signal source (V_s). When V_s and V_i are at the same frequency, the result is a form of "on-cable" co-channel interference similar to that seen on antenna systems. Since the shield is supposed to be at ground potential this form of induced ingress is called common mode interference.

Table 1: VHF wavelengths

Frequency (MHz)	Wavelength (feet)* λ	$\lambda/2$	$\lambda/4$
54	17.31	8.65	4.33
216	4.33	2.16	1.08
400	2.34	1.17	0.58

*Velocity factor of 0.95 used.

Solutions

One way of preventing a ground loop is to figure out a way of breaking it up. Since safety requirements mandate an AC/DC power ground on CATV cables, single-point grounding must be used. In theory, one way of breaking up a ground loop is to add an inductance to the cable shield as illustrated in Figure 2 (page 56). A common mode choke will pass DC and differential mode signals while blocking common mode interference and preventing it from passing through to the load. But knowing a theoretical solution and actually implementing it with a practical device are two different things. A subsequent part of this article will examine a number of practical devices for implementing this kind of cure.

DPI is a form of common mode ingress picked up on coaxial cable shields. In theory it can be remedied by adding inductance to a cable shield. But practical solutions depend upon appropriate application of practical devices. Diagnostic testing can determine whether you have a DPI problem and whether DPI suppression methods are appropriate. **CT**

Reference

[1] J.L. Stern, "Direct pickup interference," *Communications Technology*, July 1993, page 51.

Part 2 of this article will explain some of the diagnostic tests used for confirming shield DPI and detail its sources and symptoms.

By Jeff Thomas

Improving quality in automatic proof measurements

With the push a button you can get proof-of-performance test results and record the answer in a Federal Communications Commission report. You rely on the speed and accuracy of these measurements to make cost-effective use of your time. But what if it is wrong? Bad data can jeopardize FCC approval or call for unnecessary maintenance. This article explores some logical techniques you can use to make sure that your measurements not only make sense, but that you get the best accuracy from your automatic proof test equipment.

What are the danger signs that your readings are in error? Usually, readings don't feel right for one of the following reasons: 1) constantly changing values, 2) never-changing values, or 3) extreme values.

Constantly changing values indicate an instability in the measurement procedure or test point. Values that don't change may indicate that the test equipment is "locked up" in some loop of its own, like a computer that has frozen. Extreme values are more common indications of bad data. These show up as readings that are way out of normal, either too good or too bad. For example a carrier-to-noise ratio (C/N) of 64 dB many amplifiers deep in the plant is indeed "too good to be true."

We will discuss some general rules for good measurement practices, then apply these to some specific measurements: carrier levels, C/N and distortion.

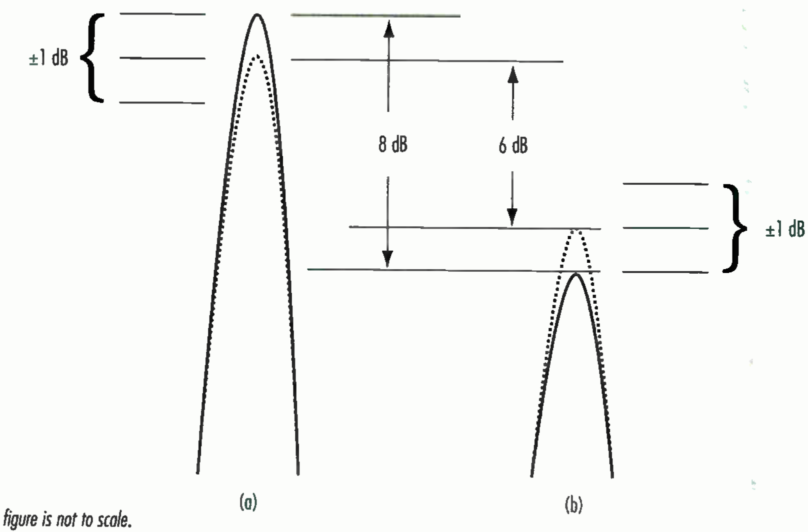
Good measurement practices

Just because your equipment is automatic, don't be lulled into neglecting these fundamentals:

- Test equipment specifications
- Test equipment maintenance
- Measurement conditions
- Measurement procedures

Jeff Thomas is an applications engineer with HP CaLan in Santa Rosa, CA.

Figure 1: Relative carrier levels depend upon SLM accuracy



This figure is not to scale.

First, check your test equipment specs. They may not be good enough to make the measurement no matter how automatic. The equipment may never be able to make the measurement because it was not designed to provide the level of accuracy you require. In fact, its error may be greater than the tolerance your measurement requires.

Second, test your test equipment. Even though the data sheet says it's good enough, your specific box may not be adequate because it is out of calibration or has sustained physical or electronic damage. It may require routine or special maintenance.

Third, your measurement conditions may not allow an accurate measurement. For example, too much signal power at the input of your cable TV analyzer can cause distortion measurement errors.

And finally, the measurement procedure may not be appropriate for the automatic measurement. For example, using an signal level meter (SLM) to measure C/N without a bandpass filter.

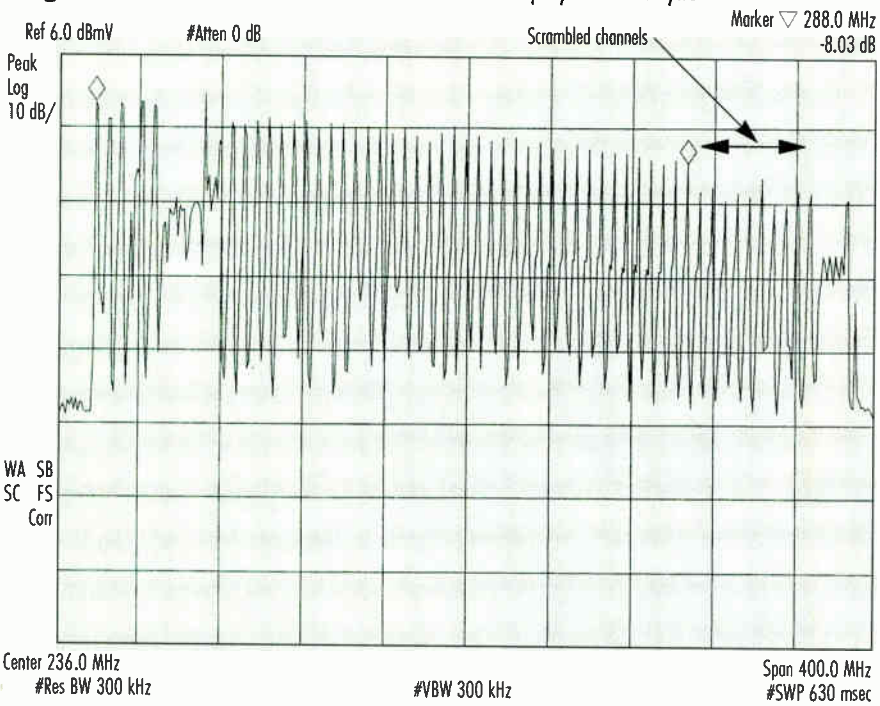
Three measurement areas that illustrate these practices are the measurement of carrier levels, C/N, and composite second order/composite triple beat (CSO/CTB) distortions.

Carrier levels

The bread-and-butter measurement with an SLM is the absolute and relative levels of carriers. These measurements have been made painless and simple in modern SLMs. But check the SLM's accuracy. You may wish to include a measurement guard band so that FCC compliance with carrier amplitude tests is guaranteed.

An example illustrates the guard band process. Let's say that the amplitude accuracy of your SLM is ±1 dB. Doesn't sound like much error until you consider that the value applies to each of the signals measured. This means that the total error between any two signals can be as much as ±2 dB. That is, twice the single signal uncertainty. This is shown in Figure 1. The reason the error is doubled is that the signals are individually read by the SLM with the same uncertainty of ±1 dB. From the figure, the amplitude difference read by the SLM is 8 dB. The uncertainty of each level could be as much as 1 dB different than the observed

Figure 2: Unscrambled and scrambled channels displayed on analyzer



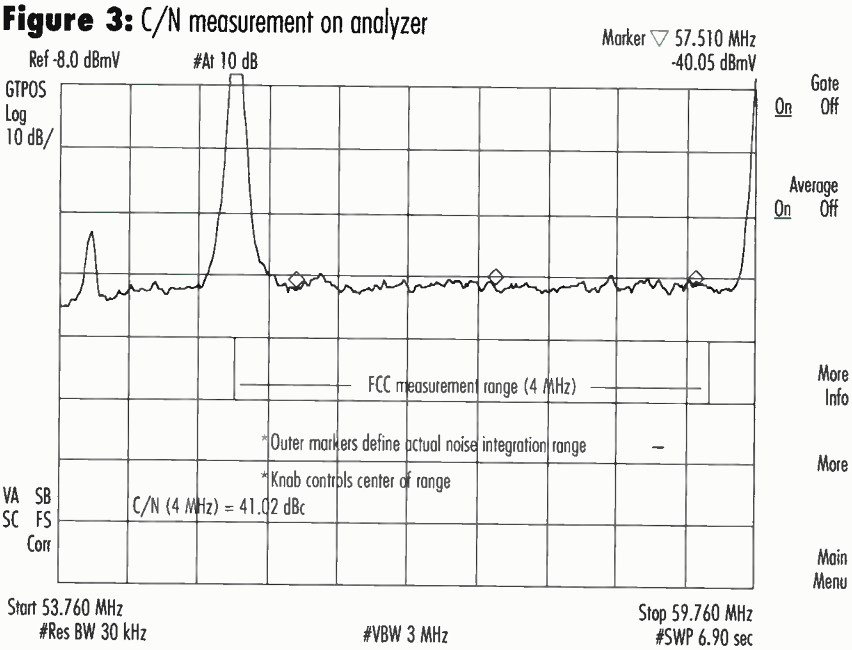
value. And worse, the two signals could be at opposite extremes of the ±1 dB variance. This is illustrated by the dotted line responses in Figure 1 (page 60). Carrier (a) is actually below the viewed signal and (b) is above, each due to the SLM uncertainty. In this case, the actual signal response is 6 dB, 2 dB better than the SLM measurement.

Given these conditions, how do you guarantee that your reported carrier data meets the FCC 12 dB carrier level rule? Simple. You keep your system flat within the 12 dB *minus* the measurement uncertainty of 2 dB. That is, you have to keep system flatness, as measured by an SLM whose accuracy is ±1 dB, to within 12 dB - 2 dB, or 10 dB as measured by that type of SLM. This assures you and the FCC auditor that your SLM is not reporting better frequency response than actual. The worse the accuracy of the SLM, the higher the guard band must be, and the tighter you must keep the system signal flatness. The solution: use the SLM with the best accuracy you can.

Procedurally there isn't much that can go wrong with a modern SLM. However, if your readings are off by a surprising amount, say 5 dB to 15 dB, suspect that the SLM is out of calibration or has been calibrated with a bad calibration signal. Gross inaccuracies also can be made when measuring the amplitudes of sync-suppressed scrambled channels. Suspect that a channel picture carrier is scrambled if wide variations in its level occur from measurement to measurement. In some test equipment, it also could have been viewed as lower than adjacent channels. Some of this is shown in Figure 2, although some of the high-end channel amplitude change is roll-off. The apparent amplitude difference is due to the way the cable TV analyzer measures visual carrier amplitudes. A minimum amount of time at the carrier center frequency is required to read its amplitude repeatability and accurately.

How does this relate to automatic measurements? SLM and cable TV analyzer equipment may not be able to automatically distinguish between scrambled and nonscrambled visual carriers. You need to check the operating manuals of these products to see if you can preset them so they automatically adjust their measurement techniques for sync-suppressed scrambled channels. In the cable TV analyzer, you can usually set the scrambled channel switch for that channel. For the SLM, set the manufacturer's recommended dwell time in the SLM's channel measurement table. In the cable TV analyzer, there may be a comparable table to identify sync-suppressed scrambled channels.

Figure 3: C/N measurement on analyzer

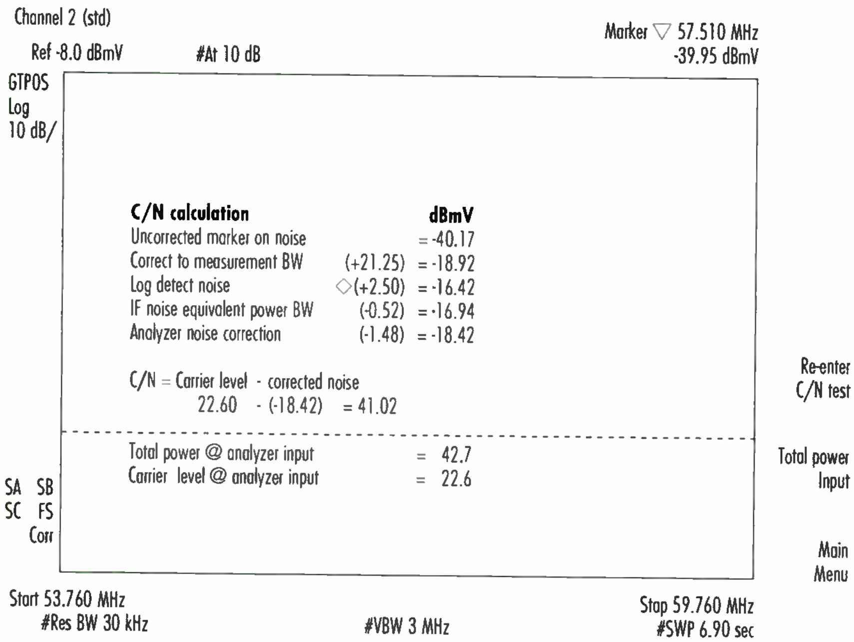


Carrier-to-noise ratio

C/N is one of the most troublesome and yet most essential measurements in proof-of-performance. Every dB counts. That is, a dB can make the difference between passing a test and failing a test, especially now with more stringent FCC requirements. Automatic C/N measurement equipment has taken a lot of the mystery out of the procedures, but you still have to optimize measurement accuracy.

Few SLMs are capable of making highly accurate and repeatable C/N measurements in the range of levels required for proof testing. An SLM input receives all the cable signals at once, making it difficult for the unit to pick system noise out of the high-level sig-

Figure 4: Information page for C/N measurement



nals. SLMs are specified with the requirement that the measurement must be made with an external channel or band-selected preselector (bandpass filter) placed between the SLM and the system tap. This addition can be a source of error if the frequency response and insertion loss of the preselector are not considered. But SLMs remain a quick and reliable way to do checks on system C/N in the field.

SLM specifications for C/N usually quote accuracy of ±2 dB with repeatability of ±1 dB. This means that your answer may be a total of ±3 dB from the actual C/N. In a measurement where every dB counts, this can be a frustrating offering to the FCC. For example, to meet a 46 dB C/N with an SLM, using the guard band concept, your C/N readings should be better than 46 + 3, or 49 dB, to guarantee compliance performance.

Improvement of analyzer accuracy

Cable TV analyzers are designed to make proof measurements. Built-in features such as internal measurement software, preamplification, error correction and the ability to make noninterfering C/N measurements on modulated channels improve the ease-of-use, accuracy and repeatability of the tests. Overall, cable TV analyzer C/N accuracy can be ±1 dB.

The cable TV analyzer may require a bandpass filter to preselect the channel under test just as an SLM. Cable analyzers are more adept at handling higher input power, viewing system noise amidst all the input channels, and automating the test process. But

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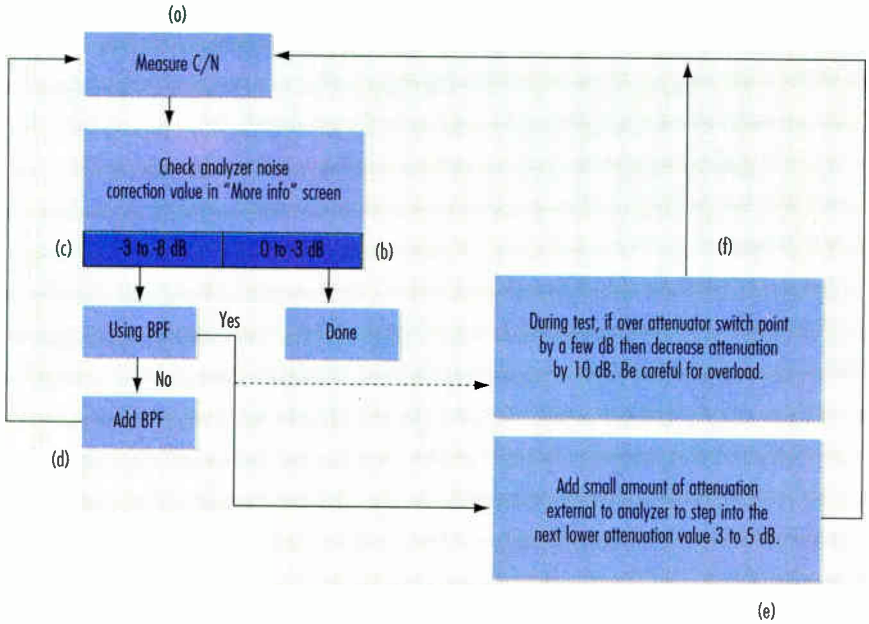
Figure 5: Diagram for improving analyzer C/N accuracy and reliability

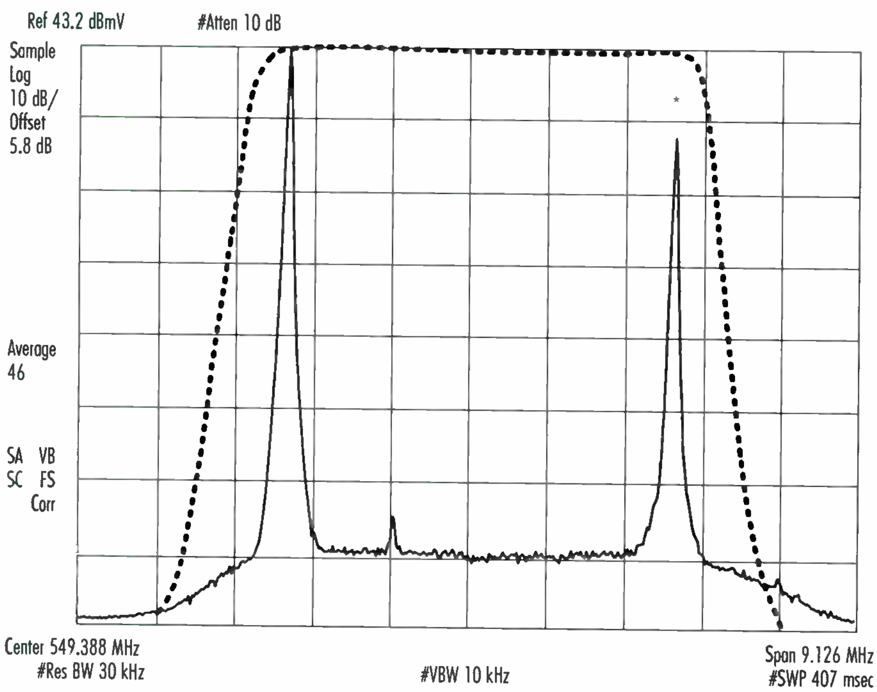


the best, and somewhat hidden feature is the ability of some cable TV analyzers to judge their own accuracy after each measurement. When making a C/N measurement with one such cable TV analyzer, the measurement screen has an information page you can bring up after each test. (See Figures 3 and 4 on pages 62 and 64.) The key to the measurement's accuracy and repeatability is found in the line called "analyzer noise correction." The value in the parentheses gives the analyzer's estimate of how accurate and repeatable the C/N number is.

The following table shows the correlation between the analyzer's noise correction and the measurement uncertainty.

Correction	Uncertainty
-1 dB	±1 dB
-3 dB	±2 dB
-7 dB	±3.5 dB

Figure 6: Bandpass filter response and resulting analyzer channel display



The analyzer can judge its own uncertainty because it knows how much of its measurement is made up its own noise and how much is cable system noise. If the cable system noise is close to the analyzer's noise, then the noise measurement will too high by this correction value. The more negative the correction value, the less likely the analyzer can separate its noise from system noise, so the accuracy or uncertainty of the measurement increases. From the table, the analyzer noise correction of Figure 4 (page 64), -1.48 dB, means that the accuracy of the 41.02 dB measurement is between ±1 dB and ±2 dB.

Here is where you may help the analyzer make better automatic measurements. The analyzer's ability to see the low level system noise is called its sensitivity. If the analyzer's input is overpowered by all tne cable signals coming in, its input attenuator will be automatically increased to prevent the carrier levels from being distorted. For every increase in attenuation of 10 dB, the analyzer sensitivity is reduced by 10 dB. So it is important to find the optimum attenuator setting for each measurement situation. But if the correction value, and therefore, the uncertainty, is too high for your situation, then you can help the measurement by following the diagram in Figure 5.

Here is an example: The analyzer makes the C/N measurement automatically. This is represented as the block at (a) in Figure 5. Read the analyzer noise correction. If this value is between 0 and -3 dB, represented by (b), then the uncertainty is about as good as you are going to get. Record the data. This is represented by the box marked "Done."

If the correction is worse than -3 dB, represented by the point at (c), then you can improve the measurement by inserting a bandpass filter (BPF) in front of the analyzer, (d), and repeat the measurement. If the correction is still too high, at (c), and you are using a BPF, then you can use a 3 to 5 dB attenuator between the BPF and analyzer, as in (e). You need to use an external attenuator because the analyzer's internal input attenuator changes in 10 dB steps. On the next C/N measurement the analyzer may use the next lower 10 dB internal attenuator setting thereby optimizing its sensitivity and improving its accuracy. The analyzer noise correction should now be reduced, hopefully better than the -3 dB level.

In some cases, the analyzer may be too conservative in its setting of the at-

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than the dual pilot automatic gain control (AGC) systems used in trunk and feeder plants. This helps keep the cost of 750 MHz amplifiers down, but also restricts them to a cascade of about six amplifiers before the Bode network loses its effectiveness and peak-to-valley issues begin to occur. These issues become more pronounced in areas that experience a large seasonal variation in temperature.

Second, a rather extensive fiber-optic network is necessary because of the short cascades to which we are limited. In dense (over 80 homes per mile) areas, these short cascades are generally not a problem because you will probably reach your maximum house count size before you run out of cascade reach. However, if your plant consists of large rural areas, you will often find yourself cascade-limited and can expect some nodes serving 100 homes or less in these areas.

"The single factor that can have the largest negative effect on a project is providing the design house with inaccurate or outdated as-built maps."

Node size

With the cascade limitations of your design in mind, you will need to decide upon the maximum number of customers to be served from each f iber node.

Based on your company's present and future plans, this can be addressed in one of three ways.

The first way is to extend the reach from the node as far as possible regardless of how many customers you can serve.

Second, you can establish a maximum number of customers to be served from each node.

Third, you may be able to serve a larger number of customers from one node location with the node subdivided into pockets for future node size reduction. This option gets more expensive in rural areas.

60 vs. 90 volt

There are several advantages to powering a system at 90 as opposed to 60 volts.

The first is that a higher voltage presence results in a lower current consumption by each amplifier. Hence, a 15 ampere power supply is able to serve more amplifiers and the total number of power supplies in the plant will decrease.

Second, amplifiers running at 60 volts are generally able to work down to about 40 volts—a 20-volt range of operation. Amplifiers running at 90 volts are generally designed to operate down to 55 volts or less, resulting in a 35-volt range of operation. Therefore you should see fewer maintenance problems due to insufficient voltage.

Keep in mind that whether the amplifier is operating at 60 or 90 volts, it is drawing the same wattage from the power supply. Thus, migrating to 90 volts will not necessarily reduce your monthly power bill. Also, remember that 90 volts still poses some National Electrical Code issues.

Summary

Although we have not covered all the areas involved in a 750 MHz upgrade, the time you spend addressing these and other issues prior to the start of your project will be paid back many times over in the form of a smooth-running and cost-effective project. **CT**

What's in a specification?

There are several ways a specification can be documented by the equipment manufacturer. Here are a few of the most popular:

- *Worst-case:* a guaranteed accuracy limit, not to be exceeded.
- *Typical:* a specification that is more stringent than the guarantied spec, and is arrived at by collecting production test data on large numbers of factory instruments over a long period of time.
- *Root mean squared (RMS):* specifications that lie between worst-case and typical specs and are considered to be the best estimate of the performance you will get from your instrument. RMS bases the instrument performance on the nature of measurement parameters and statistics.
- *Over temperature:* specifications that are guarantied over an ambient temperature range are valuable for measurements in the field. These may be more relaxed than the room temperature specifications provided. If no temperature range is stated in the data sheet, the specifications are intended only for room temperature.

To illustrate the differences between these methods of specification, consider this example. A carrier amplitude measurement is specified as accurate to ±2.0 dB worst-case, at room temperature. The typical accuracy for this instrument may be ±1 dB. The RMS accuracy will lie somewhere between these two, and usually closer to the typical value, say ±1.4 dB. The RMS value is the most probable value you will encounter in your measurements over time. Over 40°F to 85°F accuracy may be degraded by ±0.5 dB. This means that realistic accuracy over temperature is the RMS value, ±1.4 dB, plus the temperature variation, ±0.5 dB, or ±1.9 dB.

tenuator. You can manually lower the attenuation by one 10 dB step during the measurement, and re-measure C/N. This is represented by (f) in Figure 5 (page 66). The danger here is overload.

Always let the analyzer measure C/N after you have tinkered with the measurement parameters. Let the analyzer make several sweeps before recording the value. This assures that any variances due to signal or distortion interference will be averaged out.

Bandpass filters

Here's a couple of tips when using a bandpass filter to preselect the channel under test. Make sure the C/N is taken at the center of the filter's flat response curve. If you take the reading on the filter's skirts, the C/N will read better than it really is because the filter skirt reduces system noise level. Also make sure the filter is peaked to its maximum response. Any reduction in filter response level reduces the analyzer's measurement range and accuracy. Figure 6 (page 66) shows a channel response when using a bandpass filter centered properly.

CTB/CSO distortions

Distortion measurements require wide dynamic range just as in C/N. But internal noise of the measurement instrument (that is, its sensitivity) is not the only limiting factor for CTB and CSO tests. The distortion created by the measurement instrument also can limit the measurement accuracy. This distortion is caused by pushing so much signal power into the SLM or signal analyzer that their input mixers or amplifiers begin to operate in their nonlinear areas, producing distortion signals that are not at the input.

CSO/CTB measurements using an SLM

Accuracy for CSO and CTB are usually specified in ±dB over a measurement range. For example, an SLM may specify a CTB accuracy of ±1.5 dB for a measurement range of 40 to 50 dB, with the provision that the total power to the input of the SLM is less than -20 dBmV. Since the total power of most systems is far above this level, a bandpass filter is required. The SLM's data sheet may or may not make this clear. Measurements with the BPF in place are usually accurate and repeatable to the specified levels, however, most SLMs do not have the capability of measuring CTB or CSO further down than about 50 dB from the peak carrier level because of their sensitivity. CSO and CTB measurement procedures are simple with an SLM, but require that you have assistance at the headend to turn off the modulation (for CSO) and/or carrier (for CTB).

CSO/CTB measurements using a cable TV analyzer

The signal analyzer is capable of a much wider measurement range than the SLM. A typical range for CSO and CTB is 50 to 75 dB down from the carrier peak. In addition, the modern cable TV analyzer has features to make the measurement easier and more automatic. One feature, gated sweep, allows CSO measurements to be made on most modulated signals.

As in C/N, accuracy varies with the actual distortion level because, as the distortion signal gets closer to the noise floor of the analyzer, it becomes more difficult for the detection circuits to capture. As an example of accuracy, a CSO at 65 dB may be accurate to only ±4 dB, whereas at 53 dB the accuracy may be ±1.5 dB. Because the analyzer's accuracy is determined by an interaction of its noise floor, input power handling capability and internal distortion, CSO/CTB specifications are usually given in a graphical form such as shown in Figure 7 (page 71). In this CSO specification graph, the distortion level is plotted along the vertical axis, increasing toward the top. The peak power of the carrier is plotted along the bottom of the graph, decreasing to the left. For the same distortion levels, lower carrier levels produce less accurate results because the distortion product is closer to the analyzer's internal noise. This is the same effect as in the C/N measurement. Similarly, higher CSO numbers (lower distortion) are less accurate because the distortion is closer in amplitude to the analyzer noise and/or the internally generated distortion of the analyzer.

The cable TV analyzer tries to prevent internal distortion from being recorded as system CSO/CTB, but there is one quick manual test you can perform to check suspiciously high CSO/CTB signals during the automatic measurement. While looking at the distortion products, change the analyzer's input attenuator and watch the signal levels. If the level changes correspond exactly as the value of the attenuation, that is, they go down (or up) by 10 dB as you increase (or decrease) the input attenuator by 10 dB, then they are legitimate distortion products. Otherwise,

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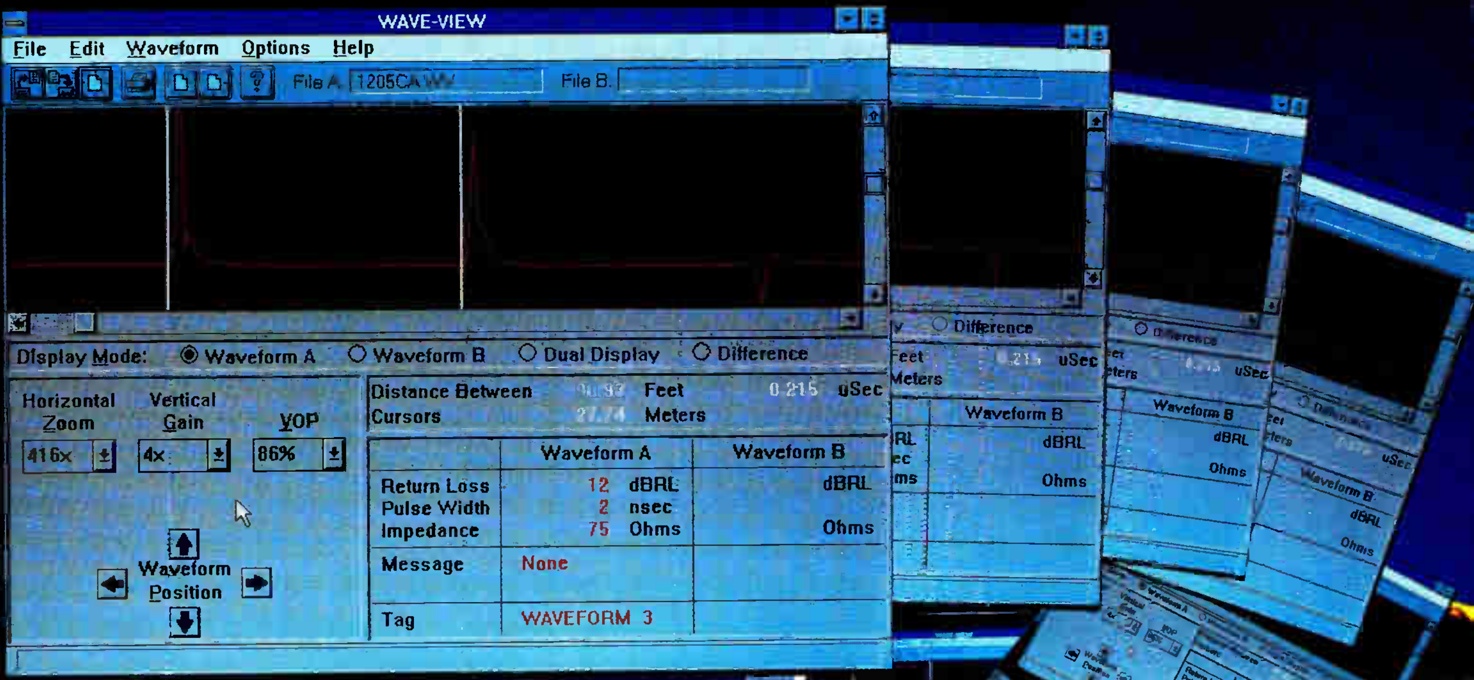

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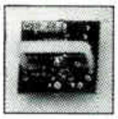

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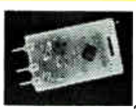

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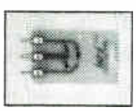

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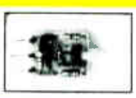

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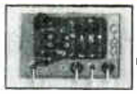

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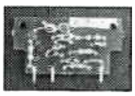

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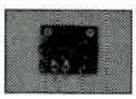

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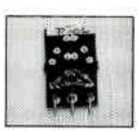

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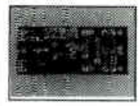

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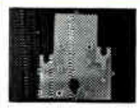

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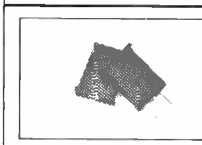

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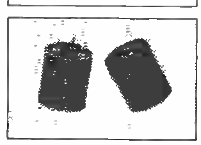

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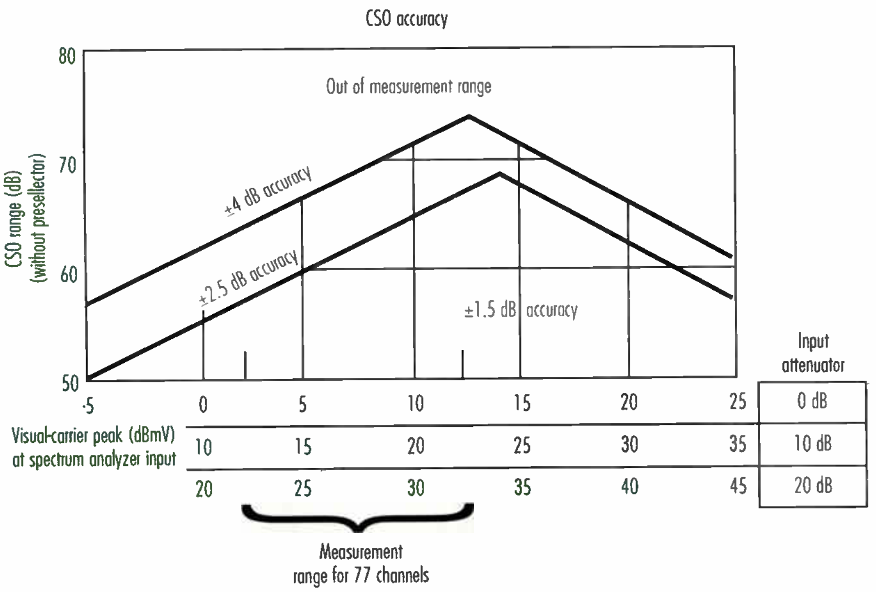
Figure 7: CSO accuracy (without external preselector filter)



set the attenuator to the highest value at which the distortion signals "track" the attenuation changes, and you will be assured that the CSO/CTB is from your system not the analyzer.

If you are using a preamplifier, make sure that the attenuation changed is at the input to the preamplifier and not just the analyzer. The distortion could be caused by the preamp or a combination of preamp and analyzer.

Conclusions

Good measurement practices must be applied to your daily measurement procedures whether they are manual or automatic. If your results are tough to repeat or too good to be true, you need to look closely at the measurement procedures. The errors are most likely a result of inadequate test equipment specifications, poor equipment maintenance, tough measurement conditions or improper measurement procedures.

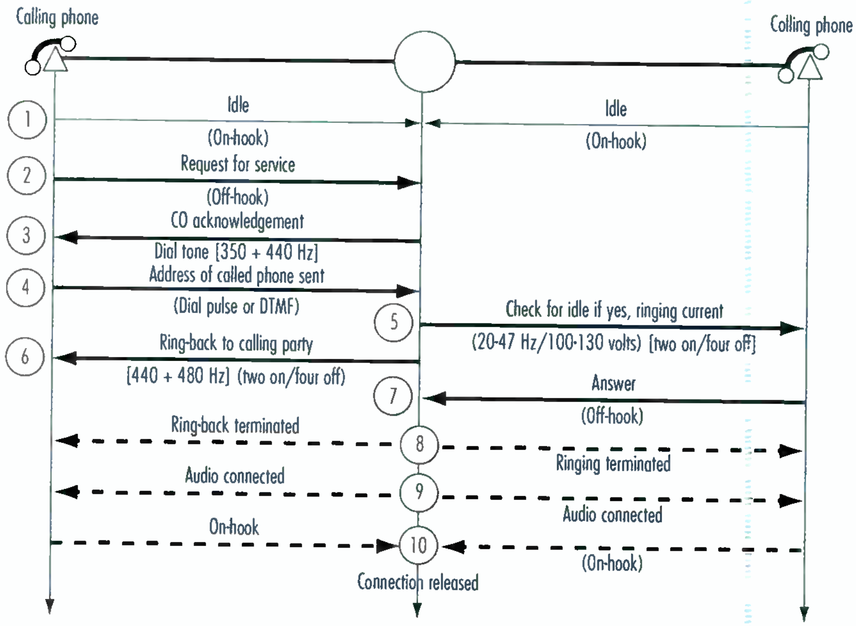
Carrier level accuracy guard band ensures system flatness compliance. Gross amplitude errors are often a result of improper bandwidth settings in unscrambled channels or too short dwell times when measuring sync-suppressed scrambled channels. Automatic C/N measurements can be verified on some equipment using the built-in appraisal feature that checks its own accuracy; and there are a number of procedural changes you can make to improve C/N accuracy. Automatic CSO/CTB measurements have similar accuracy constrains as C/N tests, plus the distortion generated by the test equipment itself. Fortunately, internal test equipment distortion is easily identified and eliminated using input attenuation. **CT**

By Randy Reynard

Basic telephony overview — Part 2

In the first installment of this article ("Communications Technology," November 1995, page 70), we investigated the telephone set and subscriber loop. In this part, the discussion turns to call processing and switching. Switching represents the real "work" in telephony and is used in transmitting a great majority of our telephone calls through the telecommunications network. Part 3 will look forward into new technologies and how the advent of digital transmission is changing the look of the telephone network.

Figure 4: Call progress sequence (within one CO)



In the early days of telephony, connections were made manually by an operator physically plugging a cord connected to the originating phone into a jack that was connected to the terminating phone. The operator controlled the calls, and all telephone calls depended on the operator for processing. No operator, no calls. Unfortunately, operators could be less than reliable and sometimes less than totally scrupulous, sharing information made during telephone calls that could benefit relatives or friends.

The inefficiencies (and problems) with local exchange operators prompted an undertaker in Kansas City, MO, named Almon Strowger to invent a mechanical switch that would eliminate the need for an operator. Strowger's switch depended on electromagnets to control a rotary switch's position from one phone connection to up to 100 others by a method of horizontal rotation and vertical stepping. This device was sometimes known as a stepper switch. The control of the switch was direct from a dial-pulse phone, which interrupts the battery current from the exchange and trips the electromagnet's levers. There were many mechanical inefficiencies to this "click and bang" switch, but the new switch did succeed in cutting out the intermediate personnel and resulted in a more reliable (and secure) local exchange system.

There were several other stepping mechanical switches, all of which had similar problems to those found in relay systems, including arcing, metal fatigue and general wear of contacts. Eventually, the crossbar was invented, which was another type of mechanical switch that did not require as much physical motion and space. As the name implies, the crossbar switch utilizes a connection made by rotating bars with contacts physically embedded into the bars so that each bar lines up in a position to make contact between selected lines. This switch required a control system that initially consisted of analog computers to match pulses coming in on the phone line with associated voltage (and eventually numerical) values.

The call process

Electronic switches eventually evolved to handle analog phone calls. These ranged from simple transistor (and diode matrix) switches to the most sophisticated digital switches in use today. Regardless of the technology of the switch, call processing remains essentially unchanged. Figure 4 provides a graphic representation of the following simplified call processing process.

Before a call takes place, both phones remain idle. There is no loop current passing through the circuit except that battery voltage from the central office (CO) is present at both ends (48 volts direct current and positive ground). The caller decides a call will be made. The phone at the calling end is taken off-hook. The CO detects the off-hook due to a flow of loop current through the calling phone. The CO responds to the call request by returning dial tone. The caller then signals the address of the called phone by either dialing with the dial-pulse dialer or by pressing buttons that cause tones to be sent. The CO switch receives and translates the signaling into the circuit position of the called phone. It checks the called phone to ensure that it is idle and, once that is determined, sends the ringing current. At nearly the same time, a synthesized ring-back tone is sent to the calling party to indicate that the call is being processed. →

Randy Reynard is technical training manager for Antec Corp. in Englewood, CO.

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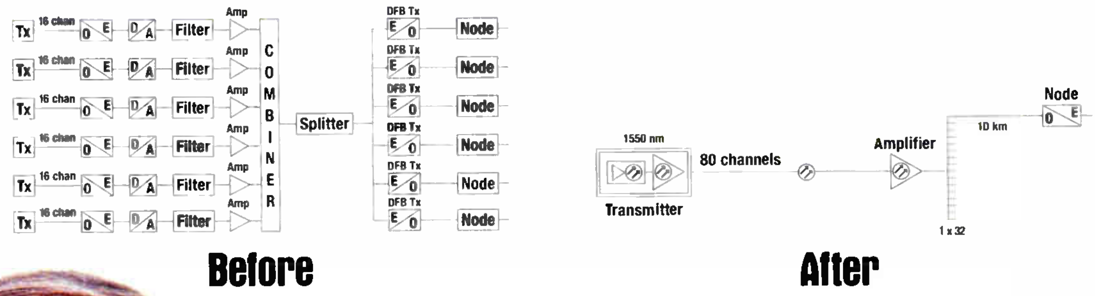

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17	43	69	95	121	147	173	199	225	251	277	303
18	44	70	96	122	148	174	200	226	252	278	304
19	45	71	97	123	149	175	201	227	253	279	305
20	46	72	98	124	150	176	202	228	254	280	306
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23	49	75	101	127	153	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 Telecommunications Engineers)?
01.__yes 02.__no

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

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

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

D. In the next 12 months, what cable equipment do you plan to buy?
30. ___ Amplifiers
31. ___ Antennas
32. ___ CATV Passive Equipment including Coaxial Cable
33. ___ Cable Tools
34. ___ CAD Software, Mapping
35. ___ Commercial Insertion/ Character Generator
36. ___ Compression/Digital Equip.
37. ___ Computer Equipment
38. ___ Connectors/Splitters
39. ___ Fleet Management
40. ___ Headend Equipment
41. ___ Interactive Software
42. ___ Lightning Protection
43. ___ Vaults/Pedestals
44. ___ MMDS Transmission Equipment
45. ___ Microwave Equipment
46. ___ Receivers and Modulators
47. ___ Safety Equipment
48. ___ Satellite Equipment
49. ___ Subscriber/Addressable Security Equipment/ Converters/Remotes
50. ___ Telephone/PCS Equipment
51. ___ Power Supps. (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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12	38	64	90	116	142	168	194	220	246	272	298
13	39	65	91	117	143	169	195	221	247	273	299
14	40	66	92	118	144	170	196	222	248	274	300
15	41	67	93	119	145	171	197	223	249	275	301
16	42	68	94	120	146	172	198	224	250	276	302
17	43	69	95	121	147	173	199	225	251	277	303
18	44	70	96	122	148	174	200	226	252	278	304
19	45	71	97	123	149	175	201	227	253	279	305
20	46	72	98	124	150	176	202	228	254	280	306
21	47	73	99	125	151	177	203	229	255	281	307
22	48	74	100	126	152	178	204	230	256	282	308
23	49	75	101	127	153	179	205	231	257	283	309
24	50	76	102	128	154	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 Telecommunications Engineers)?
01.__yes 02.__no

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

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

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

D. In the next 12 months, what cable equipment do you plan to buy?
30. ___ Amplifiers
31. ___ Antennas
32. ___ CATV Passive Equipment including Coaxial Cable
33. ___ Cable Tools
34. ___ CAD Software, Mapping
35. ___ Commercial Insertion/ Character Generator
36. ___ Compression/Digital Equip.
37. ___ Computer Equipment
38. ___ Connectors/Splitters
39. ___ Fleet Management
40. ___ Headend Equipment
41. ___ Interactive Software
42. ___ Lightning Protection
43. ___ Vaults/Pedestals
44. ___ MMDS Transmission Equipment
45. ___ Microwave Equipment
46. ___ Receivers and Modulators
47. ___ Safety Equipment
48. ___ Satellite Equipment
49. ___ Subscriber/Addressable Security Equipment/ Converters/Remotes
50. ___ Telephone/PCS Equipment
51. ___ Power Supps. (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 Meter
76. ___ Signal Level Meters
77. ___ Spectrum Analyzers
78. ___ Status Monitoring
79. ___ System Bench Sweep
80. ___ TDRs
81. ___ Video Test Equipment

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

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

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

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

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

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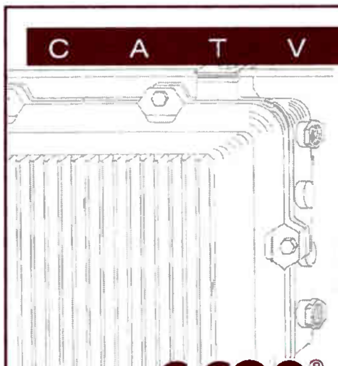
When the called party answers the call, a flow of loop current is detected by the CO and ringing and ring-back are terminated. In the most modern systems, a short test tone (inaudible to most subscribers) is sent through the network to test continuity. Then, the audio is connected. When the parties are through with the call and return their phones to the on-hook status, the CO is signaled to show that the call is complete. The CO then disconnects the path and returns everything to an idle state.

If a call is placed to a phone that is not in the same CO as the caller, a much more complex process takes place. For the purpose of this discussion, the same general process is followed, but there may be several intervening switches, each with "routing tables" that tell the switch how to handle the call and which other switch(es) will be required to complete the call.

If a long distance call is made, the customer's selection of a long distance carrier determines which carrier will carry the call. The call destination information is sent from the local exchange carrier to the long distance company, often called the interexchange carrier (IXC). For instance, a call from Salt Lake City to Miami could pass through Phoenix, AZ, Denver, Dallas, Kansas City, MO, Chicago, Atlanta and Orlando, FL, before it reaches its destination. While this process may seem circuitous, the IXC will always process calls in the most efficient and economical way possible. IXCs will select, test and activate the primary call route, and some carriers will determine a secondary route that place the call on standby in case the first route becomes unusable during the call. Most customers in this type of system would hear, at most, a slight click when the call is transferred from the primary to secondary route.

The media used by telephony includes twisted-pair copper, coaxial cable, terrestrial microwave, fiber optics and satellite transmission. Coax, terrestrial microwave and satellite transmission have given way to fiber optics over the last few years, and it is uncommon for calls to be carried any way other than digitally and over fiber, especially in the long-haul networks of today.

There are several topologies for handling telephony in the new era of technology. In the third and final installment of this series, we will look at some of those topologies and see where we might be headed in the near future. **CT**



New System Combines Video, Ethernet and T1

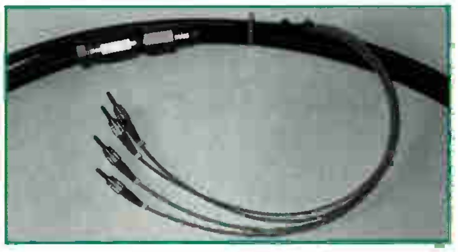
A unique new multiplexer, the Series 7000 Supermux™, will multiplex two baseband video channels, two audio channels, Ethernet, T1 and RS232 data. The product, developed by Radiant Communications, combines information via a high speed TDM system and transmits it both ways over two fibers for distances up to 70 Km. A one fiber option is also available.

Reader Service Number 254

New Cost-Effective Last-Mile Telephony Products

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

Reader Service Number 255



Fiber Optic CATV Drop Cables

Radiant offers a full line of fiber optic cable plant products. The company guarantees drop cables with back reflections of –60dB for ultra polish terminations and –70dB for angle polish terminations. Available from two to twelve fibers with customer specified node connector. Also available are fiber optic assemblies, couplers, fiber management systems and the industry's first and best low backreflection attenuators— both fixed and variable.

Reader Service Number 256

By Cable Television Laboratories

Opportunities in high-speed data

The big selling point for cable modems is simple: a tenfold-or-better increase in data rates for on-line services and the Internet.

Andy White, senior information systems specialist for CableLabs, thinks these speeds — leaving telco POTS (plain old telephone service) and ISDN (integrated services digital network) in their dust — will "fundamentally change the nature of the Internet" for the user. Why?

In recent characterization studies at CableLabs, White and his CableLabs colleagues concluded that with text and simple graphics, the user's experiences of POTS and ISDN (at 14.4 kbps to 156 kbps) vs. cable modems (at 10 Mbps or higher, depending on what the customer wants to pay for) are "not appreciably different." But with multimedia content — audio, video and animation — at 10 Mbps, the difference becomes dramatic: "The high speed comes into its own when you are moving large hunks of data."

The Internet, White said in a recent interview, "has literally been transforming itself every nine to 12 months." For example, yesterday's newsgroup model is giving way to the World Wide Web metaphor. What's next? Today's model in which audio and video are downloaded for subsequent use will give way, at cable modem speeds, to "streaming," meaning the user clicks on an icon and the sound or video begin instantly and in real-time, said White. A crude version of streaming audio is in use already in Internet/telephone and Internet/radio services.

The result, adds White, will be "real-time multimedia, including a form of video-on-demand (VOD), on the Internet. All sorts of new services will be enabled. This presents a unique opportunity for cable operators and one that I hope they will capitalize on."

The accompanying figure illustrates one approach to provide two-way data communication through the RF plant from the Internet to the home. Internet access to the headend is provisioned via dedicated high-speed circuit(s) typically obtained through an interexchange carrier (IXC) or local exchange carrier (LEC) to the Internet backbone, although smaller systems may more cost-effectively purchase this service from an Internet access provider (such as AlterNet, BBN, Netcom, PSI, etc.).

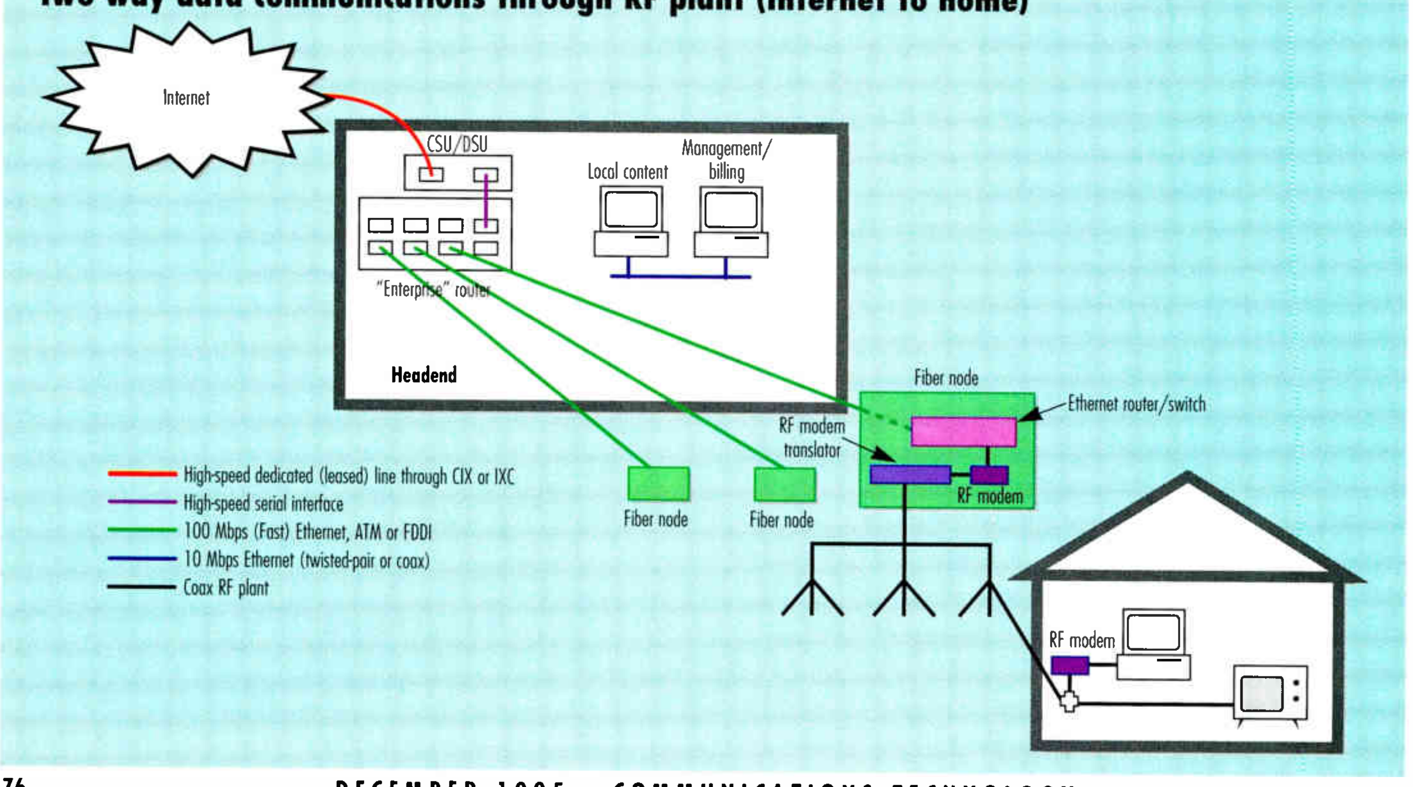
In the headend, an enterprise router connects local content servers and network management and billing workstations with the data traffic to and from both the Internet and the RF network. By linking routers at multiple headends, larger network service can be provisioned.

In most typical scenarios, high-speed data connections will be established to individual fiber nodes serving 250 to 2,000 homes. At the fiber node, a smaller bridge/router (or possibly a high-speed Ethernet/ATM switch) will connect traffic from nodes on the RF plant to the enterprise router at the headend.

Within the two-way RF plant, one RF modem at the fiber node will "speak" to all other RF modems located in customers' homes.

Major decisions confront cable system designers as they bring up modem

Two-way data communications through RF plant (Internet to home)



HEADENDS THAT SERVE WELL INTO THE NEXT CENTURY.

While digital technology will become commonplace in the future, most subscribers today still live in an analog world. That's why you need to invest in headend solutions which support both present and developing video communications applications. Solutions which let you make the transition only when it makes the most economic sense. That's why you should choose Scientific-Atlanta. With the industry's broadest line of headends, we offer you more options, with more advanced technology than anyone else. So no matter how you plan to compete, plan to make Scientific-Atlanta your headend partner.

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Reader Service Number 46

service, White noted. In terms of hardware, three "pretty straightforward" ingredients are needed, which include the following (see accompanying figure on page 76):

- A connection between the headend and the larger Internet.
- Some sort of routing mechanism, presumably at the headend but possibly elsewhere.
- Equipment at the customer site to talk to the subscriber's PC or other computer equipment.

The headend is where the cable plant, which functions as one or more local area networks, is tied into the Internet, "and the Internet is really nothing but the biggest wide area network there is," White said.

Typically present at this interconnect are frequency translators, RF modems, data routers and servers storing the most frequently accessed content.

A major design decision involves whether to be a "bit pipe" or a "value-added carrier," in White's words. Some MSOs will link up their headends to the points of presence (POPs) of partnered on-line service companies, like CompuServe, America Online, Microsoft Network or Prodigy, leaving many value-added functions to these partners. Those who choose to create their own "value-added" services, such as Tele-Communications Inc.'s announced @Home service, will connect directly to Internet backbones with no on-line service provider in the loop.

At the network level, upgrade decisions many MSOs are making now — about fiber, amps, node sizing and network management tools — all will impact on their systems' ability to transmit high-speed data, White noted.

Another decision is upstream signaling. White noted that although all MSOs apparently want to use cable plant RF upstream eventually, some "will undoubtedly choose to use a telco return path initially in order to bring the service to market in a timely fashion."

At the customer premises, perhaps the biggest decision is whether to go with asymmetric modems, which are faster downstream than upstream, or with more expensive symmetric modems, which support the kind of high-speed uploading needed for serious telecommuting or videoconferencing, he said.

Caches and backbones

Since "the Internet is scattered all around the planet" and disk space is getting cheap, White expects to see "a huge move toward caching." People, he says, are unlikely to want to pay for 10 Mbps-or-greater connectivity if they're pulling material from a remote server that has a much slower Internet connection. Because of this problem, White thinks cable companies may want to cache frequently accessed content in "several gigabytes" at their headends. One problem he sees as solvable is making sure users get content that's as current as that on the source server.

Guaranteeing high-speed throughput also will require that cable companies' connections to Internet backbones, and the backbones themselves, all be extremely fast, he noted.

Cable companies "will need to have good traffic models" so they're sure their flat rates are high enough to cover what they will be paying Internet backbone providers, who have already announced they intend to meter and bill for the aggregated traffic they carry, White said.

Cable modems and PCs will not, in White's opinion, usurp the role envisioned for digital set-tops, video servers and TV sets. "Computers are making great strides, but they're still primarily meant for data communications and manipulation of data," he said.

He sees television and cable modem services being complementary. Movie trailers (in real-time), promotions and giveaways, interactive ads and other communications-intensive services — these will all be huge modem service features, he predicts.

"People like getting information when they want it through their computer. But one-way mass distribution, pushing a lot of video down to the customer, is still the core cable business. It's been optimized for that and will continue to be so."

Besides, he adds, "The Internet is not set up to take the stream rates of a video server." That may change eventually, but White likes to remind people that cable modem services will be just one fairly narrow two-way channel amid the hundreds of digital video channels on a future cable systems.

"Cable modem service will provide a big pipe relative to what most people are used to for data communications. But it's really only a small segment of the pipe that the cable industry is already delivering." **CT**

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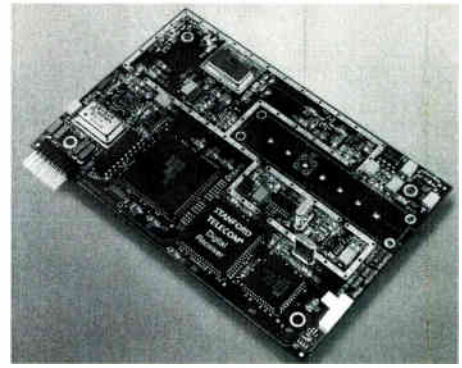
Headend receiver



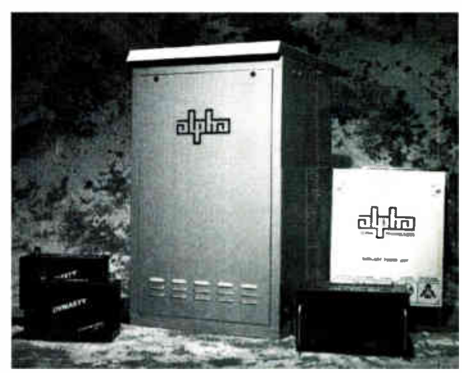
The Telecom Products Group of Stanford Telecom announced the STEL-9244 burst receiver for interactive cable TV digital headend equipment. The unit offers a ready-made solution to one of the most difficult technical challenges in implementing interactive broadband services: providing the upstream demodulation functions that enable information transmitted by subscribers to be received by the headend equipment.

While the traditional downstream channel is relatively straightforward to implement, the upstream channel is more difficult because it consists of hundreds of subscribers sending information through a single line. This funneling of digital signals is compounded by the addition of noise and other interference.

To meet this challenge, this standard board-level QPSK headend receiver provides robust performance in the presence of impulse noise and other channel degradations, while providing the necessary digital signal processing to demodulate signals that have been optimized for upstream transmission over hybrid fiber/coax systems. Prototypes of the unit have been tested using actual upstream echo profile measurements from cable plants. The results showed degradations less than 0.5 dB, according to the company.

The receiver operates in the 5-40 MHz range at 2.59 Mbps. This performance allows efficient utilization of the spectrum allocated to the return path, and is suitable for both telephony and data applications.

Reader service #309



UPS systems

Alpha Technologies introduced the CPS Series of expandable uninterruptible power supply systems for cable TV and broadband communications networks. Designed for local powering of hybrid fiber/coax nodes, the units provide unprecedented powering flexibility, according to the company.

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vary drastically by subscriber (depending on the services provided), these units fill low-power requirements and permit additional capacity to be added as new services grow. The standard configuration consists of a single power supply module and battery string. By adding an additional power supply module, the overall capacity can be expanded to more than 3 kw. Additional batteries and/or a generator can be added for extended standby times.
Reader service #306

Power meter, light source

Trilithic's TR-2040 optical power meter and Series 3000 light sources are said to be designed to provide years of dependable service in the most rugged, demanding applications. The company says that aluminum casings, tactile membrane switches and rubber impact bumpers give these units exceptional resistance to shock and water damage, and an optional padded case adds even more protection.

Both units operate for eight hours on a charge and have a special quick-charge mode for fast recovery. The standard TR-2040 operates at four wavelengths: 780, 850, 1,300 and 1,550 nm. The light sources are available in all common wavelengths.
Reader service #312

Leakage detector/SLM

Wavetek introduced the Interceptor CLI-1450, a combination leakage detection and signal level meter. It incorporates a highly sensitive leakage detection mode and MicroStealth measurement technology to make it the most versatile meter for advanced cable networks, according to the company. →

The lightweight hand-held meter features a leak detector with the sensitivity and accuracy required to find and measure cable leaks, but still includes all the powerful features of MicroStealth SLMs: multichannel measurement displays, a go/no-go quick check function (to ensure FCC compliance and reduce subscriber call-backs) and an easy-to-read, high-resolution LCD.

With the growing implementation of digital carrier transmission, guarding against ingress is important. More installers are required to certify cable installations by checking for leaks. This unit also can be used by leakage crews, and with leakage GPS tracking systems. It also provides signal level measurement in cases where repairs are required. In addition, the headend video "tagging" option differentiates leaks in overbuilt systems, increases detection range and limits false alarms.
Reader service #310

MDU amplifier

Lindsay Specialty Products unveiled the 7000 Series MDU amplifier, which utilizes the company's patented Dynofin housing. The tamper-proof amp features high-tolerance NC milling, which produces cool running operation, and greatly improved EMI isolation, according to the company.

The unit also features two-way symmetrical performance, 5-42 MHz reverse, 1 GHz forward bandwidth, power doubling options, ALC control and many gain options to 42 dB.
Reader service #308

Active combiner

The R.L. Drake Co. added an active combiner to its line of commercial cable headend equipment. The AC16 active combiner and PC16 passive combiner create a series for use in cable and SMATV installations that combines the outputs of at least 16 modulators, channel processors or commercial satellite receivers onto a single coaxial cable. Together, these two units can be used for system configurations that require combining up to 77 different channels.

The AC16 compensates for loss in the system when combining multiple channels and cuts down on the amount of equipment. With this unit, an operator needs only one amplified combiner instead of a distribution amplifier and combiner.

The unit features a built-in amplifier and a gain range adjustable over a 10 dB range minimum. An additional input also is provided to allow for connection to passive combiners, and the test output is accessible from the front panel. The internal circuitry of the unit allows adjusting combined output to the same level as the other inputs. The unit also comes with a removable power cord.
Reader service #307

Hand-held SLM

Sencore introduced the hand-held SL754 Channelizer signal level meter. The unit is designed to be an affordable answer to equipping service technicians, allowing them to tune to any CATV channel in the spectrum 50 to 810 MHz, plus 5 to 50 MHz with the optional sub-band.

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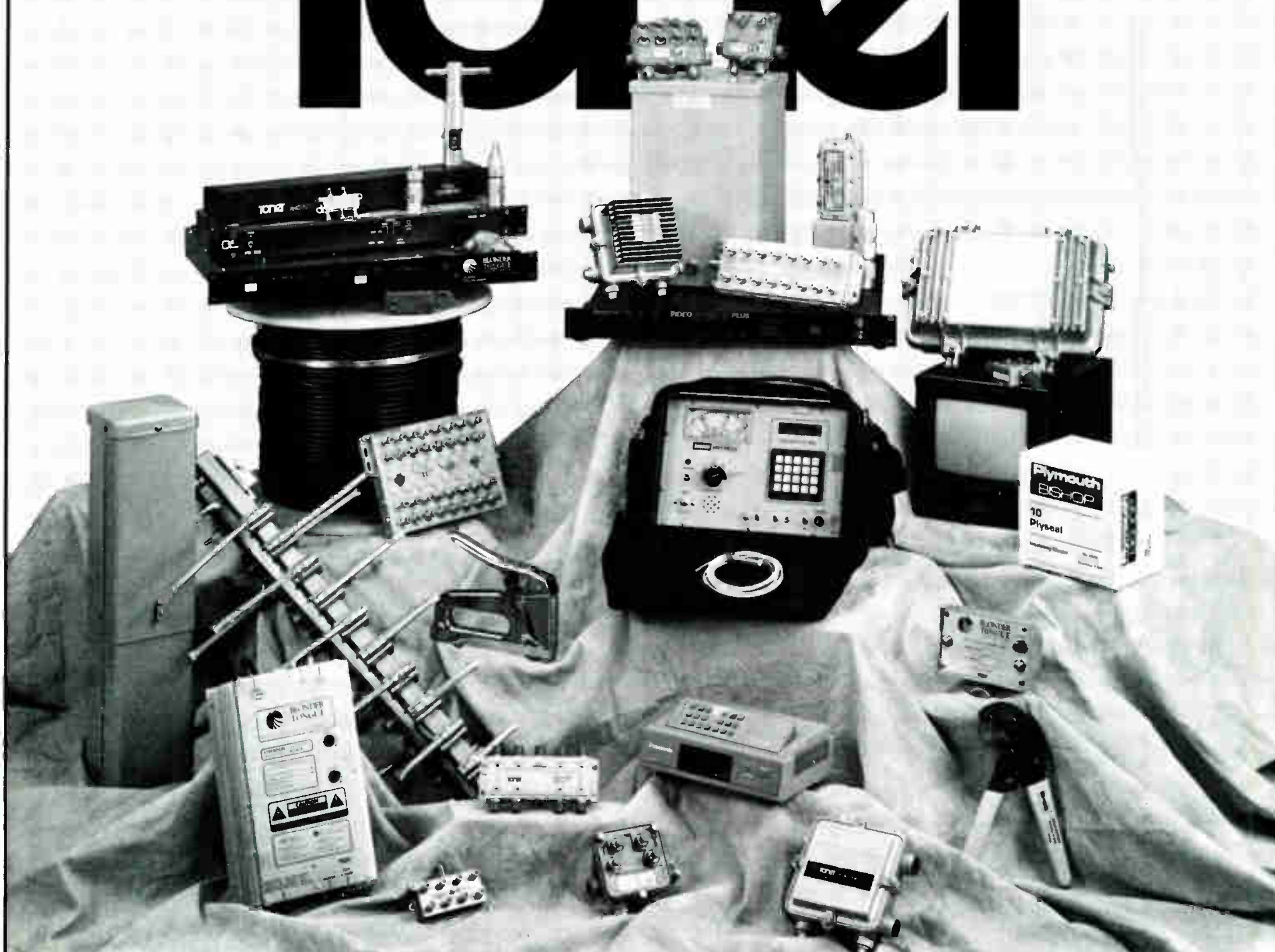

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Reader Service Number 101

lows the user to tune to any frequency to measure pilots, DMX carriers, converter control signals or other carriers used in today's modern systems. The unit eliminates the guesswork of using a manual tuning dial with hard-to-read or nonexistant channel indicators. The unit allows the user to switch between FCC standard, HRC, IRC, VHF and UHF channel plans or build a custom channel plan right from the keyboard.

The large two-line LCD is said to be easy to read even in the brightest sunlight and in the coldest weather. There are no confusing scales to interpret or attenuators to add or subtract from the readings. Attenuator functions are automatic and provide direct signal level readings from -35 to +60 dBmV.

In addition to signal level measurements, the unit enables the user to test hum on any carrier, not just a test carrier, but on any live "in use" TV carrier on the system. This eliminates the need to interrupt a customer service to get these critical measurements. The unit also allows C/N and A/V readings while simultaneously measuring video and audio levels to help in testing system performance and troubleshooting.
Reader service #304

Cleaner

HydraFoam 2020, new from American Polywater Corp., is a foaming aerosol cleaner that dissolves a wide variety of CATV and telco grime using a unique water-based, nontoxic, biodegradable and water-rinsable formula that is certified to contain no sulfur, halogens or butyl. The cleaner clings to vertical surfaces and penetrates porous materials, lifting grime with foaming action. As well, it contains no CFCs or chlorinated solvents and is safe on plastics and the environment.

Reader service #311

Transmitter/receiver

Ortel Corp. introduced its expanded frequency system transmitter and receiver that allows cable operators and network broadcasters the flexibility to locate satellite antennas up to 40 km away from studios and the headend. The new System 10000 L-band unit features an extended frequency range from 950 to 2,050 MHz, the emerging world standard for cable TV networks.

The system can transport all satellite signals over a fiber cable over long distances without repeaters or equalizers, offering flexibility in choosing antenna sites. Using the company's technology, users are able to install satellite dishes at more remote sites that provide maximum directional coverage instead of being forced to locate them in close proximity to the headend. Satellite earth stations based on waveguides and coaxial cable, on the other hand, require antennas to be virtually co-located because traditional cable experiences unacceptable signal losses at high frequencies.
Reader service #298

By Jerry Thorne

Understanding intermediate gain hybrid amplifiers

In the 1970s, a well-known cable TV instructor lectured, "The best cable TV amplifier has 20 dB gain."

In many applications in the headend or in some multiple dwelling unit (MDU) installations, the decibel vs. the dollar bill ratio finds its mark in single-hybrid amplifiers with an 18 dB or 22 dB hybrid inside. This type of amplifier works in the home when a low-cost, 10 dB gain transistor amp has too much distortion due to high output levels. The single hybrid amplifier also can provide needed channel lash-up isolation in a single headend serving multiple franchise channel lineups.

Today's installer is sometimes faced with a need for more signal in the subscriber's home. With the proliferation of VCRs, home theater system, bedroom TV set, TV sets in the den and now computer modems, many homes have four or more outlets. Changing the tap in the feeder line will get more signal inside. But of course, that will increase the tap insertion loss and lower levels for the remainder of the feeder line. Solution: Amplify the drop signal.

Amplifier manufacturers have responded with low-cost, low-gain drop amplifiers and house amplifiers with passive return, some with active return paths inside. These amplifiers work well when output levels in the +15 to +20 dBmV range are needed. For large hotel, motel and condo applications, there are many high gain, push-pull, power-doubled, feedforward and even dual power-doubled (we say "quadra-powered") amplifiers with two-way capability that work well for those applications.

Jerry Thorne is an applications engineer with Quality RF Services Inc.

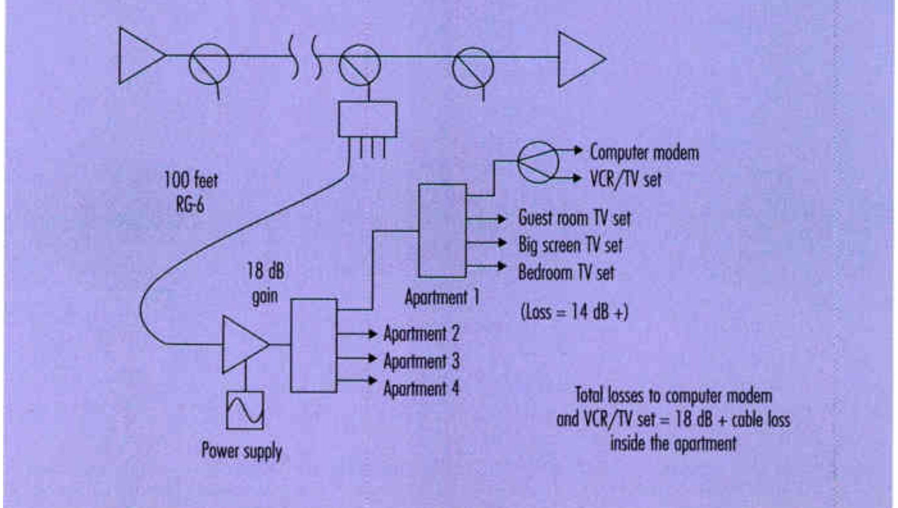
"The push-pull hybrid configuration provides a higher output capability than low-cost, single-ended transistor models."

MDU dilemma

For small MDU applications, low-cost transistor drop amplifiers with 10 dB gain are not enough. For example, in the patio home design prevalent in parts of south Florida, it's common to have four apartments, each with three bedrooms, in a single ground-level building. With these types of buildings, each residence could have four outlets, and some of those outlets could have a two-way splitter to feed a converter, TV set/VCR combination or computer modem. Just the splitter losses alone can account for up to 15 dB or more, not to mention drop cable loss and slope considerations at 550 or 750 MHz.

With this kind of small MDU environment, a low-cost single hybrid amplifier with 17 to 21 dB of gain and an active or passive two-way return path has real possibilities (Figure 1). The push-pull hybrid configuration provides a higher output capability than

Figure 1: Small MDU amplifier application



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

☛ *Exploring Fiber-Optic Architectures* — Ed Callahan, Earl Langenberg, Bob Luff, Jay Vaughan and David Willis discuss the different fiber architectures in use today, covering fiber's uses, performance and future applications. (1-1/2 hrs.) Order #T-1106, $45.

☛ *Interdiction and Other Signal Security Techniques* — Paul Harr, Roger Pence, Leonard Falter and Terry Mast define and evaluate signal security methods of preventing service theft, including positive and negative traps, scrambling, interdiction and video compression. (1 hr.) Order T-1107, $35.

☛ *Anatomy of Professionalism* — Produced by SCTE in association with the National Cable Television Association and funded by CableLabs, this outstanding program serves as an effective tutorial for BCT/E Category VII, "Engineering Management and Professionalism." Even for those who are not pursuing BCT/E certification, this professionally produced tape offers an in-depth evaluation of case studies relating directly to cable industry operations. (1 hr.) Order #T-1110, $18. **(Reference for BCT/E Category VII)**

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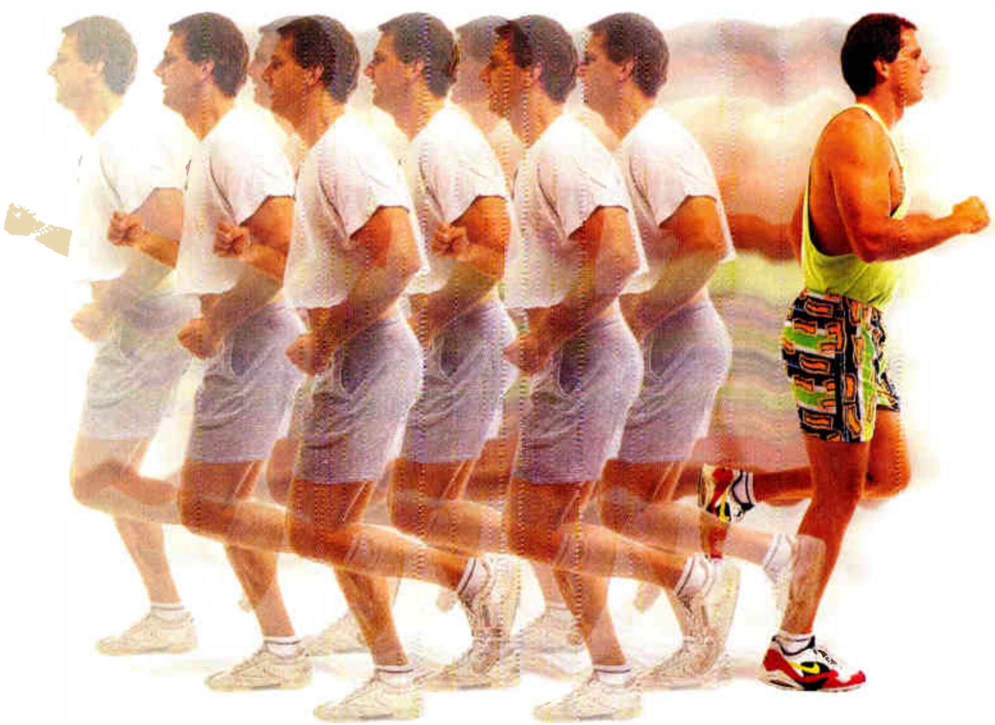

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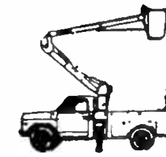

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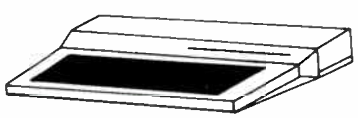

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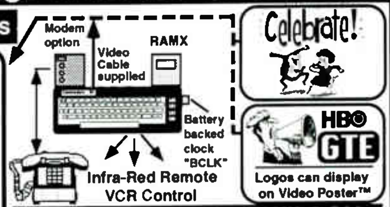

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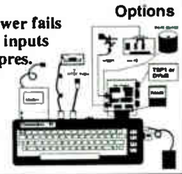

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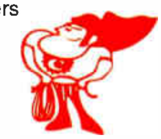

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December

4-7: Antec Fiberworks training course, fiber-optic systems, Denver. Contact (800) 342-3763.
5: SCTE Southeast Texas Chapter meeting, BCT/E and Installer exams to be administered, Walden, TX. Contact Richard Grahn, (713) 579-6319.
5: SCTE Southeast Texas Chapter meeting, BCT/E and Installer exams to be administered, Houston. Contact Richard Grahn, (713) 579-6319.
5-6: Scientific-Atlanta training course, interactive broadband delivery system overview, San Antonio, TX. Contact Bridget Lanham, (800) 722-2009.
6: SCTE Appalachian Mid-Atlantic Chapter meeting, BCT/E exams to be adminstered, Chambersburg, PA. Contact Doug Hair, (717) 243-4918.
6: SCTE Delaware Valley Chapter seminar, advanced systems and competitive access, Williamson's Restaurant, Horsham, PA. Contact Chuck Tolton, (215) 657-6990.
6: SCTE North Country Chapter meeting, Installer exams to be administered, Paragon Cable office, Minneapolis. Contact Bill Davis, (612) 646-8755.
6: SCTE Smokey Mountain Chapter Cable Technology Expo '95 vendor show, BCT/E exams to be administered, Quality Inn, Johnson City, TN. Contact Roy Tester, (615) 878-5502.
6: SCTE West Virginia Mountaineer Chapter third annual vendor show, Ramada Inn, South Charleston, WV. Contact Steve Johnson, (614) 894-3886.
6-7: Scientific-Atlanta training course, understanding hybrid fiber/coax design, Chicago. Contact Bridget Lanham, (800) 722-2009.
6-8: Scientific-Atlanta training course, hybrid fiber/coax operation and maintenance, Atlanta. Contact Bridget Lanham, (800) 722-2009.
7: SCTE Great Plains Chapter meeting, BCT/E and Installer exams to be administered, Bellevue, NE. Contact Randy Parker, (402) 292-4049.
7: SCTE New England Chapter seminar, converters, BCT/E and Installer exams to be administered. Contact Tom Garcia, (508) 562-1675.
9: SCTE Oklahoma Chapter meeting, BCT/E exams to be administered, Edmond, OK. Contact Oak Bandy, (405) 364-5763, ext. 249.
9: SCTE Cactus Chapter seminar, transportation systems, Dimension Cable Office, Phoenix. Contact

Planning Ahead

Feb. 21-23, 1996: Texas Cable Show, San Antonio Convention Center, San Antonio, TX. Contact (512) 474-2082.
Feb. 25-Mar. 1, 1996: OFC '96, San Diego. Contact (202) 223-8130.
April 15-18, 1996: NAB '96, Las Vegas, NV. Contact (202) 429-5300.
June 10-13, 1996: Cable-Tec Expo, Nashville, TN. Contact (610) 363-6888.

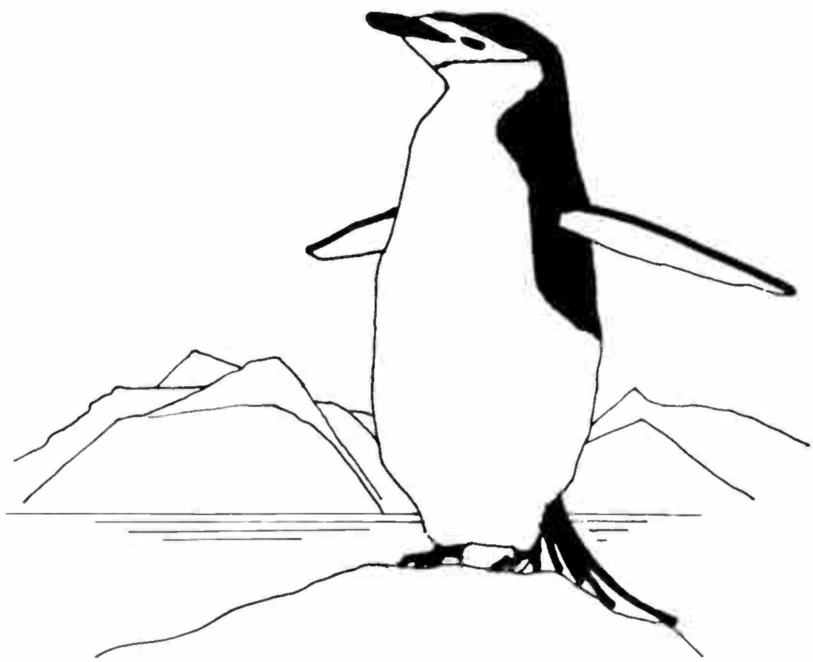
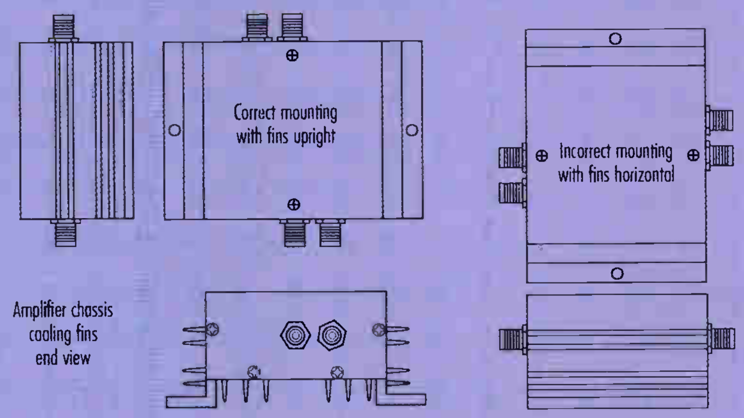


Figure 2: Amplifier mounting (right and wrong)



low-cost, single-ended transistor models. The output levels needed for these applications can easily be in the +25 to +40 dBmV range. The hybrid amplifier also has a better frequency response and some models have a plug-in pad and equalizer allowing a better chance of meeting peak-to-valley signal level requirements at the TV set.

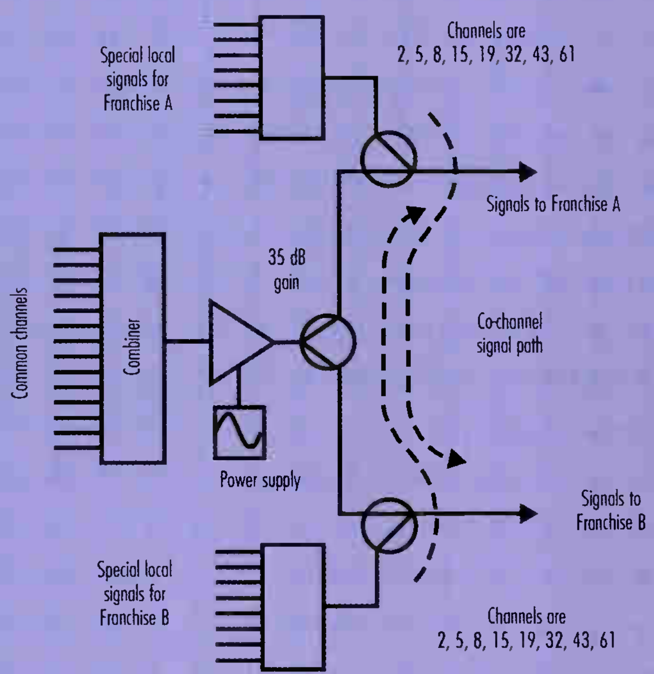
Since the hybrid amplifier generates more heat than a transistor amplifier, a finned housing is quite often used. Be sure to mount the amplifier in an upright manner on a wall board or inside the tap enclosure box to allow convection cooling (Figure 2). Remember, hot air rises. Make sure the fins will allow convection air flow upward. Don't forget about moisture in the air. Is the amplifier location in a secure, stable environment? Above or near a furnace is not a good location. Is there soot or other contaminants in the air? Is there a swimming pool nearby? Chlorine from a swimming pool will evaporate and corrode metals in the area—a real problem here in Florida and similar areas.

Keep in mind that a single hybrid amplifier has only one real fixed value of gain. An amplifier with plug-in pad and equalizer allows overall gain and slope changes from the input to output, but also allows the user to fall into a trap that can compromise carrier- to-noise-ratio (C/N) performance. Do *not* try to use a 30 dB gain amplifier when only 18 to 20 dB gain is needed. Padding down the input signal too far leads to trouble.

Determining input level

The desired output of a single hybrid amplifier, minus the gain of the hybrid, *always* dictates the input level. If an output of +30 dBmV is needed, don't use a single hybrid amplifier with a 34 dB gain hybrid. To meet the output level, the input pad and EQ would drop the signal levels presented to the hybrid to a level of

Figure 3: Poor headend isolation



Harold Mackey, (602) 352-5860, ext. 135.

11-14: Antec Fiberworks training course, digital networks, Denver. Contact (800) 342-3763.

12-13: Siecor training course, cable TV passive fiber-optic system design, Chicago. Contact (800) 743-2671, ext. 5539.

12-14: SCTE Wheat State Chapter meeting, BCT/E exams to be administered, Wichita, KS. Contact Joe Cvetnich, (316) 262-4270.

13: SCTE Badger State Chapter cable games, Holiday Inn, Fond du Lac, WI. Contact Brian Revak, (608) 372-2999.

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

13: SCTE Mid-South Chapter meeting, BCT/E and Installer exams to be administered, Time Warner office, Memphis, TN. Contact Kathy Andrews, (901) 365-1770, ext. 4110.

13: SCTE Miss/Lou Chapter meeting, Ramada Inn, Slidell, LA. Contact Austine Matthews, (601) 374-5904.

14: Society of Cable Telecommunications Engineers Satellite Tele-Seminar Program, "Fault Location in Fiber-Optic and Coaxial Cables (Part II)" from Cable-Tec Expo '94 in St. Louis, to be shown on Galaxy 1R, Transponder 14, 2:30-3:30 p.m. ET. Contact SCTE national headquarters, (610) 363-6888.

14: SCTE Central Florida Chapter seminar, fiber optics overview and restoration, Sheraton Inn East, Tampa, FL. Contact Pam Kernodle, (813) 371-3444.

14: SCTE Mount Rainier Chapter meeting, BCT/E exams to be administered, Viacom, Everett, WA. Contact Bruce Gladner, (206) 869-4116.

14: SCTE Music City Chapter meeting, BCT/E exams to be administered, Nashville, TN. Contact Kenny Long, (615) 244-7462, ext. 392.

14: SCTE Northern New England Chapter seminar, telephony/headends, Ramada Inn, Portland, ME. Contact Bill DeRochers, (207) 646-2672.

14: SCTE Razorback Chapter seminar, Arkansas one call system, Hot Springs, AR. Contact Jack Trower, (501) 327-8320.

18-19: Antec Fiberworks training course, broadband cable TV technology, Denver. Contact (800) 342-3763.

18-19: Antec Fiberworks training course, compressed video concepts and transmission, Denver. Contact (800) 342-3763.

21: SCTE New England Chapter meeting, Installer exams to be administered, Worcester, MA. Contact Tom Garcia, (508) 562-1675.

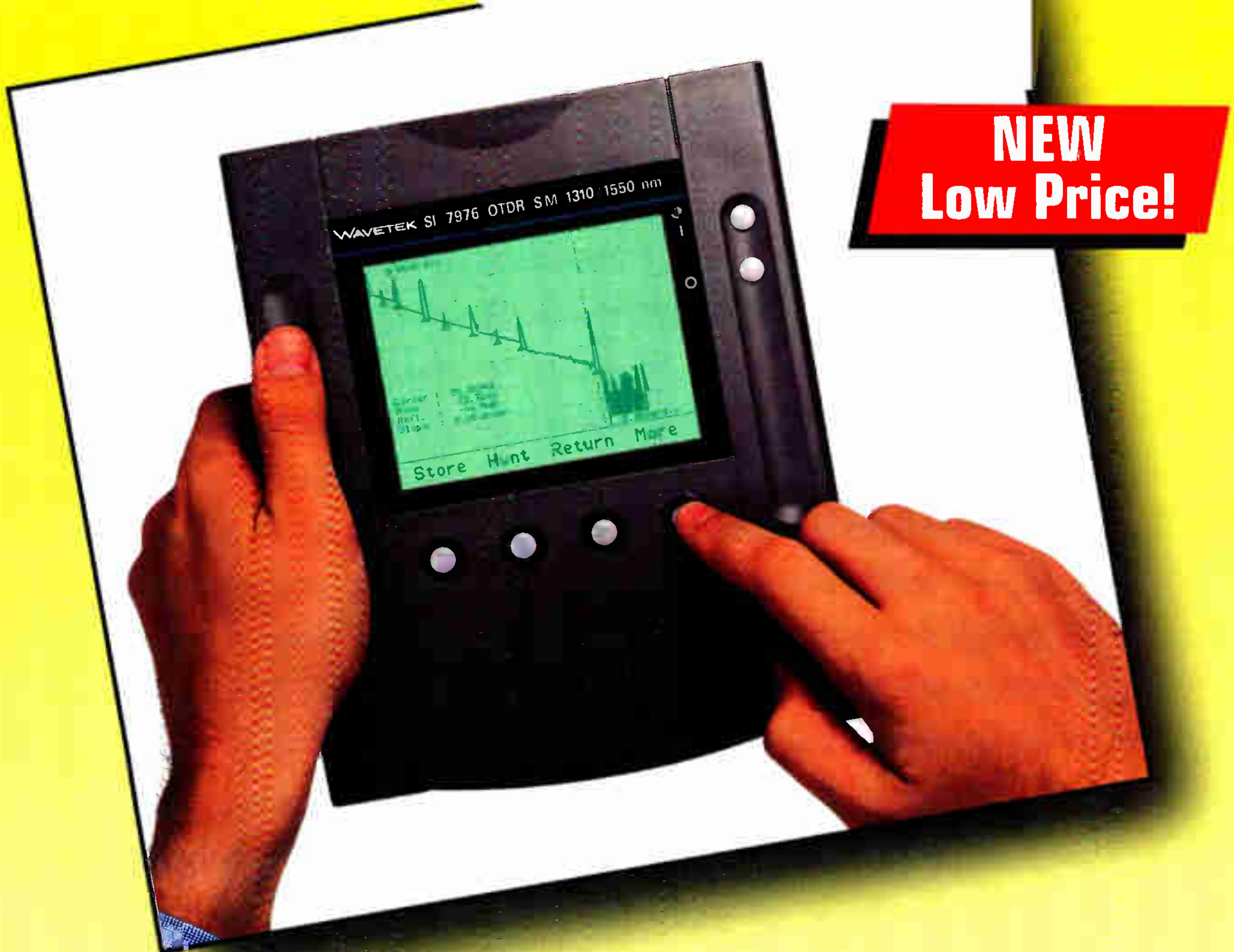
29: SCTE Wheat State Chapter meeting, BCT/E exams to be administered, Great Bend, KS. Contact Joe Cvetnich, (316) 262-4270.

January

8-10: Society of Cable Telecommunications Engineers Conference on Emerging Technologies, San Francisco. Contact (610) 363-6888.

9-11: SCTE Wheat State Chapter meeting, BCT/E exams to be administered, Wichita, KS. Contact Joe Cvetnich, (316) 262-4270.

10: SCTE New England Chapter meeting, Installer exams to be administered, Worcester, MA. Contact Tom Garcia, (508) 562-1675.



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WAVETEK

By Rex Porter

Beginning this month by popular demand, multiple choice answers are being offered for each question. Answers to the last set of questions appear first. (The last "Cable Trivia" ran on page 82 of the November issue.) Look for answers to this month's questions in a future issue (along with a new set of 10 questions). The person supplying the most correct answers (see additional requirements below) will be awarded an industry-related novelty prize (e.g., cap, water bottle, T-shirt).

Your answers need to be sent to: The Trivia Judge, *Communications Technology*, 1900 Grant St., Suite 450, Denver, CO 80203; fax: (303) 839-1564; e-mail: CTmagazine@aol.com. To be in the running for a prize, your answers need to be postmarked, faxed or e-mailed to us by the 20th of the month of the issue date that the specific trivia test appears in. The first person who sends in the most correct answers will be the award winner. Good luck!

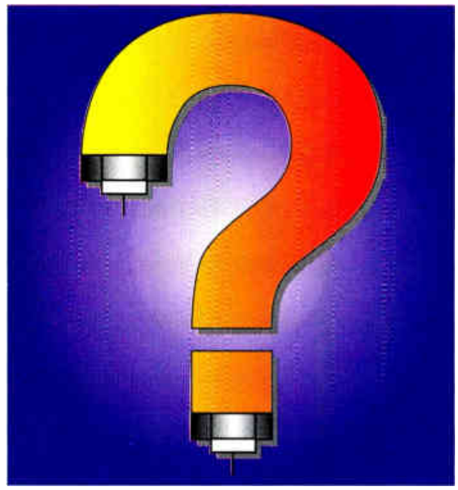
Trivia test #4 answers

1) Microwave equipment, Towers
2) CAS Electronics
3) Antec
4) Frank Drendel
5) California
6) Sigourney Weaver
7) Copyright
8) TCI
9) CATA
10) HBO

Trivia test #5

1) Thirty years ago in the April 1965 trade magazines, Jerrold listed its Model TAGC solid-state AGC amplifier at a price of:
A) $165
B) $295
C) $350
D) $400

2) A pioneer in the publishing industry and the man recognized as being responsible for creating the Cable Pioneers club is:
A) Bob Titsch



B) Stan Searle
C) Paul Maxwell
D) Al Warren

3) Thirty years ago at the 19th annual NCTA convention in Denver, Jerrold set a record for convention sales, which stood only until the following NCTA convention. During that five-day show (not including contracts for turnkeys) Jerrold had sales of:
A) $2 million
B) $5 million
C) $7.55 million
D) $10 million

4) In 1976 Viacom and Times Mirror began delivering programming on one transponder to California systems and this network was:
A) Showtime
B) Hollywood Home Theatre
C) Premiere
D) HBO

5) One of the original members of the Cable Pioneers club traveled from Minnesota to build El Paso, TX, for Teleprompter, then pulled off a real coup by purchasing the cable system in Vail, CO, from TCI for less than $1 million and selling it a few years later at an enormous profit. His name is:
A) Gene Schneider
B) Bill Daniels
C) Frank Thompson
D) Irving Kahn

6) The 1934 Communications was amended by Congress and became known as the Cable Communications Act of:
A) 1974
B) 1980
C) 1984
D) 1990

7) An alumni of General Electric, this individual became vice president of operations for ATC, left for a short stint with Viacom, and then started and sold Douglas Communications to the Tribune Co. This person's name is:
A) Bob Savard
B) June Travis
C) Dan Mezzalingua
D) Doug Dittrick

8) In 1974 the CATV industry announced the end of "fully" financed turnkeys and manufacturers cut sales and marketing staffs. At TCI, Bob Magness hired this Jerrold executive to head operations for the growing MSO. His name is:
A) John Evans
B) Bob Rosencrans
C) John Malone
D) Gus Hauser

9) In the late '70s and early '80s Times Fiber Communications offered the first fiber-optic system for CATV into the home. It was called:
A) Mini-Hub
B) Century 2000
C) Pathmaker
D) Nova 300

10) In 1981 what company purchased Teleprompter with Bill Bresnan serving as chairman of its cable operations:
A) Cablecom General
B) Westinghouse
C) ATC
D) Warner Communications

And the winner is ...

Congratulations to Neil Serafin, a sales engineer with Cable TV Supply Co. in its Denver office, for getting the most correct answers to our October "Cable Trivia."

By Bill Riker

A new building — A new future

Our national headquarters will have a new home in 1996 and I'd like to take this opportunity to familiarize the membership with the events that have led to this major milestone in the Society's evolution. Let's take an in-depth look at the building, its intended functions and activities planned to take place there in the near future.

The following is a general timeline of the significant stages in the planning and construction of the building:

- Nov. 29, 1994 — SCTE board of directors approves the 1995 budget that includes the construction of a new national headquarters building in the Pickering Creek Industrial Park.
- June 5, 1995 — An eight-acre tract of land in the park is purchased.
- June 29, 1995 — The construction contract for a 15,000 square foot building is executed.
- July 18, 1995 — A groundbreaking ceremony is held on the new site.
- August 2, 1995 — Work on the building foundation begins.

As of this writing, the exterior walls, roof and floor are complete and there is water and electric service into the building. In November, work began on all interior construction including walls, wiring, sprinkler systems and flooring. By the end of November, the parking lot was paved and all landscaping completed. Work is proceeding on schedule, with completion set for the end of the year, and the staff is scheduled to move in around mid-January.

The old and new

One of the building's many exciting features will be the in-house cable museum. It seems fitting to have an exhibition displaying our technical heritage. It will be a tribute to the founding and evolution of the cable industry in addition to an educational display of vintage CATV hardware.

The museum's first piece of equipment is a Model 704 signal strength meter donated by Darrell Galatas of Mandeville, LA. Donations to the museum are welcome, as we have a great need for relevant historical hardware. Anyone wishing to contribute vintage equipment in good condition should contact Roberta Dainton at (610) 363-6888.

We also plan to display modern equipment demonstrating the direction in which the industry is headed. To date, new equipment has generously been donated by General Instrument, Channel Master, Standard Communications and Times Fiber. All contributors, whether donating new or vintage hardware, will be recognized with plaques displayed in the museum near the donated items.

There also may be temporary displays from the National Cable Television Center and Museum. These displays would be rotated between the NCTCM's new facility in Denver and SCTE's national headquarters.

Another benefit of the new building is its huge warehouse, which will comfortably store the many publications, videotapes and other merchandise made available to the Society's membership. This will facilitate our product fulfillment process, as SCTE currently has very limited on-site space for this material and much is currently housed at three off-site rented storage units. The warehouse will provide easy access to the materials, which will greatly increase the efficiency of distribution.

Yet another feature of the new facility will be its ample meeting space for committee meetings, working groups, training seminars, etc. The building will have a conference room for groups of up to 20 people that can be used for board meetings and small gatherings. There also will be a larger room capable of holding up to 40 people. This can be used for larger meetings and training activities. Up until now, we were unable to offer such services because our present national headquarters building is too small. This newly acquired space will accommodate increased on-site member interaction.

A complement to the meeting space is a large cafeteria that can be used to cater lunches for meetings and training

sessions. The cafeteria area also will better accommodate the Society's growing staff.

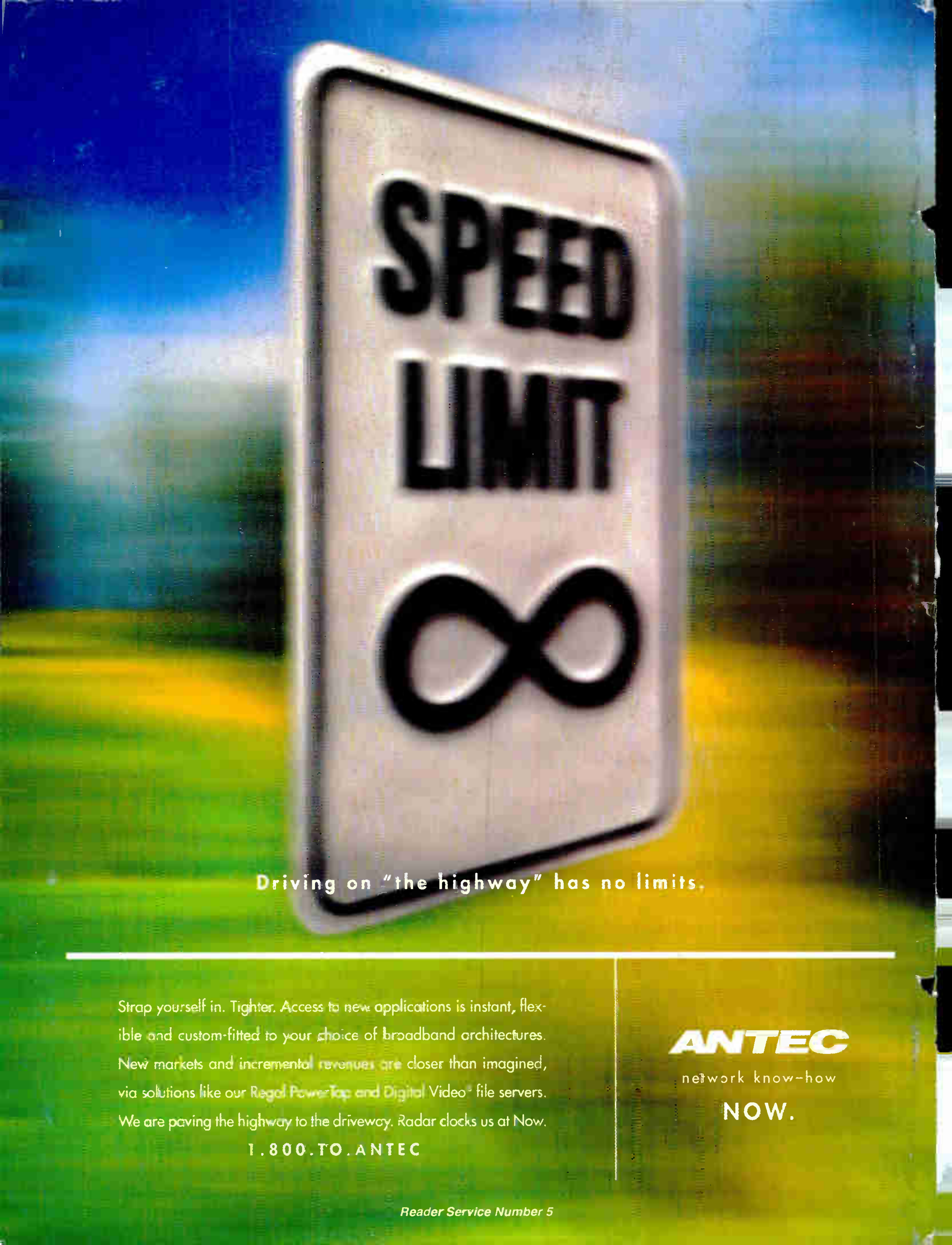
At Expo '95, the Ohio Valley Chapter generously donated $1,500 to the Society for the purchase additional furnishings needed for the new building, and I would like to once again thank the Ohio Valley Chapter for its greatly appreciated contribution. Because we have not been able to host meetings in the present headquarters, we have no furniture for such activities. We will need to furnish both the large and the smaller conference rooms, and all donations will be noted with accompanying plaques.

The grand opening ceremony of SCTE's new national headquarters is planned for February 1996, with subsequent "open houses" to be held to introduce the building to the Society's membership and the industry in general. Present at the grand opening will be members of the press, SCTE's board of directors, the architect and developer, local dignitaries, township representatives and the staff. At this time, the board will hold its first meeting in the new facility.

And there's more: We also plan to offer four training seminars at the new site during 1996. These will be among the first activities utilizing the newly acquired meeting space.

The staff looks forward to relocating to the new facility and putting its plans of better serving the membership into motion. As always, I will keep you informed of any new developments within the Society. **CT**

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