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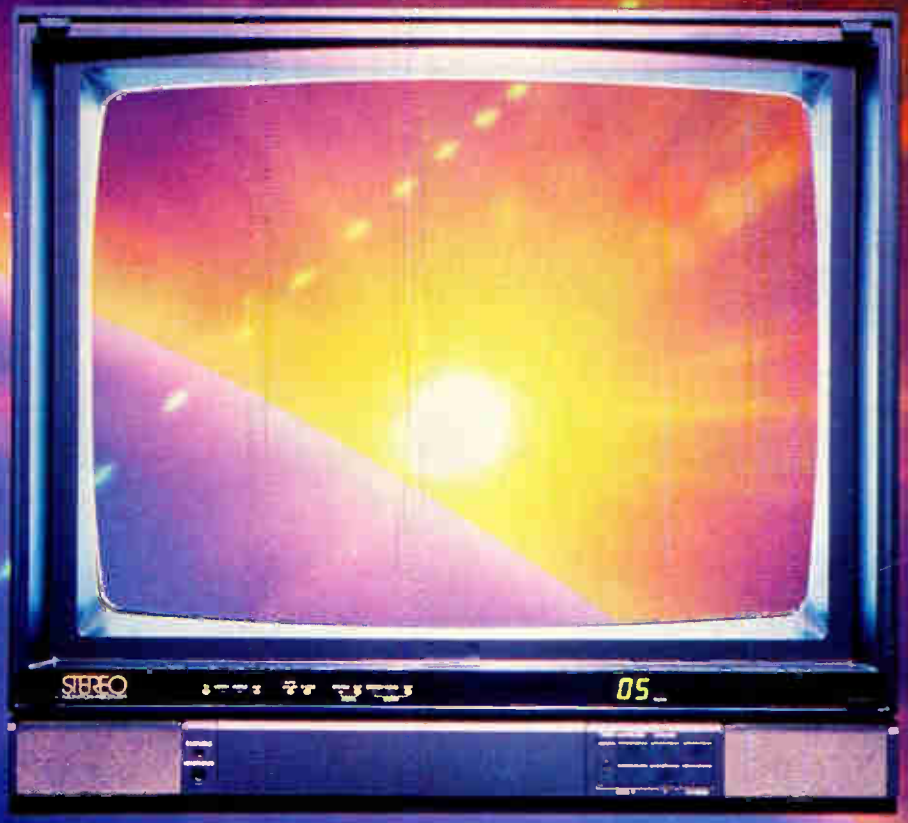

The 'Starburst' architecture: Making cable 'future-ready'

—page 26

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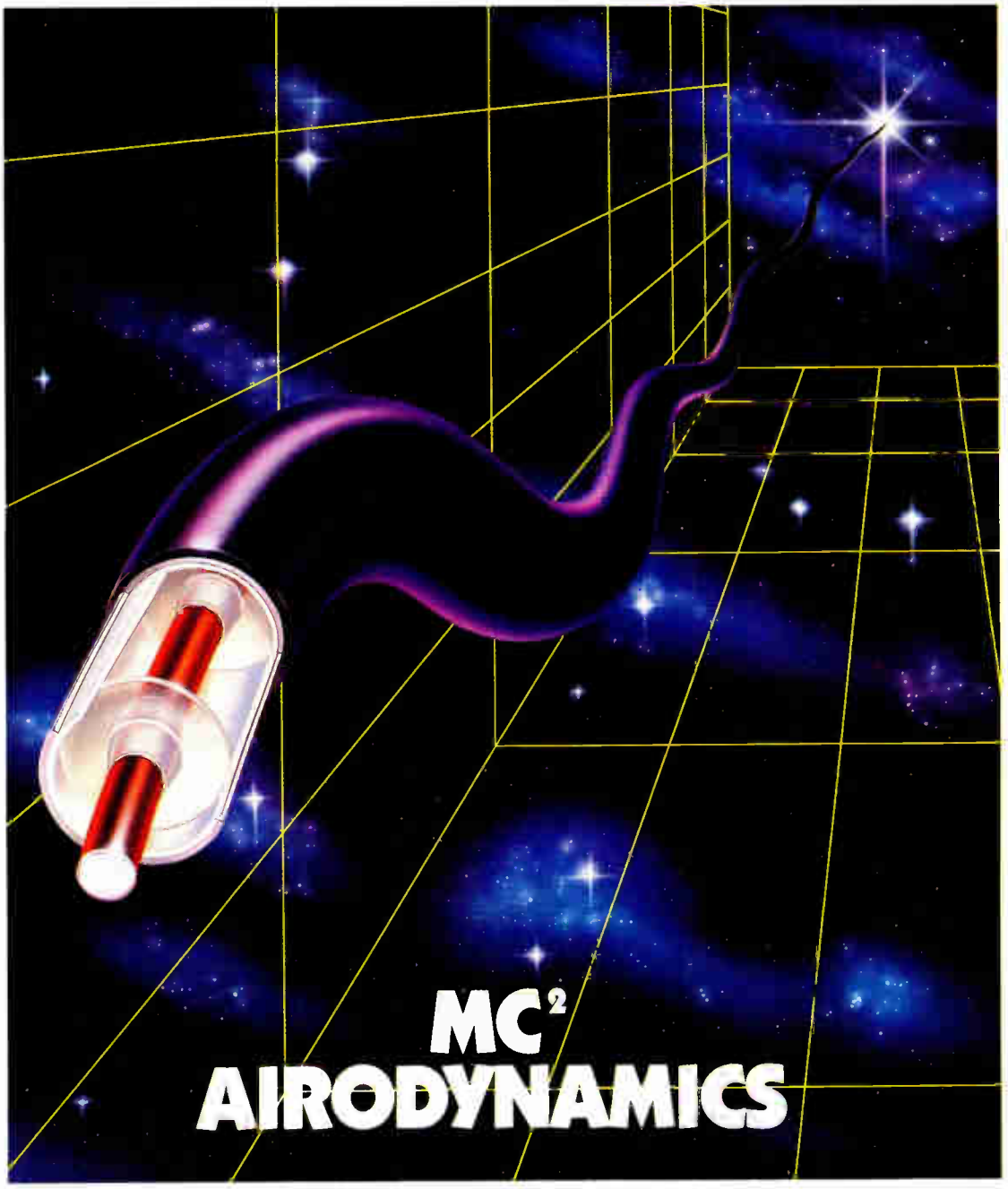

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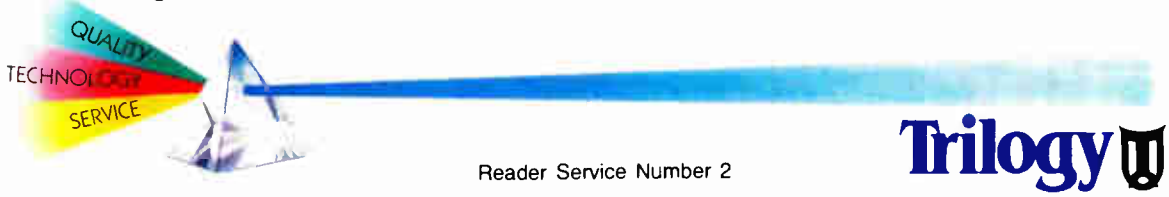

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April 1991

CED

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DEPARTMENTS

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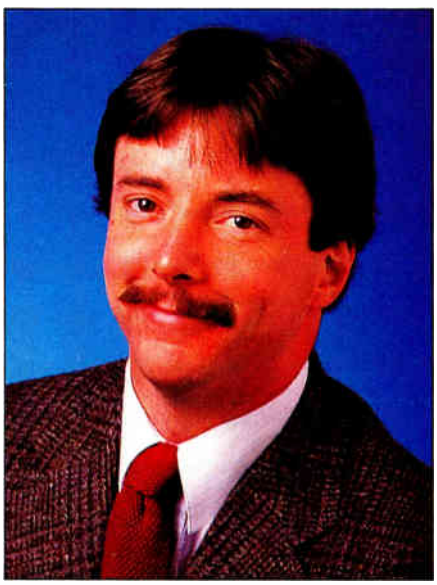
DEFINITELY AHEAD OF OUR TIME

Reader Service Number 3

Perched in the catbird seat

Last month's announcement by General Instrument that it has developed a digital compression and transmission method for CATV use puts the industry in the catbird seat, and for several reasons.

Not only will Digicable (as the system has been dubbed) permit cable systems to transmit more channels down their coaxial and fiber optic pipelines, it also opens the door to multiple HDTV systems being used. The cable television industry could once again give itself enough flexibility to eschew standardization efforts and use the best technology available (or evolve as new technology is developed).



Here's how: As we all know, the Federal Communications Commission has been pursuing a terrestrial transmission standard for advanced television in North America. Testing of proposed systems, including one from General Instrument, was slated to begin this month, but officials admit the schedule may slip because testing procedures and software programs may have be altered to accommodate the new, all-digital proposals.

Anyway, at some point, the FCC's advisory committee will come to a conclusion and pass its recommendation to the commissioners. Then a standard will be chosen and receivers will begin appearing on the market while broadcasters begin touting their ability to produce HDTV special events. Just for the sake of argument, let's assume something other than the General Instrument system is chosen.

In the meantime, cable operators who need more channel capacity may have implemented the Digicable system, which reportedly can transmit one HDTV channel in a 6-MHz space, in addition to two standard NTSC channels. What's to stop the cable industry from using Digicable *and* the FCC-approved system? Nothing, as long as cable made the FCC-mandated programming available.

In fact, those close to the HDTV scene admit there is significant support for a "multiport-type" HDTV receiver—one that accepts numerous signal transmission formats.

While the broadcast community would once again be strapped to a standard that is unlikely to change for decades, cable operators could constantly upgrade to new and improved technology, availing itself of the best possible picture. The prospect of CATV being able to provide a better picture than the broadcasters is an intriguing idea indeed. Is it possible? Stranger things have happened!

Roger J. Brown

Roger Brown
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Jerrold debuts compression method, PPV converter; demonstrates PCN

Immediately prior to the 1991 National Cable Show, Jerrold Communications made several important technology developments that promise to significantly impact cable system operations.

Video compression

In what could be a major boon to cable operators with full channel line-ups, General Instrument's Jerrold Communications division has unveiled Digicable, a digital compression and transmission system designed specifically for cable television. The system reportedly can compress as many as five pay-per-view channels or two standard NTSC channels into a single 6-MHz channel slot without degrading the picture. Of course, satellite figures are doubled: up to four full-motion NTSC signals and up to 10 movie-type channels can be sent over a single transponder.

Miller said pictures generated in the 2:1 compression mode will be virtually free of degradation. As the compression ratio climbs, however, the possibility of impairments increases.

The announcement is surprising in that as recently as 12 months ago there was widespread skepticism that video compression of this magnitude could be performed this quickly. The technology is a spin-off of GI's all-digital DigiCipher video compression technology, which was submitted by the VideoCipher Division to the FCC for testing and consideration as the North American advanced television transmission standard.

The reason why Digicable can compress five "movie" channels but only two "standard" channels has to do with the properties of film vs. videotape, says Matthew Miller, vice president of business development and advanced technology at Jerrold. Simply stated, film runs at 24 frames per second, and is therefore easier to compress than video, which operates at 30 frames (or 60 fields) per second.

The Digicable product family will eventually include encoders for satellite uplinks, digital decoders for cable headends, transmission technology for the distribution network and decoders for subscribers' homes. However, the first products to appear will be the satellite uplink encoder and headend decoder. In fact, those products are on the fast track because a new generation of C-band satellites is scheduled for implementation beginning in 1992.

Naturally, the product line will then grow from there. Miller refused to set a timetable for product introduction, but acknowledged the subscriber's converter will end up costing much more than today's analog converter. How much more is entirely dependent on volume, features, etc.

In fact, Jerrold is actively soliciting opinions on what features should be included in that family of product. "This is a major technology development," he said. "Now we want to know what the other products should look like."

In addition, Jerrold touts Digicable as a "gateway technology" that allows for the migration to high definition technology because it will transmit one HDTV signal in a 6-MHz slot.

But perhaps more importantly, the technology allows cable operators to effectively double their channel capacity without performing a major rebuild or a complete electronics changeout and simultaneously providing a clear migration path toward delivery of HDTV.

Pay-per-view and Olympics

Underscoring the significance many have attached to the 1992 Olympics as a major source of PPV revenue, Jerrold debuted a new addressable converter designed to receive and descramble PPV events only. Designated "Olympian 2000," the new converter allows operators to either upgrade to addressability or further expand their addressable universe without encountering the consumer unfriendly drawbacks.

Operators can use the converter to remotely control PPV event authorizations. In the meantime, non-PPV programming is bypassed when the unit is turned off, allowing systems that use traditional trap technology to maintain their consumer-friendly features. Therefore, when subscribers are not ordering and watching PPV, all features associated with cable-ready TVs and VCRs will be retained.

Because it lacks many of the features built into Jerrold's full-featured converters, the Olympian 2000 is priced at $75, which could allow cable operators to pay for the descrambler from their split of Olympic PPV revenue. Naturally, Jerrold officials hope it will also help spur the growth of PPV programming while avoiding the problems associated with interfacing with consumer electronics gear.

This method is seen by many to be an appropriate way to expand the addressable universe and brighten the prospects for high buy rates of the Olympics. According to Dan Moloney at Jerrold, the addressable converter approach solves many of the logistical problems operators will face with the three-channel positive traps that will be used in conjunction with the Olympics event.

Personal communications

In response to the enormous interest cable operators have shown in Personal Communications Networks (PCNs), Jerrold planned to demonstrate the integration of telephony and cable television on a single drop at the National Show in New Orleans.

PCNs have captured the interest of numerous large MSOs by promising to provide a means by which CATV operators could act as voice carriers (or possibly even service *providers*—see page 36). Several operators have applied and been granted experimental licenses by the FCC to test such networks. They rely on low-power microcells to receive and transmit voice signals from mobile handsets.

Wegener licensed to build VC II-Plus

In an effort to bolster the video side of its business, Wegener Communications has agreed in principle with the VideoCipher Division of General Instrument to manufacture a new line of low-profile standalone commercial descramblers for CATV and SMATV systems. The new descramblers will stand just 1 3/4 inches high.

According to Ned Mountian, Wegener's vice president of marketing, Wegener plans to have the new descrambler in the field by June of this year. Mountain said also that a second product in the standalone descrambler line will be available by August 1 for

ESPN affiliates who require the switch-and-retune functions for sports blackouts. This descrambler will interface with most existing remotely tunable satellite receivers.

Simultaneously, it was announced that Jerrold has also agreed to manufacture the low-profile VideoCipher commercial decoder. The new units are expected to be used by cable operators as they upgrade to receive VC II-Plus transmissions from satellite programmers.

ACTV gains entrance to hotels

Businessmen and vacationers will soon have something new to watch when they check into their hotel rooms. In addition to the traditional broadcast and cable channel lineup, viewers will be able to tune into ACTV's interactive programming via Spectradyne's in-room pay-per-view delivery system.

The first installation of the ACTV technology is scheduled for late this year. The system allows viewers to "personalize" the programs they watch by responding to questions or making choices posed by the television programs. The programs, in turn, allow the on-screen actor to respond to a viewer's input instantly.

Initial program fare will concentrate primarily on game shows, where viewers participate for actual prizes. For example, the card game blackjack will be offered and viewers can choose to "hit" or "stand" on their cards.

The agreement between ACTV and Spectradyne follows an ACTV market study, which was designed with input from Spectradyne, and was conducted at a Sheraton Hotel with actual hotel guests. The study suggested that the technology would result in "significantly increased usage of PPV programming," said an ACTV official.

It wasn't immediately clear how rapidly the technology would spread throughout the Spectradyne universe, which consists of more than 700,000 rooms in North America, the Caribbean and the Pacific Rim.

CableLabs seeks compression info

Cable Television Laboratories has created a new subcommittee to direct the consortium's efforts to expand cable systems' programming choices via digital video compression.

Termed the Video Compression Subcommittee, the group will be part of CableLabs' Technical Advisory Committee. It will be chaired by Edward Horowitz, senior vice president of Viacom International.

According to a press release issued by CableLabs, the subcommittee's top priority is the issuance of a request for information (RFI) to about 35 companies. Information returned will result in the establishment of technical guidelines for digital video compression that will, in turn, be issued to CableLabs member companies.

"The cable television industry is aggressively pursuing digital video compression options for application in cable systems in both NTSC and ultimately, high definition domains," said Horowitz. "The application of digital processing will enhance our capability to provide additional service, a higher level of security and the highest level of picture quality."

CableLabs President and CEO Dr. Richard Green intimated that the RFI is just the beginning of a larger digital agenda. "This subcommittee and the RFI it has issued are part of CableLabs' ongoing work on digital video compression that we expect to be a critical portion of the next-generation of cable networks," he said. "That network architecture will include a digital component attained through an evolutionary approach."

Jerrold boosts laser performance

Jerrold Communications continues to "tweak" its line of AM distributed feedback lasers to provide the CATV industry with ever-improving performance. The recent introduction of a new "Starfire" laser is said to deliver 60 channels of video with at least a 2-dB better carrier-to-noise ratio, regardless of the optical loss budget used.

According to David Robinson, director of Cableoptics, a Jerrold business unit, the new laser is well-suited for fiber to the feeder systems because it allows for more optical splitting, which in turn reduces headend space requirements and costs. "The new laser also improves point-to-point link performance, allowing extensions of fiber-to-the-feeder even in outlying areas of cable franchises," added Robinson.

Officials were quick to point out that the new laser is not a "hero" laser, hand-chosen for its high performance capabilities. In fact, Robinson said the device can and will be manufactured in quantity.

In addition to better noise performance, advancements were made with distortions. The Starfire laser offers guaranteed composite triple beat and composite second order specifications of 63 dB and 61 dB, respectively, for full 60-channel loading.

Perhaps to help the sales of the new laser along, Jerrold engineers have developed a new fiber-to-the-feeder topology that features the benefits of a star system without the cost penalties associated with telco switched-star architecture.

Called "Starburst" (see page 26), the new fiber/coaxial hybrid system reportedly offers construction economies similar to traditional tree-and-branch systems, but with none of the growth barriers, said Robinson.

The architecture calls for a complete line of fiber and RF headend and distribution products, and provides for future CATV system growth. Specifically, the system is:

- Bandwidth expandable because all components have been qualified to 1 GHz capacity.
- Open to use of optical amplifiers and 1550 nm operation, an important consideration as CATV operators mull the benefits associated with 1550 nm transmission.
- HDTV-friendly because bandwidth expansions can be accommodated for eventual HDTV transmissions.
- Inherently interactive because the star architecture is a natural for two-way interactive communications. Switches can be added when justifiable. Status monitoring and path redundancy capabilities are built-in.
- Capable of accommodating digital video compression schemes.
- Designed for PCN/telephony, with large numbers of node locations.

Magnavox, Orchard ink fiber pact

Magnavox CATV Systems and Orchard Communications have agreed to co-develop new optical technologies and products. In addition, the agreement calls for Orchard to benefit from Magnavox's marketing and distribution operations.

—Roger Brown

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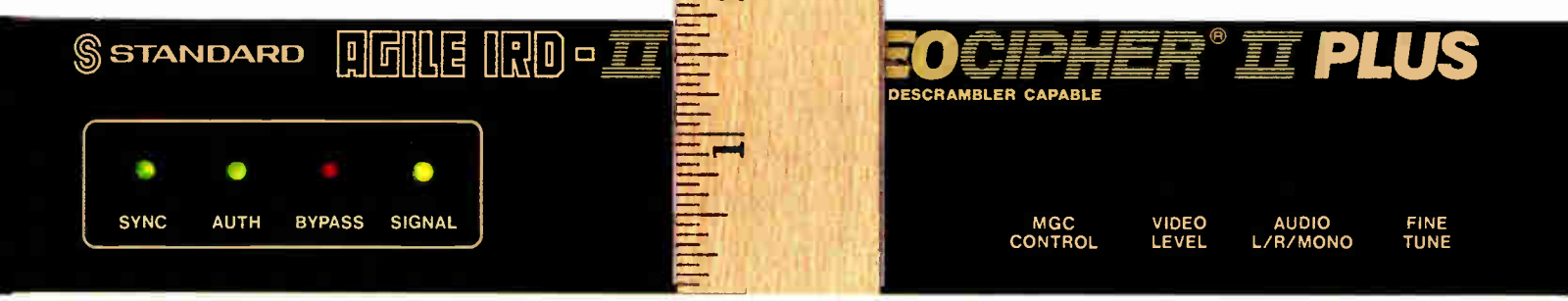

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What's more, like all standard Corning fibers, Titan fiber provides excellent reel-to-reel consistency, which makes splicing easy.

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Del Heller

From tech to top

Talk about gutsy. In 1971, Del Heller, Viacom's director of engineering, quit his job as a nuclear electronics instrumentation specialist one day—with a wife and two young ones at home and no other source of income lined up. Why? "Two reasons," Heller reminisces, "One, a lot of my time was spent underground in the Nevada desert. It was too much travel with a family as young as mine. And, when I was in the office, I worked in a building with no windows. So one day, I just said 'the heck with it' and resigned."

Two weeks later, Heller answered an ad in the Sunday newspaper and was quickly added to Viacom's payroll as a service technician. He's been there ever since, working his way up through Viacom's technical ranks to his current role. "I jokingly say I'm just an old cable tech that's been promoted too many times," the humble Heller laughs. Indeed, during his 20-year tenure with the California-based MSO, Heller has essentially performed (and excelled at) practically every technical discipline imaginable—from repairing amplifiers on the bench to developing an in-house technical training program to leading Viacom's 18 technical operating centers.

Looking to the future

Currently, Heller's focus is on strategic planning. "The one big project I have this year is to develop 18 system-specific, long range technical plans for each Viacom operating center," Heller explains. So basically, just trying to put together a sensible, progressive plan of technical development for all the little goodies that are happening these days."

One such "goody" is Viacom's involvement in the latest cable television buzzword—PCNs, or personal communications networks. The company has applied for five experimental licenses in San Francisco, Milwaukee, Dayton, Nashville and the Seattle/Tacoma region.

PCN signal propagation tests slated

"Right now there are no specific frequency assignments for any PCN network," Heller expresses, "but there are what's called Part 15 spectrums that are non-licensed, so to speak. They're open to the public for activities such as the spectrum used by microwave ovens, for example."

Under Heller's direction, Viacom plans to participate in the designated Part 15 spectrum areas, starting with signal propagation tests to determine how well signals transmit in the presence of physical and environmental obstacles "like trees, buildings, fog, rain, inversion layers—things like that," Heller describes. The geographical diversity of Viacom's participating test centers will lend well to these tests, Heller says, because "we have the opportunity to see what heavy rainfall and then no rainfall does."

Also included in Heller's technical strategy is further involvement in Viacom's K-Prime DBS partnership and aggressive deployment of fiber optic technology—but not without serious technological scrutiny. "My major challenge is to maintain high professional and technical standards across Viacom's entire technical force," Heller says. "It's no secret among the vendors that we typically take a conservative and very thorough approach to product examination and technological developments. We've had at least one full-time product evaluation engineer on our staff for at least 20 years."

Cable technologist

Heller credits much of his success in his current position to his two predecessors, Joe Van Loan and Frank Bias. "I continually try to follow in their footsteps in order to maintain the high technical standards they set forth for Viacom," Heller explains.

But Heller's casual, unassuming manner is offset by a large dose of common sense—and years of hands-on technical opportunity. "I consider myself to be a cable technologist," Heller says. "I'm not an engineer's engineer, by any means. I'm the kind of person who believes in surrounding himself with intelligent, motivated people. Since I've been with Viacom for 20 years, I know what people can do the job."

Interestingly, Heller's son also carries a Viacom business card, as a technical manager in one of the company's converter repair facilities. When not at Viacom, the father-and-son team enjoy fishing with Heller's two grandsons. But, "after my wife (Wanda), golf is my number one passion," Heller laughs. The Hellers also have a daughter who is "the entrepreneurial type—determined never to work for anyone but herself," Heller boasts.

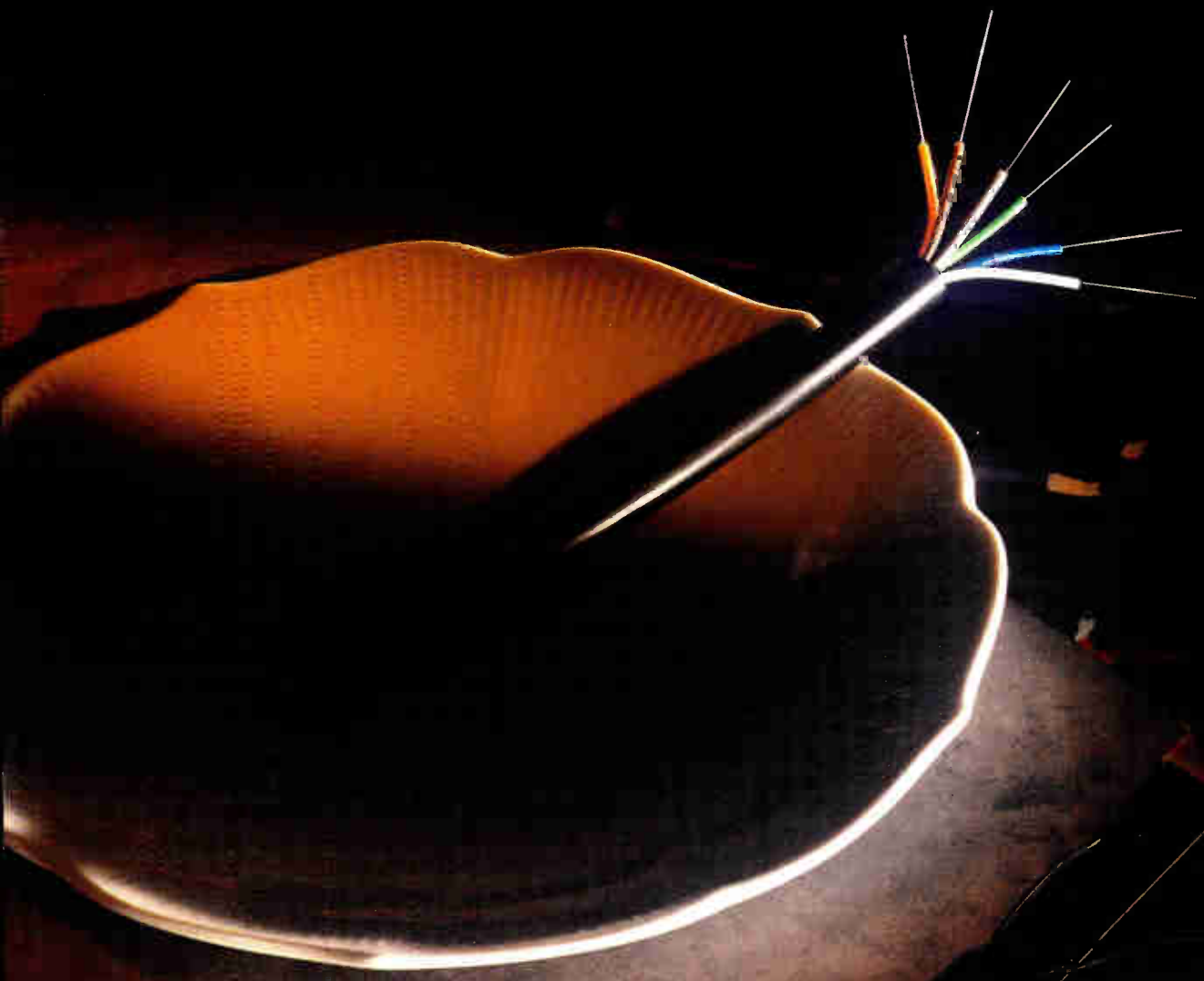
Heller is very active in cable's engineering community, and firmly believes in getting his technical staff involved as well. "Then they can keep abreast and get involved, and I can pick and choose the projects I want," Heller admits. While involved in CableLab's technical advisory committee, Heller's acknowledged pet project is one that started nine years ago at a joint NCTA/EIA engineering committee meeting. "That is to solve the RF shielding problem on cable-ready television sets," Heller offers. "It means getting the consumer electronics side to put better metal shielding around the television tuner assembly, and getting them to consider the length and quality of the connecting cable between the tuner input and the input connector on the back of the set." Heller laughingly hopes the problem is resolved "during my lifetime."

When asked about the future of cable television, Heller is decidedly pensive. "We have to be careful that in this exciting period, we realize that there's a danger of becoming enamored with our technological opportunities. Because if we try to do *too* much, we might become excellent at nothing," Heller reflects. "It's kind of like going to a restaurant where the menu looks great, and you want to order something of everything because your appetite is so big. But then, you can't really do the meal justice, can you?"

Probably not. Unless, of course, cash (and calories) don't count. ■

—Leslie Ellis

Now SAM has added fiber.



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Reader Service Number 9

WAVETEK

Kudos to industry vendors

It is my hope that you will be reading this article during a few spare moments (I believe everyone can find a few) at the 1991 NCTA Show. New Orleans is a wonderful place for a convention, with many temptations in terms of food, entertainment, music and culture—but alas, we are at the convention primarily to do business.

For those of you who walk around, look at the booths and take time to talk to vendors, the following comments are for you.

Tough times for vendors

The last year and a half has been very difficult on our hardware vendors. Even before the U.S. economy was permeated with thoughts of a potential recession, the unholy specter of the savings and loan debacle created a domino effect that manifested itself in a nervousness in the credit market. This, in turn, meant that many cable operators either could not go forward with rebuild plans or decided to delay scheduled projects until they saw an end to the economic plight.

None of this is news. However, it seems to me that during this time many of our vendors have begun to think they don't have many friends remaining in the cable industry. It is my sincere hope that vendors don't come to believe this, and that other industry professionals don't exacerbate this unfounded perception in any way.

Take a moment to consider what our vendors do for this industry—besides sell us equipment. Let us not forget, for example, that it was the vendors that started this industry in the first place. The whole vision of cable television as a viable business was the result of vendors who wanted to sell equipment to customers for a new service.

The business certainly changed—*rapidly*. But the fact that it changed at all is directly attributable to the vendors who not only risked the capital to develop new products, but frequently had to originate the idea for the service as well. Through the years, it has been our vendors who have consistently come up with new innovations to solve problems. Likewise, vendors have provided the capital to start new companies that bring products to bear upon old problems.

Indeed, it is said that the cable television equipment manufacturers (one large vendor in particular, which shall remain nameless) were the major force behind the idea of the National Cable Television Association. But they didn't stop there. Over the years, the support of the hardware vendors for the NCTA and its activities has been real and substantial.

Expenses incurred

Indeed, every time the vendors have stood behind an NCTA project or problem, they have done so in such a manner that benefits the customer—and not necessarily themselves. Some may argue that this is one and the same; that if customers are successful, happy and profitable, they will buy more equipment and as such, enrich the vendors. But for anyone to believe that cable operators and vendors share the same policy issues is just plain foolish.

While the hardware vendors are represented on the NCTA Board of Directors, these are not necessarily easy shoes to fill. Vendors can—and have—found themselves in debate with their own customers. Nobody particularly enjoys being in that position.

Yet over the years, the associate board members of the NCTA have handled these situations with both dignity and carefully reasoned comments, backed by a strong belief in their respective positions.

Recently, the associates committee (made up of our industry's hardware suppliers) gave up a day during a tough business year to come to Washington, D.C. at the request of the NCTA staff. During the day, they worked on lobbying congressmen, senators and the FCC on political and regulatory issues. When I walked past the committee meeting room and saw the quality of the people sitting in that room, I was reminded once again that whenever we have asked this particular group of companies to come forward and help, they have done so.

Some of these companies stand out in my mind as people who have prompted or worked with the NCTA on issues that had no direct bearing on their products or relationships with cable operators. Companies in the RF world have served on fiber optic committees, people in the wire world have served on policy and regulatory committees, and people in the consumer electronics world have helped our legal committees on various issues. In other words, these are guys who are in it for the long haul; who, while trying to run a business to the benefit of the shareholders, have not been so single-minded as to do so only by manufacturing equipment. Instead, they have participated with their time, money and intellect at all levels of this industry's activities.

The plain truth is that the the engineers that serve on the NCTA Engineering Committee and its many subcommittees are a vital part of the breadth and depth of that deliberative body.

Show your support

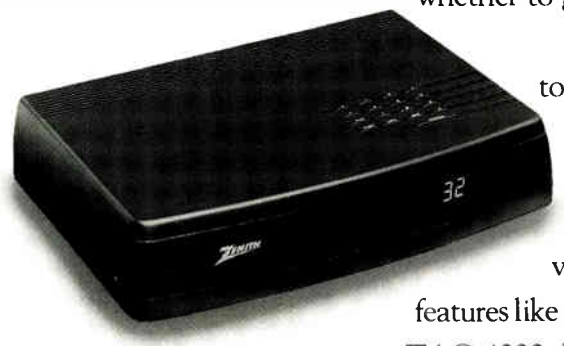
All in all, this has been and is a great group of people. So at this Show, make a point of stopping by and hearing what they have to say. The cable industry is still a growing business, and regardless of what troubles we had last year, one thing to remember is this: We always come through. We still have plant to build and services to offer, and we can't do it without the help of these companies.

Visit the booths, talk to our vendors, see what product offerings they have and take time to see how these products fit into your immediate and future plans. But most importantly, let them know that they aren't friendless. Because over the years, cable's vendors have never let us down when we've needed a friend. ■

By Wendell Bailey, Vice President Science & Technology, NCTA

ADDRESS -ABILITY

For many of today's smartest cable operators, the question isn't whether to go addressable. It's how.



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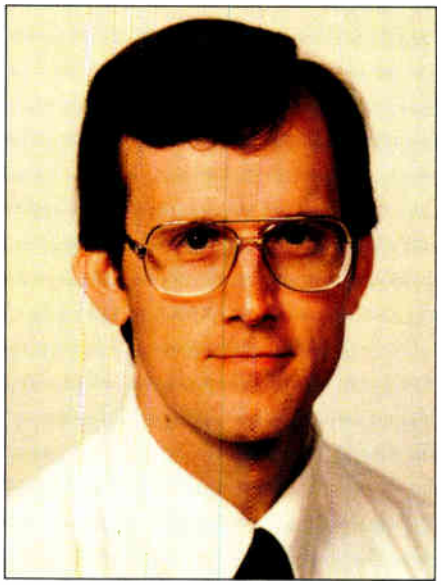

E_b/N_0 versus C/N

I've written several columns over the years concerning the relationship between carrier-to-noise ratio (C/N), carrier-to-noise-power-density ratio (C/N_0), video signal-to-noise-ratio (S/N), and FM threshold. All of these discussions were, of course, related to the specification and performance of analog video.

This month, the topic will be the relationship between C/N and its corresponding parameter in the digital transmission realm—called the bit-energy-per-noise-power-density-ratio, or, E_b/N_0. Just as we strive to maintain high values of C/N_0 in an analog link in order to maintain excellent S/N performance, we also strive to maintain high values of E_b/N_0 in a digital link in order to obtain the best possible bit-error-rate (BER) performance. The relation-ship between C/N and E_b/N_0, remark-ably enough, is so straightforward that the analog satellite link analysis tools learned over the years can still be used.

Digital modulation

E_b/N_0 (typically pronounced "E B over N zero") is a term that will be heard more and more as digital video transmission becomes prevalent in the industry.

By Chris Bowick, Vice President Engineering for Headend Equipment, Scientific-Atlanta, Inc.

In digital transmission systems, either the phase or amplitude (or both) of an RF carrier is modulated to a specific discrete value or state which may represent either a single bit, or group of bits, in a serial data stream.

Note that it's possible for a state or symbol to represent more that one bit by allowing the symbol to take on multiple values. Two bits, for example, could be encoded into any one of four discrete modulation states or symbols (00, 01, 10, 11); three bits into eight symbols, etc.

In this manner, with a four-state (symbol) modulation scheme, for example, the modulator can simply change states four times to transmit any eight bits of data (two bits per state times four states).

Similarly, in an eight-state modulation scheme, with each state represented by three bits, the transmission of 24 bits of data will require that the modulator switch states only eight times. Because the modulator is being switched to a new state or symbol at a much lower rate than the actual data rate, the occupied bandwidth of the modulated *signal* is reduced accordingly.

While the carrier can be modulated with any number of modulation schemes such as BPSK, QPSK or quadrature amplitude modulation (QAM), the basic analysis remains the same. Unfortunately, the increased data rates and reduced modulation bandwidths afforded by these modulation formats don't come without penalty.

Intuitively, it can be seen that the amount of transmitted energy that can be allocated to each data bit is a function of both the carrier power and the amount of time that each bit or symbol is "active." Thus, the higher the symbol or data rate, the lower the transmitted energy per bit. At the demodulator, this decrease in energy per bit simply makes it more difficult to decode each transmitted bit in the presence of channel noise. In an effort to quantify this relationship between bit energy and channel noise, the term E_b/N_0 was born. Its relationship to C/N can be traced as follows:[1]

The average energy in a modulated bit can be defined as:

$E_b = C \times T_b$ where

C = average carrier power

T_b = time duration of each bit

Since the time duration of each bit (T_b) is the reciprocal of the bit rate (f_b), this equation can also be written as:

$E_b = C \times 1/f_b$

Thus, as the data rate (bit rate) increases, the amount of transmitted energy per bit decreases.

Noise power spectral density, N_0, is defined as noise power per unit bandwidth, or $N_0 = N/B_w$.

For satellite link analysis purposes, B_w is typically assumed to be equal to the receiver's IF bandwidth.

Therefore, combining terms we have:

$E_b/N_0 = (C \times T_b/(N/B_w)$

$= (C/f_b)/(N/B_w)$

$= (C/N) \times (B_w/f_b)$

For satellite transmission applications for example, what this equation says is that E_b/N_0 is equal to the familiar term C/N times the ratio of the receiver's noise bandwidth to the transmitted data rate.

This simple relationship allows use of existing link analysis tools to calculate link budgets for high quality digital satellite links.[2] In a satellite data receiver the actual noise bandwidth used depends on the modulation scheme as well as the bit rate. We can trick our link analysis programs or equations into calculating E_b/N_0 instead of C/N by simply replacing the noise bandwidth of the receiver with the transmitted bit rate. We then carry out the resulting link calculation as if the link were analog. With the noise bandwidth replaced by the bit rate, the term B_w/f_b becomes unity and therefore C/N equals E_b/N_0. The result of the link analysis calculation will be E_b/N_0.

Another interesting result of the above equations, as well as the earlier intuitive analysis is that as more spectrum efficient modulation schemes are employed, thereby allowing a higher number of bits per given modulation bandwidth (bits per hertz), the ratio of B_w/f_b decreases.

Using the above equation, we can see that in order to maintain the same value of E_b/N_0, thereby maintaining the same BER over the link, a higher value of link C/N must be maintained. A digital modulation format that offers twice the spectral efficiency (half the bandwidth) of another, for example, will therefore require a 3 dB higher link C/N in order to maintain the same bit-error-rate (BER) performance. ■

References

1. Feher, Kamilo, *Advanced Digital Communications Systems and Signal Processing Techniques*, Prentice-Hall Inc., 1987.

2. Rovira, Luis, Internal Technical Memorandum, Scientific-Atlanta Inc.

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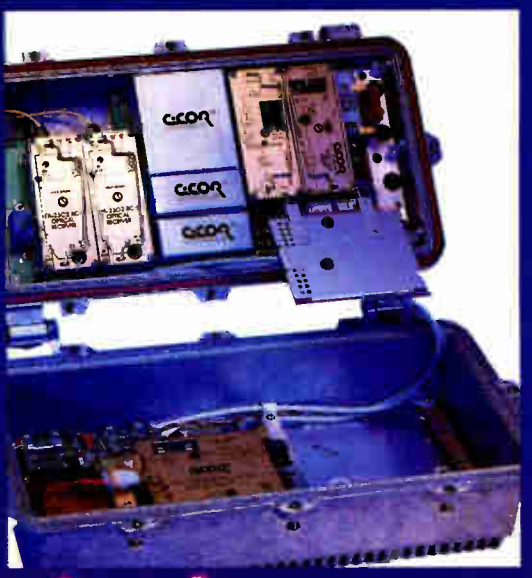

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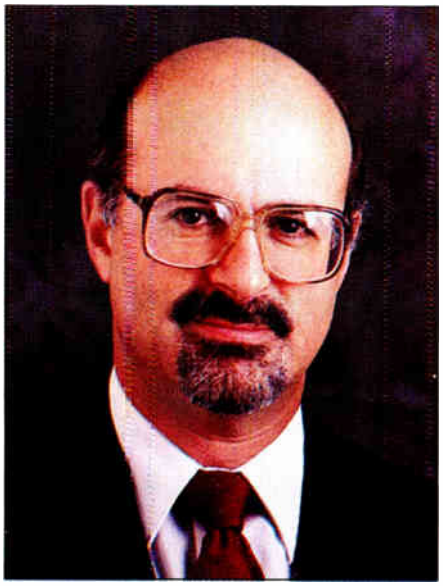


Radio-based Local Area Data Nets

On January 28, Apple Computer filed a petition with the FCC, asking for an allocation of 40 MHz of spectrum in the 1850 MHz to 1990 MHz band for a high-speed local area data communications network.

This is one of several new radio-based approaches for data communications. In addition, it reflects the broader interest in low power radio systems for personal communications networks that has recently become evident.

But in my opinion, Apple picked the wrong frequency band for its radio local area network (RLAN). It should have gone after the 2596 MHz to 2644 MHz MMDS frequencies. Instead, it picked frequencies used by police departments and oil companies.

The RLAN—A new technology

An RLAN is a cousin to a wireless PBX, carrying data among personal computers rather than voice. Personal computers need the flexibility of networks that can be redefined and reconfigured as needed, instead of pre-wired networks that are expensive and difficult to reconfigure. The Apple proposal appears to satisfy these needs, but other companies have also addressed this market.

The first RLAN systems came out in the market in late 1989 and 1990. They were made possible by the FCC regulations for spread spectrum communications devices adopted in Part 15 of the FCC Rules. Those now on the market operate in the 902 MHz to 928 MHz band. Newer spread spectrum products that are still under development will operate in the 2400 MHz to 2483 MHz band. Like other Part 15 devices, these spread spectrum products do not need an FCC license for operation, but they are not given any protection from interference.

One problem faced by the currently-available RLANs is their limited data capacity. Their effective limit is a few hundred kilobits per second of data. This is partly due to the limited amount of spectrum available and the low power levels permitted by the FCC Rules.

In addition, there are potential interference problems for these spread spectrum devices, because they share frequencies with motion sensors and anti-pilferage systems.

Partly as a result of these problems, manufacturers have been looking at other frequency bands for RLAN use. Motorola asked for spectrum around 18 GHz, which the FCC approved about a year ago. This spectrum consists of 100 MHz in the 18,820 MHz to 18,870 and 19,160 MHz to 19,210 MHz ranges. Unlike the unlicensed Part 15 frequencies, these frequencies require a radio license, but this prevents interference from other users. Motorola itself has already applied for and received licenses in nearly 300 cities.

The Apple petition

In contrast to Motorola, Apple has asked for an allocation of 40 MHz of radio spectrum from within the 1850 MHz to 1990 MHz band. It chose this band based on tests of radio propagation within buildings, a system design based on microcells of 100 meter (330 feet) diameter, and considerations of low power levels and small antennas.

Unfortunately, this frequency band is already heavily used by point-to-point microwave systems. The typical users include oil companies, railroads, gas and electric utilities, and local governments. The local government users include public safety agencies—local police departments, fire departments and state police.

These point-to-point users are not going to sit back and allow the spectrum to be taken from them. They have already mobilized to fight off the incursion of voice personal communications networks. Recall that Millicom and others are testing the feasibility of sharing the 1850 MHz to 1990 MHz band, overlaying voice PCNs on the existing point-to-point users.

These are the same microwave users that a decade ago lost the 12.2 GHz to 12.7 GHz band to the Direct Broadcast Satellite service. Although they lost that battle, they later got explicit Congressional recognition of the special communications needs of public safety agencies.

The MMDS frequencies

Unlike the unused 18 GHz frequencies found by Motorola, there are no unused frequencies around 2 GHz to satisfy Apple's needs. Any band Apple picks will likely involve a big technical and political battle at the FCC.

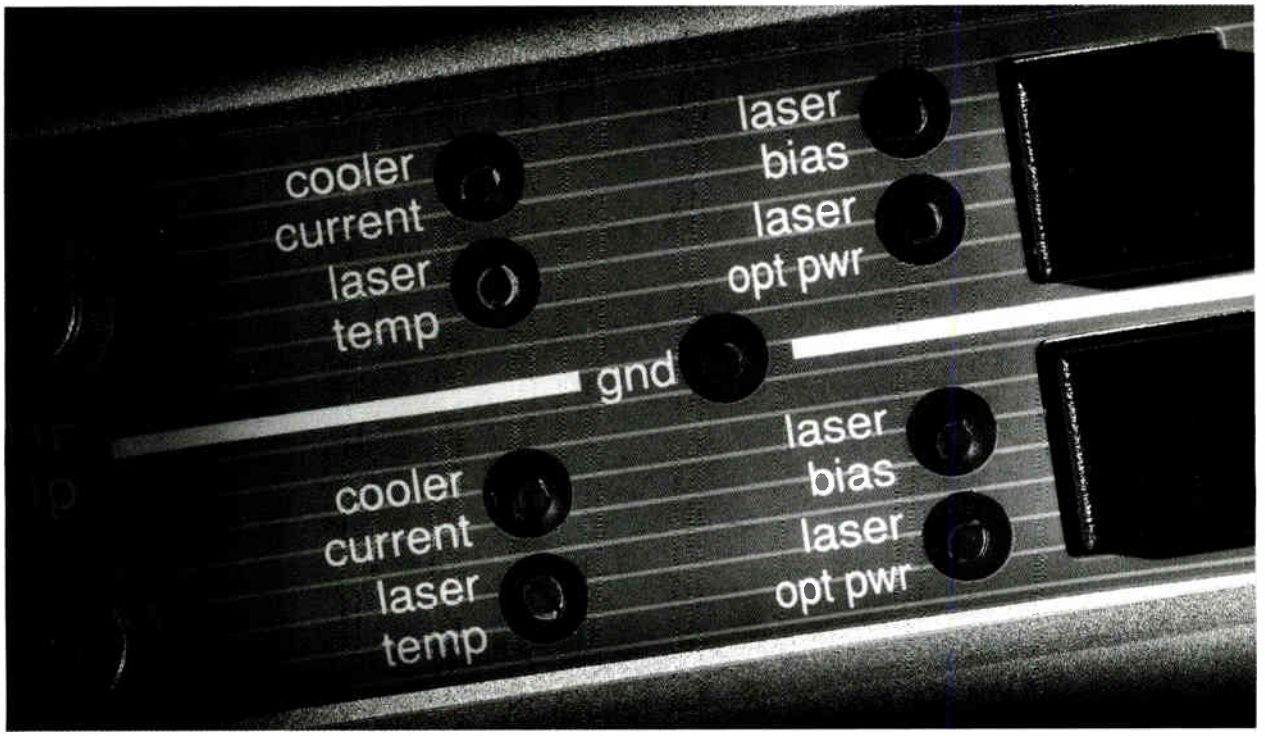
Rather than picking a fight with the oil companies, power utilities and public safety agencies, here are some of Apple's other options to fight for 2 GHz spectrum: broadcasters (a bad idea); telephone companies (also a bad idea); Federal Government agencies (not a chance); ITFS (a fight with the Catholic Church and local school systems will lose); and MMDS (clearly the weakling of the bunch).

The 2596 MHz to 2644 MHz MMDS band is lightly used. Only a few cities have MMDS systems in operation. Although more cable programming is now available to MMDS operators than formerly, severe technical problems still exist. These include adjacent channel interference, seasonal path blockage problems, and the inherent difficulties of vestigial sideband AM modulation at microwave frequencies. But unlike the satellite bands at 4 GHz and 6 GHz, MMDS is stuck with AM modulation because there isn't enough spectrum at 2.6 GHz to support FM modulation for MMDS.

Over the next few years it will become clear that MMDS will not be able to offer a multichannel video service that can compete with cable TV. Interest will shift to satellite delivery, and to terrestrial delivery at higher frequencies where there is more unused spectrum. That will make the MMDS spectrum a prime candidate to be grabbed away for other uses. I think Apple should have tried first. ■

By Jeffrey Krauss, Independent Telecommunications Policy Consultant and President of Telecommunications and Technology Policy of Rockville, Md.

Some call it the way of the future. We're ready now.



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Reader Service Number 12

Spectrum for sale?

Spectrum congestion is pandemic. It is a consequence of too many occupants, unbalanced allocations, and inefficient utilization. In 1945, the AM radio band was considered to be congested with about 1,500 stations in operation. Today, there are over 5,000, and growing, in virtually the same frequency band. Nearly 40 percent of the technically most useful portions of the electromagnetic spectrum below 1 GHz is allocated exclusively to audio and video news and entertainment.

Spectrum congestion

After 40 years, almost a third of the channels allocated for commercial TV broadcasting, and half of those reserved for educational use, have not yet been activated. Moreover, the TV channels that are activated carry only a small fraction of the information content of which they are capable. The systems now being developed for HDTV clearly demonstrate the significant potential for packing many times more information in each 6 MHz channel.

Like the demand for ever-increasing cable TV channel capacity, or the need for greater traffic handling capability on super-highways, the demand for more spectrum space is unrelenting. Technology continues to respond to commercial needs by opening up higher frequencies, splitting channels, increasing modulation efficiency, and reducing vulnerability to interference. Practical limits to this process may exist, but are nowhere in sight.

Nevertheless, there is a growing perception that the spectrum management process itself may be outmoded. Frequency bands, once allocated, tend to be set in concrete. Broadcasters have no incentive to share their sacred birthright, established in the 40-year-old Table of Allocations, with other services that might take advantage of underutilized or inactive channels. Land mobile spectrum users must be grandfathered through a full depreciation cycle before they can be required to adopt more efficient technology.

By Archer S. Taylor, Senior Vice President, Engineering, Malarkey-Taylor Associates, Inc.

> You cannot play football, or the commodity markets, or manage the spectrum, without ground rules and referees.

President Bush's Council of Economic Advisers (CEA) recently endorsed auctions as a means for reallocating government frequencies that may soon be released by Congress for commercial users. "Without the force of competition, spectrum bands are not necessarily used in ways that generate the greatest social value," CEA suggests. "When portions of the spectrum previously reserved for government use are made available to the private sector, they should be auctioned off without restrictions on resale."

It is not difficult to fault the traditional process of spectrum management. Some parts of the spectrum are glutted, while others are largely vacant. The process is inherently inflexible, and its response to new technology and commercial opportunities is sluggish, at best.

Alfred Sikes, chairman of the Federal Communications Commission (FCC), recently told the House Telecom Subcommittee that the bill reallocating some government frequencies to commercial use should specify competitive bidding. He said that availability of more spectrum is the key to growth, not only of telecommunications, but of the U.S. economy.

Janice Obuchowski, assistant secretary of commerce and administrator of the National Telecommunications and Information Agency (NTIA), concurs. In a recent issue of the IEEE *Communications Magazine*, she acknowledges that we have "...the best and brightest cadre of spectrum engineers in the world." Yet, she says, we need "...market mechanisms that respond to the growing shortage of spectrum."

An oversimplification

The argument is provocative. But, like the concept of a "flat tax," the concept of competitive bidding as a panacea is grossly oversimplified.

Chairman Sikes, for example, advocates exempting public safety and related services from auctions. In deference to intense opposition, moreover, he also proposes to exempt broadcasting from competitive bidding for frequency assignments. In fact, he concedes that his recommended exemptions would mean that only cellular telephones would actually be auctioned. Not surprisingly, an AT&T witness suggests "private negotiations and payments" instead of a public auction open to all qualified applicants.

Moreover, Sikes called for mandatory technical and financial requirements for companies to qualify for participation in auctions. Certainly, spectrum management must deal seriously with matters affecting technical interference, such as frequency coordination, maximum effective radiated power and antenna heights.

Experience with AM stereo painfully demonstrates the impotence of market forces to assure the emergence of practical compatible technical standards. The lottery procedure has effectively clogged the MMDS pipeline with speculative applications. Spectrum reservations for non-commercial educational or other public purposes, without sunset provisions, has resulted in large blocks of unused spectrum being withheld permanently from potentially profitable uses.

It may be possible to rely on market forces in some way to encourage spectrum conservation within necessarily rather narrow constraints. President Bush has endorsed auctions to reallocate up to 30 MHz of spectrum that might be made available under 20HR-531. Details have not yet been revealed. Considering the practical realities, however, the results of such a test seem likely to be mixed. ■

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CONTEC INTERNATIONAL

Reader Service Number 13

Starburst: Today's future-ready cable TV architecture

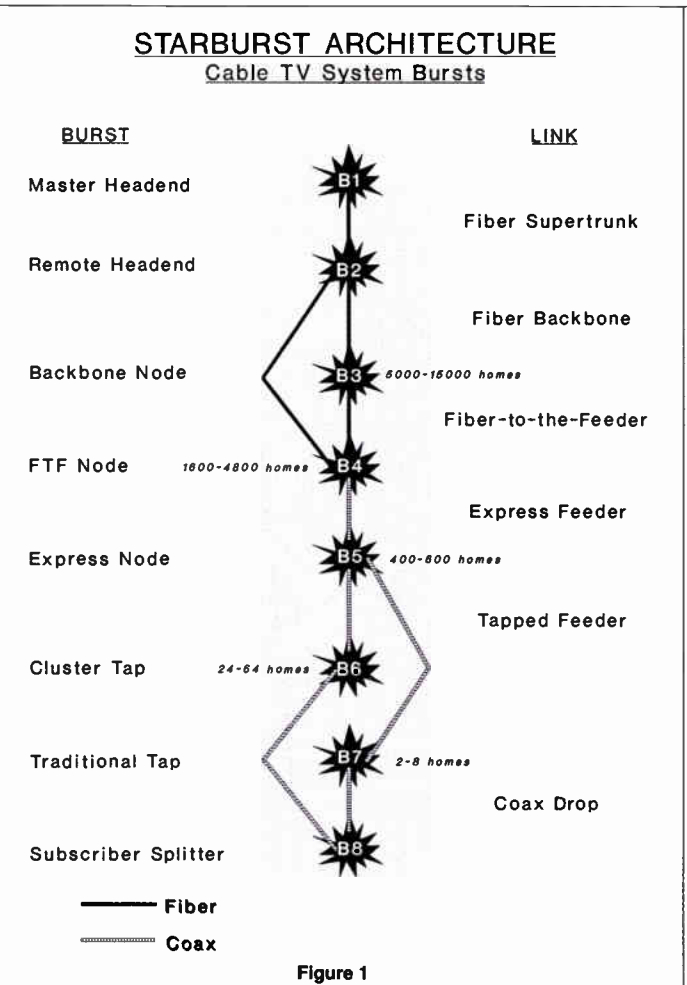

Figure 1

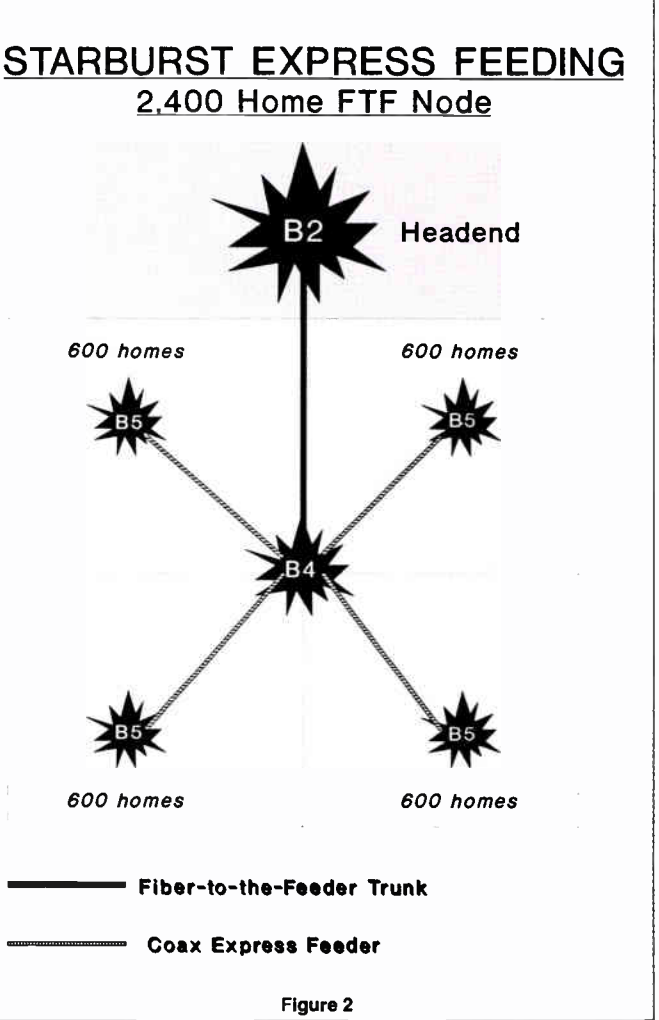

Figure 2

Cable television needs a new growth platform. The coax tree-and-branch architecture has helped the industry attain remarkable success, but its limits are clear. The telephone industry's traditional switched-star network has its own limits, principally expense.

Meanwhile, increasing consumer demand for more and better broadband communications services continues unabated. Communications public policies are shifting. Related technologies promise major price/performance advances.

Programming/bandwidth expansion, fiber optics, high definition television (HDTV), compressed digital video, interactivity, telephony and personal communications networks (PCN) are among the advances that cable TV operators must plan for in plant construction decisions today.

By David E. Robinson, Director, Cableoptics, Jerrold Communications

The architecture answer is a flexible hybrid system, which we call "Starburst." It looks like a star architecture, but it has none of the cost burdens of the telco switched-star system. Further, it has construction economies similar to a tree-and-branch system, but none of the growth barriers. A fiber-coax hybrid, Starburst incorporates backbone, fiber-to-the-feeder (FTF), redundancy and telephony interface features pioneered by leading multiple system operators (MSOs).

In many respects, Starburst simply summarizes the Broadband Communications Network (BCN) architecture consensus that is now emerging among cable TV operators throughout the world. This article describes Starburst, focusing on its future-ready and cost-efficiency benefits.

The star wins

The tree-and-branch architecture cost economies are tough to beat for one-way delivery of popular broadband video services. But the long cascade of electronic amplifiers required to overcome the signal losses of the coaxial cable and branching splits leads to practical picture quality, bandwidth and reliability barriers. The challenges

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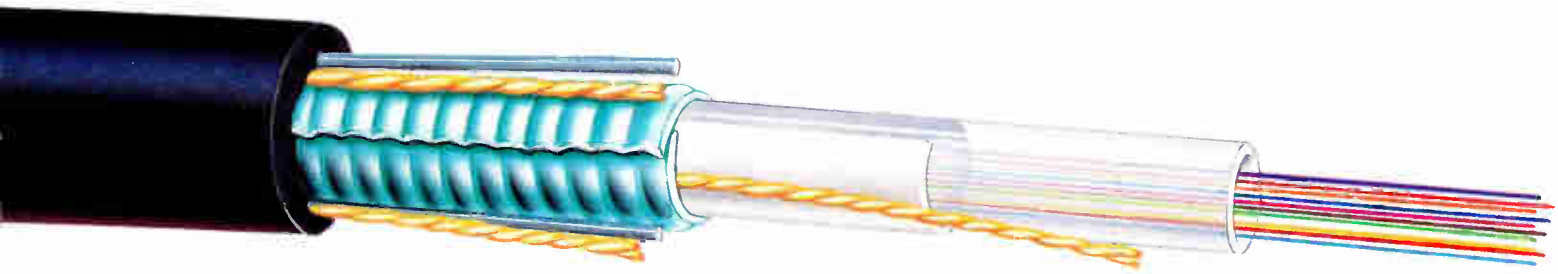

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Cluster Taps per FTF Nodes	40	50
Line Extenders per FTF Node	55	70
Incremental Line Extenders		15
X Average Price		$ 300
= Cost Increment per FTF Node		$ 4,500
Cost Increment per Home Passed		$ 1.88

Typical U.K. STARBURST FTF System

Table 1

are even greater in the return path. Going back to the headend, the many small branches combine to form what seems like a big noise antenna to many system engineers and technicians.

Telephone companies (telcos) noticed this chink in cable TV's growth platform. During the mid 1980s, they proposed all-encompassing, all-digital fiber-to-the-home switched-star broadband communication systems. By now, many of these proponents have recognized the prohibitive cost burdens of such systems. Effective with twisted copper-pairs for universal real-time interactive narrowband voice and data services, double-star architectures are a poor force-fit for popular broadband services. Premiums of approximately 500 percent relative to tree-and-branch alternatives put such switched-star systems out of consideration for now.

Backing away from engineering elegance in search of workable economics, a number of telcos now are exploring hybrid systems. Fiber-copper hybrids, analog video and passive optical networks (PONs) are integral parts of telco subscriber loop planning discussions. A bus network, similar to the tree-and-branch, also has been discussed, but appears to be losing favor to what is known as a star-PON.

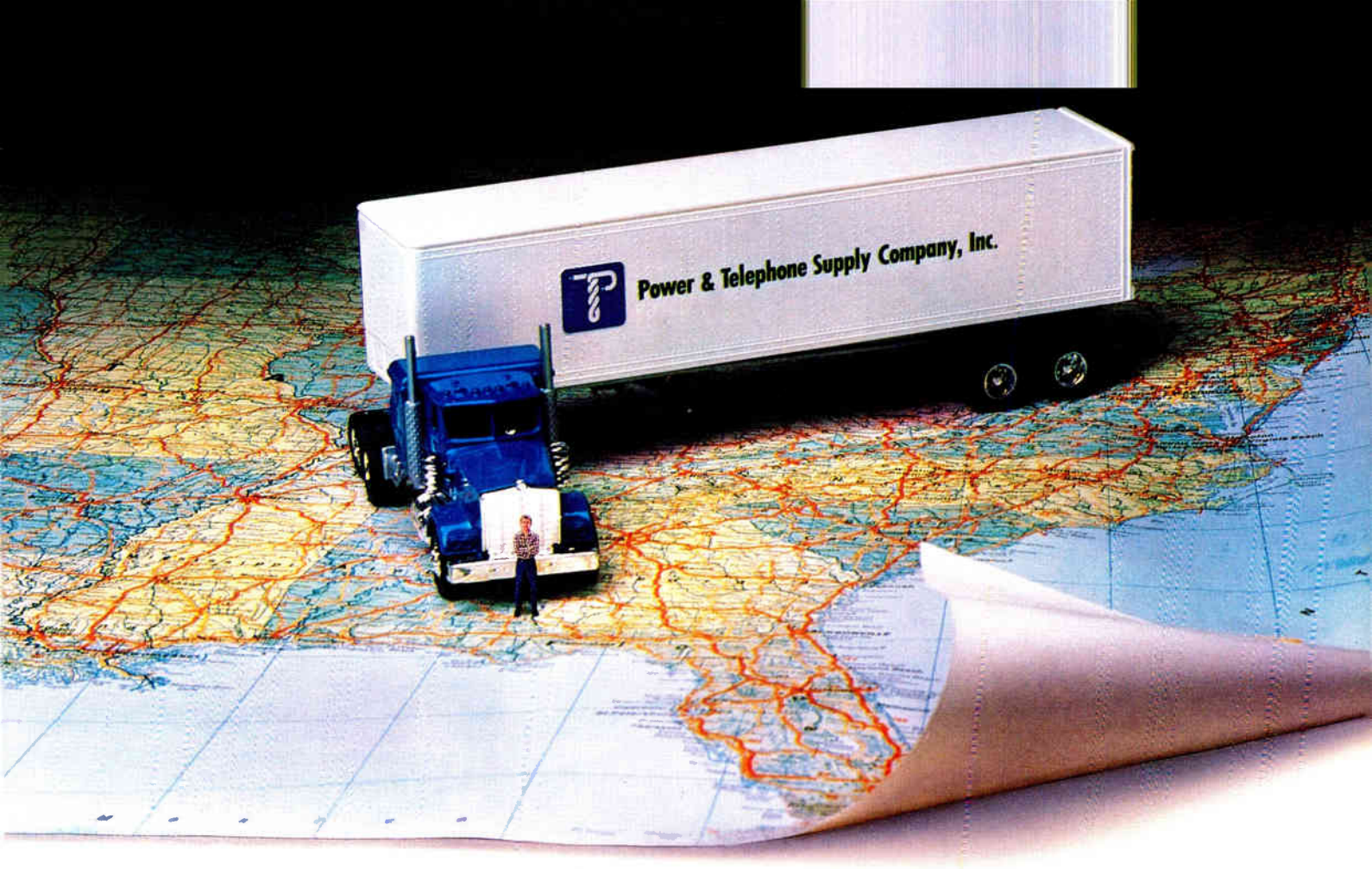
Meanwhile, operators in the cable TV industry have begun plant improvements with fiber optic trunks. The process has accelerated in part because amplitude modulation (AM) fiber optic equipment has improved more than 800 percent on a price/performance basis during the last two years. In part, looking at FTF trunks in the U.K. for example, the acceleration is due to regulatory changes that encourage telephony integration and other interactive services of the future. Regardless, the result is a modified star architecture.

Cost-efficient bursts

Today's emerging broadband communications network is characterized by a series of star-points, or "bursts." Figure 1 illustrates a series of eight possible cable TV system bursts that follow the originating burst (B0) of the satellite link or broadcast tower. In most systems, the actual number of bursts will be smaller. The large number of possible bursts relative to a traditional telco double-star architecture prevents the cost burdens associated with dedicated home-run lines.

All of the bursts allow cost-efficient signal splitting in the forward transmission path. Today, most of the bursts also include signal amplification. None need be burdened immediately with switch costs, yet each burst provides a point to possibly upgrade to switching capabilities in the future.

The first cable TV system burst, B1, is the master headend. The supertrunk links between B1 and B2, the remote headends, already are in place in many cable TV systems. However, some of these links use microwave transmission, which is susceptible to atmos-



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pheric interference (rain fade) reliability problems and of limited two-way communications value. Starburst uses fiber optics for the B1-B2 link.

With today's excellent distributed feedback (DFB) laser performance, AM often is the most cost-effective transmission means. Using sub-octave channel-loading, carrier-to-noise (C/N) performance in the mid- to upper-50s (dB) can be achieved with composite triple beat (CTB) and composite second order (CSO) distortions better than 70 dBc. Costs for the terminal equipment are less than $2,000 per channel, less than half the cost of frequency modulation (FM) or digital options. And with AM, there is no need for additional RF modulators at the remote headend. The key is to get the transmission fiber platform in place. Competitively, telcos now routinely link their central offices to their remote terminal switches with fiber.

For those who have been convinced that new FTF systems are the way to go, discussion of the B2-B3 fiber optic backbone trunking link might seem moot. In many newbuild and total rebuild construction cases, that will be the case. But in certain upgrade cases, where a significant portion of existing cable and electronics can be saved, the backbone architecture is being chosen today. To the extent that existing plant allows additional future bandwidth upgrades, Starburst consideration might still be worthwhile.

To provide for relatively efficient forward evolution, Starburst requires that backbone node (B3) locations be chosen with future B4 FTF node and B5 express node locations in mind. Amplifier stations capable of optoelectronic upgrades will ease the transmission, as will housings and feeder cable rated to 1 GHz or more.

In today's fiber-to-the-feeder B2-B4 links, the B4 FTF optoelectronic node is Starburst's heart. Optical splitting at the B2 headend allows B2-B4 terminal equipment costs to average less than $10,000. A 10-dB to 12-dB optical loss budget allows link performance of better than 50 dB C/N, and 61 dBc to 65 dBc CSO/CTB. In Starburst, 1,600 to 4,800 homes typically are served from B4. This assures compatibility with many telephony multiplexers. B4 node placement is optimized for express feeding of subsequent B5 nodes, creating future service expansion subsections of 400- to 600-home neighborhoods (Figure 2).

For best efficiencies, the B4 FTF node includes the optoelectronic receiver, a high output RF bridging amplifier and four feeder cable launch points. Provision should also be made for a return-path laser module, status monitoring module, redundancy switches and a future four-way optical splitter.

Optical amplifiers with better than 15 dBm output power have been demonstrated in laboratories. This is about four times the typical output (8 dBm) of today's best DFB lasers.

So, future placement of an optical amplifier at the B2 headend and four-way optical splitter at the B4 node should provide a simple means to extend fiber to B5.

Starburst typically requires no more than four RF electronic line extenders in cascade. Figure 3 highlights the results of a computer modeled hypothetical system build with 100 homes per mile and 49 dB C/N, 53 dBc CTB end-of-line performance. Total system construction material costs stop declining significantly at the four line extender cascade (to below $6,000 per mile). Results from an actual system design at 110 homes per mile density and 49:53 C/N:CTB performance are also

highlighted in Figure 3.

Costs excluding labor bottomed out at the four line extender cascade (to $5,620 per mile for the forward path and $6,180 for complete two-way transmission). Quadrapower® technology was used for bridging amplifiers at the B4 and B5 nodes. Line extenders use power doubling technology.

In the United Kingdom (U.K.), Starburst systems include a B6 cluster-tap. Also known as star-taps, the 24- to 64-way splitting network is co-located with the final line-extender. Drops typically can reach from 100 to 150 meters (325 to 500 feet).

Traditional four- and eight-way taps, B7, have coax inputs and coax outputs in today's Starburst systems. For future-readiness, housings and cable are fully qualified to 1 GHz or more.

Cable TV's final burst is in or at the subscriber's home, B8. Multiple TV sets already are served well by cable TV's broadcast AM video transmission and the subscriber splitter. Subscriber computers also are fed by the B8 splitter for data services, and stereo systems are fed for new digital audio entertainment services. In the U.K., duplex splitters already allow B8 to also feed telephones.

Future ready

Starburst provides an excellent platform for future evolutionary growth. Specific future-ready provisions include the following:

- **Bandwidth expandable.** All cable and feeder electronics housings and chassis are qualified for full channel loading at 1 GHz or more. Line extenders and optoelectronic nodes B3, B4 and B5 are easily expandable to accept 750 MHz modules expected to be commercially available in volume beginning in 1992. Future bandwidth expansion is expected to be further eased by new hybrid AM/digital transmission schemes (see compressed digital video section below). Lasers, photodiode detectors and optical transmission fiber all facilitate relatively easy expansion to 1 GHz+ bandwidths.

Starburst avoids feedforward technology in the feeder plant. Taking feedforward hybrids to 750 MHz appears impractical and is not expected. If such devices do become available at some time, they could be used to provide additional performance improvements, if the increased powering requirements can be economically tolerated.

Line extenders use power-doubled or Quadrapower® technology and are short-spaced by 2 dB to 3 dB relative to standard 550 MHz applications. With this layout, required line extender gains at 750 MHz are approximately 30 dB. The short-spacing cost premium typically works out to between $1 and $2 per home. Table 1 illustrates such a U.K. case that worked out to $1.88 extra per home.

Today's system optical splitters are located in the B1 or B2 headends, rather than in the field. This allows an option of more easily converting the optical network in the future. Future field-splitting and wavelength division multiplexing (WDM) expansion options negate any need for leaving headend fibers dark.

- **Optical amplifiers/1550 nm.** Based on laboratory performance of erbium-doped fiber amplifiers operating at 1550 nm, B3, B4 and B5 node location decisions incorporate projected future plant upgrades. Using narrow linewidth light sources, laboratory experiments have demonstrated that 1550 nm transmission over standard 1310 nm fiber can be accomplished with no dispersion-related increase in noise or CSO distortion.

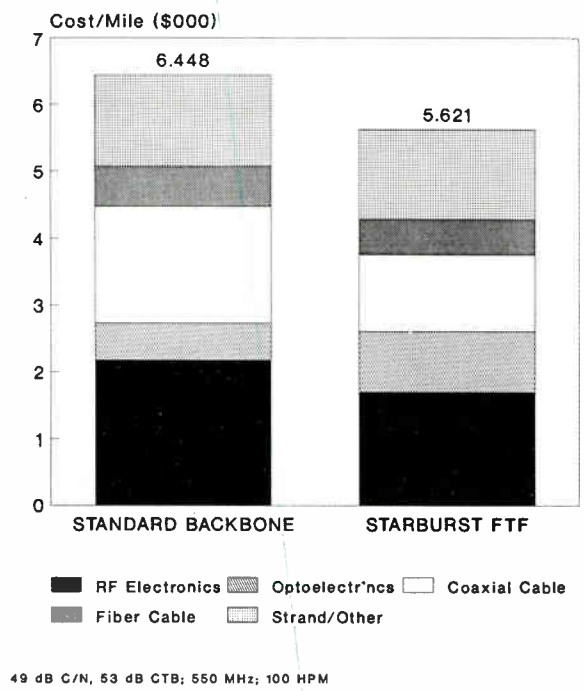

Figure 4

Other experiments have shown optical amplifier outputs of 15 dBm with no measurable contribution to system distortion and manageable noise figures of 4 dB. B1 and B2 headend transmitter housings provide expansion space for optical amplifiers, as do B3 and B4 nodes. Dual-window (1310/1550 nm) fiber and optical passives are used in current construction.

• **HDTV.** Starburst provides the bandwidth expansion and system flexibility required to handle any HDTV transmission system currently envisioned. The Starburst growth plan assumes that HDTV technology will prove-in first for premium services, that simulcast will prevail near-term and that all-digital HDTV transmission will become the norm (at least in the U.S.). Therefore, provisions for HDTV are similar to those for compressed digital video (below).

• **Compressed digital video.** Starburst is ready for expected AM/digital video hybrid transmission schemes. Based on a David Grubb III analysis published in the NCTA '91 *Technical Papers*, a 4 dB to 6 dB distortion improvement factor is projected for AM/digital systems with a 550/750 MHz split. The use of digital carriers above 550 MHz also will ease high frequency tap level requirements because the digital signals can tolerate more noise. The same principles apply above 750 MHz to 1 GHz and perhaps further.

Starburst's digital transmission upgradeability is based on digital-video systems that are being optimally designed for cable TV. Such ensures cable TV's full harnessing of this growth opportunity as telco or satellite transmission standards will not be force-fit.

• **Interactivity.** The star architecture is a natural for two-way interactive communications and narrowcasting. Switches can be added to a number of different burst locations when business reasons justify. The cost premium for return-ready plant is very small. The only significant investment is in the extra fibers required to support return signals. Activating the return path for sub-split data transmission typically costs $5 or less per home. Status monitoring and path redundancy capabilities are also incorporated to assure the reliability required for real-time interactive services. For best evolutionary cost economies, these capabilities are activated through optimal plug-in modules.

• **PCN/telephony.** Starburst provisions for interactivity, mentioned above, also apply to PCN/telephony service integration. The relatively large number of burst locations provides plenty of flexibility for future telephony service integration. Cell sizes have been chosen to best integrate with available telephony multiplexing equipment and anticipated cable TV/PCN coverage areas. Even if fiber-to-the-curb becomes economically feasible, Starburst B6 and B7 nodes are well situated for conversion to optoelectronics. Dark fibers often can be extended to B5, B6

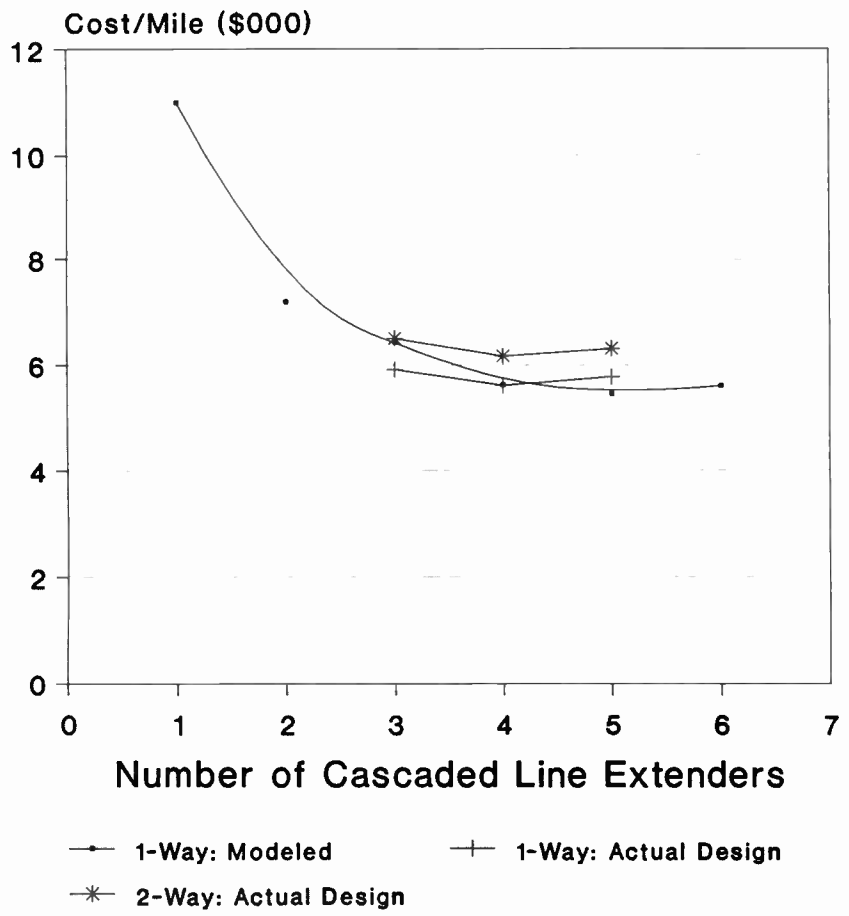

Figure 3

and/or B7 nodes today to facilitate future telephony expansion. Starburst's large bandwidth capacity provides ample room for ancillary telephony service traffic.

Cost-effective activation today

Total two-way distribution system material costs for a typical North American Starburst fiber-to-the-feeder system are compared to equivalent fiber backbone construction costs in Figure 4. The comparison assumes aerial construction, 550 MHz activation, 100 homes per mile and 49:53 (dB) C/N:CTB end-of-line performance. In this example, the Starburst FTF system is 13 percent less expensive than a standard backbone system. Of course, every actual system construction case is different. Detailed construction choices depend on a particular cable TV operation's existing plant geography, subscriber density, marketing strategy, future expansion philosophy and budget. Starburst provides a future-ready, cost-effective platform for consideration in most of today's cable TV construction opportunities. ■

Acknowledgements

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Personal Communications

An opportunity for the cable industry?

Personal Communications Networks (PCN) represent a major opportunity for the cable industry as supporting service providers and possibly as direct participants. PCN is believed to have revenue potentials well in excess of those to be enjoyed by cellular services; and CATV systems, with their existing infrastructures, are well positioned to participate in this developing area.

However, the PCN landscape is far from simple, and there are still few fixed navigation points as the service develops at a very rapid pace. An understanding of PCN's history and issues is necessary to allow the cable industry to appreciate and evaluate the opportunities and choices for participation which may be presented. This article attempts to provide some of the background necessary for this appreciation.

PCN's potential

In recent months, a flurry of experimental license applications has marked the entry of the cable industry into one of the newest, and potentially most important, areas of telecommunications services development. It is one, which while seeming far distant from cable's main business, could prove to be a major source of new revenues in the future. This are is the area of wireless personal communications services, usually called personal communications networks or PCN.

It is also an area of contention between two major groups of current switched telephony service providers: the local exchange carriers and the cellular service providers. And it is one which might become a regulatory battlefield as various interests battle for control.

That there is a tremendous demand for PCN services is well documented by a number of market studies which indicate that up to 40 percent of the potential users asked would purchase a PCN service. In contrast, cellular service penetration is less than 2 percent today and not expected to ever exceed 10 percent to 15 percent.

By Jim Rosenberg, San Francisco Consulting Group

The vision of PCN

The vision of PCN is that of a wallet-sized radio handset, which will allow the user to make or receive voice, and possibly even data, telephone calls anywhere and at any time. This is the communication element related to the C in PCN. It is the tetherless or wireless access element.

Access to the service is supported by a continuous grid of radio base stations, as in the current cellular service, but with much smaller separations between adjacent cell centers. This arrangement of a large number of "microcells," with a radius ranging from a few hundred feet to one mile, will allow the user to move about freely with uninterrupted service but will require much lower transmitter powers and thus permit the use of a very small and inexpensive handset.

As the handset is intended for use in the user's hand rather than mounted in a vehicle, the problem of hand-off between adjacent cells as the user moves about is much different than that of an automobile moving between cells at speeds in excess of 60 mph. Because of differences in system design requirements and lower power output required, it is projected that the PCN handset can be sold in high quantities for less than $200 each.

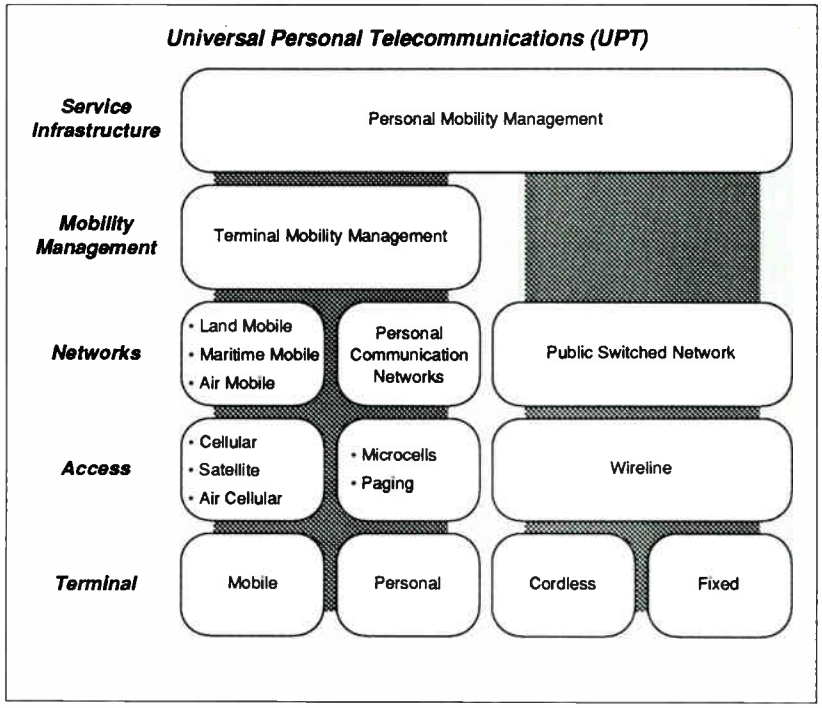

Figure 1

Networking

A second element of the PCN vision is the networking related to the N in PCN. Integral to PCN, if it is to be more than an public access cordless telephone, are network capabilities. A forerunner of the PCN concept is that of the Telepoint or CT-2 service presently provided in the United Kingdom.

In Telepoint, users' handsets substitute for payphones in that within limited areas in public places the Telepoint unit can access the public network on an originating-only basis. In Telepoint no one can call into the user's handset, service areas are restricted to high traffic areas like pubs

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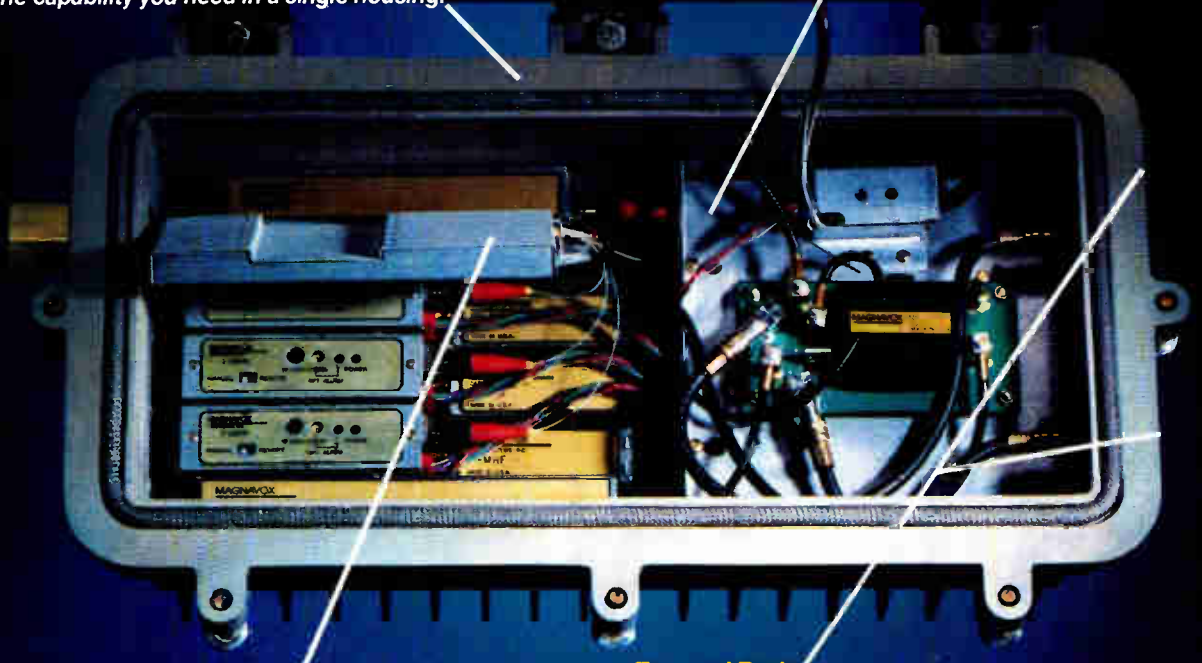

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structure for extending personal communications access and services across different networks and technologies. It is intended to encompass not only wireless access as in PCN, cellular and paging, but also fixed and cordless access through the wireline based public network. Figure 1 shows a representation of the UPT structure.

PCN, as described above, utilizes the personal handset as the terminal device, gains system access via the microcell fabric, utilizes the personal communication network and at the handset level takes advantage of terminal mobility management capabilities to provide for calling to the handset regardless of where it is located and to control its service and privileges.

Finally, a personal mobility management function maps the individual user, and the potential multiple numbers and individual feature sets associated with the user to the mobile terminal or wireline address. A similar structure is envisioned for cellular and other wireless services that may make use of macrocells, as in the case of cellular services, or satellites like those of INMARSAT for ships, planes and vehicles, or even ground-based service to aircraft, as in Airfone.

On the wireline side, there is no need for terminal mobility management but there is the common need for personal mobility management. The local exchange carriers, particularly the RBOCs, believe themselves well positioned to provide this infrastructure and the related services via the intelligent networks they are developing. The interexchange carriers, who are developing similar intelligent network capabilities, may be positioned to contest this opportunity, particularly as they are not bound by the restriction to intra-LATA services placed upon the RBOCs.

The significance of UPT is that it provides a context for not only PCN but also more general personal communication capabilities which will not be restricted to microcell access. If some 40 percent of the eligible population will seriously consider buying a wireless PCN service, the overall demand for UPT capabilities should be far greater.

A brief history of PCN

While the concepts of PCN, UPT, microcellular radio systems, and personal numbering have been under discussion for many years, PCN as a distinct and soon-to-be-realized service has only emerged in the last two years, principally as a result of actions by the British government.

The Department of Trade and Industry, looking ahead to the United Kingdom's next century telecommunications needs, the desire for competitiveness and possibly even dissatisfaction with competition in the wireline network between British Telecom and the newer Mercury networks (and concern over the slower-than-desired development of cellular services), in early 1989 issued a discussion paper called "Phones On the Move" whose vision of PCN matched that above.

After receiving a great number of responses, DTI announced that it would accept applications for licenses to build and operate one or more PCNs to serve

Millicom's prototype personal communications handset.

the U.K. Several applications were received and three licenses were issued.

One was earmarked for BT's competitor Mercury Communications from the beginning and two others were awarded, based on a comparative analysis of the systems and plans presented, to the Microtel (in which Pacific Telesis is a participant) and Unitel (in which USWest is a participant) consortia. Service via the three PCN networks is expected to begin in 1992.

The British PCNs have adopted the GSM architecture developed by the Groupe Speciale Mobile for the Pan-European digital cellular system. The choice of GSM for the architecture is important as many of the functions required for PCN are already specified and under development.

Of equal importance is the U.K.'s choice of a frequency band around 1.8 GHz for the handset-to-microcell base station links. Within the U.K., this band will become effectively free for use as the Ministry of Defence shifts elsewhere.

A version of the GSM specification adapted for PCN operation and moved from 900 MHz to the 1.8 GHz frequency band, called DCS 1800, is moving through the standards bodies in Europe and will soon be formal.

Because of the involvement of U.S. firms in the PCN license application exercise in the U.K., and the tremendous growth experienced by cellular services in the U.S., it is only natural that there would soon be a move to establish similar networks and standards in the U.S.

Millicom (which was granted the first U.S. experimental license for PCN), LiTel, and others are attempting to do just this. The spate of PCN applications, now numbering at least 56, join the more than 10 license applications for Telepoint/CT-2 trials. Those who have applied and the status of their applications is shown in Figure 2. The recent presence of a number of representatives of the cable industry is significant.

In attempting to translate the British PCN experience to the U.S., it must be noted that there are some significant differences in the situations:

- In the U.K., PCN basically arose from a government-led initiative. In the U.S., PCN is a private initiative without formal government support but fully governed by existing structures and procedures.
- In the U.K., a free frequency band was found and set aside for the purposes of PCN. In the U.S. there is virtually no free frequency spectrum and PCN must contest for whatever spectrum becomes available with multiple competing uses.
- In the U.K., the government decided at the beginning of the process how licenses would be awarded, and at least in the case of Mercury, who would be an acceptable licensee. In the U.S. there is no provision for PCN licensing and the complex and touchy issues of how to license and whom to license must be determined in a public arena.

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Cable Industry Applicants

Company	Applic Date	Contact Person	Market Test	Description
Cox Enterprises, Inc.	9/20/90	William L. Killen, Jr.	No	up to 15 microcell stations and 200 subscriber units using TDMA and CDMA
Cablevision	9/28/90	James A. Kofalt	Yes	200 microcell stations and 2000 subscriber units at Part 15 and 12 GHz CARS frequencies
Cable USA, Inc.	11/2/90		No	Up to 10,000 subscriber units
Satcom, Inc.	11/5/90	Les Hilliard	No	Up to 5000 units using FHMA, CDMA, TDMA, and FDMA
Pertel, Inc.	11/8/90	Michael J. Mahoney	Yes	Up to 100 microcell stations and 10,000 subscriber units using FHMA, CDMA, TDMA, and FDMA
Continental Cablevision	11/19/90	William T. Schleyer	Yes	Up to 100 microcell stations and 500 subscriber units using spread spectrum, CMA, TDMA
Time Warner Cable Group	12/11/90		No	Up to 100 microcell stations and 500 subscriber units
Comcast Corp.	1/10/91		No	Up to 50 microcell stations and 500 subscriber units
Cable TV of East Providence, Inc.	1/17/91	Glenn W. Winter	No	Up to 15 microcell stations and 100 subscriber units using spread spectrum and other
Casco Cable Television	1/17/91	Glenn W. Winter	No	Up to 15 microcell stations and 100 subscriber units using spread spectrum and other
York Cable Television	1/17/91	Glenn W. Winter	No	Up to 15 microcell stations and 100 subscriber units using spread spectrum and other
Viacom International Inc.	1/29/91	Edward Schor	Yes	Up to 1000 microcell stations and 10,000 subscriber units using FHMA, FDMA, TDMA, CDMA

Figure 4

• Also, in the U.S. a number of entrepreneurial individuals and smaller organizations are attempting to become players.

Despite these differences, PCN is making remarkable strides in the U.S. and stands a good chance of becoming a reality within the next few years.

The present age of PCN in the U.S. can probably be dated from the applications of Cellular 21 for CT-2 spectrum in the 900 MHz band and Millicom for full PCN spectrum in the 1.85 GHz to 1.99 GHz band. These attracted considerable attention from all members of the telecommunications community as well as interested parties outside of telecommunications and led to the FCC issuing a Notice of Inquiry in early 1990 (Docket 90-134, "Amendment of the Commission's Rules to Establish New Personal Communications Services," released June 28, 1990).

Rounds of comments and reply comments on the PCS inquiry have led to a clarification of the issues, if not to their solution and the feeling that the FCC will take steps to act decisively on the matter of PCN within the next year.

At first glance, this may seem an unduly long period before action is taken, but if one thinks in terms of how complex matters of this sort involving the mediation of multiple conflicting interests are resolved, the process is actually quite rapid.

The regulatory situation

As PCN does not yet exist in the U.S. it presents a number of potential regulatory problems which will have to be resolved rather quickly if service is to develop and become widely available to the public within the next few years. Most of these issues are interrelated and flow from technical issues.

A few key issues are: frequency bands and interference; entry, competition and licensing; and federal vs. state control.

The availability of adequate quantities of radio spectrum in a suitable band or bands is the first of several key issues which must be solved to allow for successful PCN deployment. There are currently no sizeable blocks of free frequency spectrum available at usable frequencies.

Consequently, the complex problems of clearing frequencies of existing users or setting some sharing mode must be faced. Both represent substantial technical and political problems because of the entrenched positions of existing users and systems. These users are already licensed to operate in the bands and have made substantial investments in equipment. Often the users are government, public safety, or defense organizations whose needs are particularly sensitive.

The solution to the spectrum availability problem is being approached from two directions. In the Congress there are efforts led by Representative John Dingell of Michigan to cause the federal government to re-examine its spectrum usage and relinquish 200 MHz of spectrum below 3 GHz for use by new telecommunications technologies.

HDTV and others are potential competitors with PCN for this spectrum if it is released and the process of making it available could be quite lengthy although it is believed that it could be done. In the laboratories of many organizations in the U.S. and elsewhere, technological approaches based on spread spectrum modulation which will allow an unprecedented degree of non-interfering spectrum sharing are being actively investigated.

Finally, there is an implicit solution to the requirement for PCN spectrum in the existing cellular spectrum allocations. Cellular carriers have the option of using both their currently active spectrum and that additional spectrum allocated in recent years for system expansion for PCN and PCN-like services. Whether cellular carriers would choose to do so in the absence of other PCN competition is an interesting question.

Access to spectrum

When spectrum, or adequate spectrum sharing, becomes available, the next question to be faced is who should be allowed to operate PCN services and how their entry into the service should be controlled. Using cellular services as a model, the FCC could allocate one license to the local wireline carrier and hold a lottery for the other license (or licenses if it is determined that more than two licenses should be offered).

In cellular this was done on the basis of metropolitan statistical areas (MSAs) initially and rural statistical areas (RSAs) later. This lengthy and cumbersome approach was far from controversial and may have delayed the introduction of cellular services in some areas.

Other options for determining who

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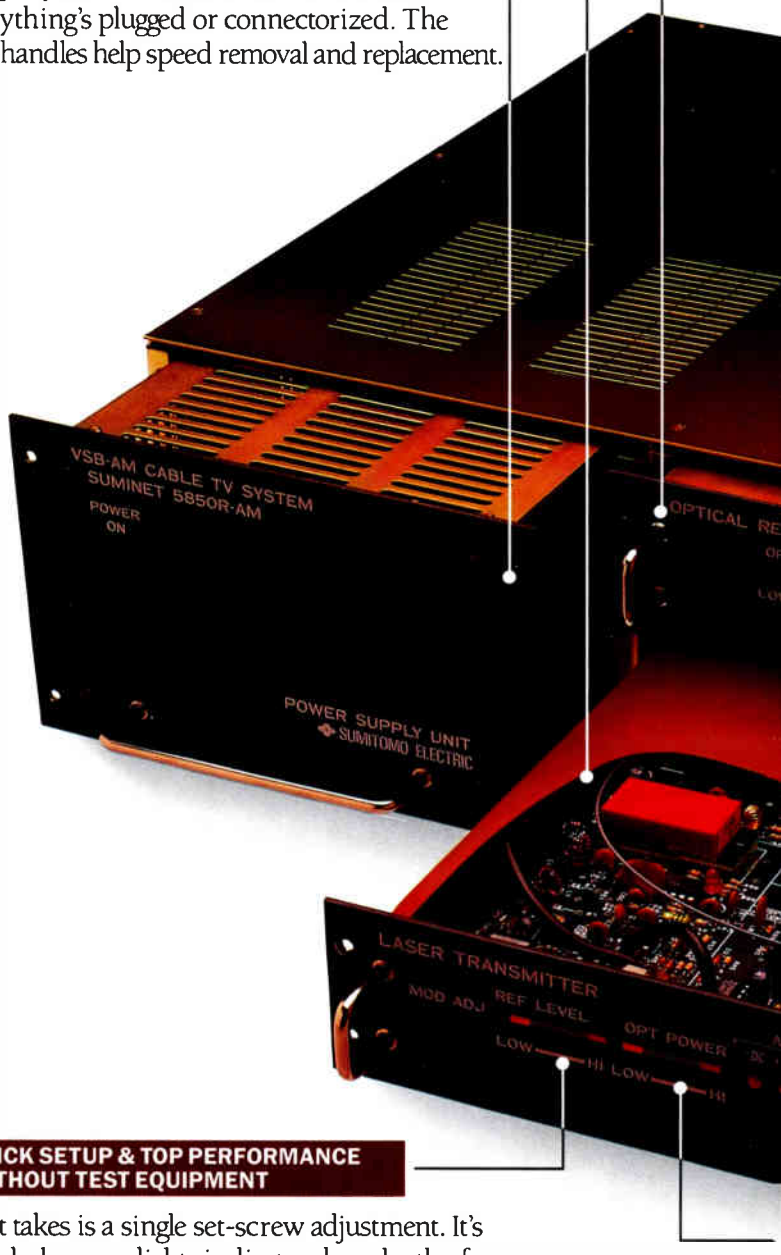

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is licensed include comparative hearings in which the technical, financial and perhaps public interest value of various proposals are weighed against one another. Comparative hearings could become particularly contentious because of the difficulty of quantifying one benefit against another.

An innovative and somewhat unconventional "open entry" approach, modeled on the way in which Airphone's air-to-ground service was handled, has been proposed by Digital Spread Spectrum Technologies, a subsidiary of Cylink Corp.

DSST's proposal is based on a combination of technology and lack of regulation and assumes that spread spectrum modulation will allow extensive sharing between fixed users and the new PCNs in a band. The band is then divided into both dedicated and shared blocks in each area with existing fixed links being blocked out to avoid interference. PCN carriers are assigned dedicated blocks and allowed to access shared blocks on a per call basis once the traffic in their dedicated blocks reaches a certain level.

The merits of this plan are that as many as 14 carriers could be accommodated in a best case area and that the market drives the spectrum required by each carrier. DSST's proposal is of interest in that beyond satisfying minimal technical and suitability requirements, there would be few impediments to becoming a PCN provider as technical standards would be allowed to evolve along with the services and be market driven. This approach could lead to very quick implementation of PCN in the U.S.

A final question relating to federal vs. state regulation goes to the heart of the service to be provided by PCN. In the U.K. model and throughout Europe and elsewhere, PCN is envisioned as being developed on a national basis with backbone trunking covering the nation. In the U.S. it is not yet clear as to whether PCN will become, as in the RBOC and cellular views, an alternative means of access to the local central office or a parallel nationwide network.

Because of intra- vs. inter-LATA and intra- vs. inter-state questions, the relative roles of federal, state, and perhaps even local authority regulation of PCN are unclear. If PCN is seen as purely a radio service, there are precedents for solely federal licensing. Regardless of how licensing and regulation is distributed, PCN providers may be subject to filing both federal and state tariffs.

In parallel to the PCS and other matters, the FCC is considering the recommendation that a "pioneer's preference" of some form be given to technical and service innovators who risk their capital to develop new services. While the extent of this preference, if adopted, might only be procedural, anticipation of it seems to be driving a number of experimental license applicants to "stake out" their territories by filing for licenses in a number of markets they wish to serve.

Technical issues

Figure 3 is a much simplified schematic of one architecture for a U.S. PCN service. It consists of four equipment elements and four sets of links. There are technical issues associated with each element and each link.

The PCN handsets and the RF links between the handsets and the microcell base stations are issues of developing new technologies. Others, like the links between the microcell base stations and the PCN, the SS7 or other signalling network between the PCN switches

and the terminal mobility management database, and the database itself do not require new technologies. However, they do require the deployment of existing technologies on a new scale and in novel ways.

Finally, the links between the PCN network and other networks can hardly be novel if they are to be low cost and cause the minimum of expense to the other networks, but they do need to be defined and configured to the satisfaction of operators of all networks.

From the point of view of the cable industry, two technical issues are of greater importance as they could have direct impacts on CATV systems and their development. These are the choices for the RF links between the PCN handsets and the microcell base stations; and the connector links between the microcell base stations and the PCN switch. Both will affect the financial viability of the PCN services as they are key cost elements in the system. If one or the other fails to meet expectations, PCN will not prosper.

The spectrum shortage imposes severe constraints on the RF link to the handsets. Even if free spectrum can be found, the efficiency of these links must be sufficient to support an economic number of simultaneous conversations. In the presence of interference this constraint becomes more severe.

Traditional analog cellular services are running up against this constraint in certain heavy traffic areas like New York and Los Angeles today and the industry has recently adopted a digital standard which should result in capacity gains of at least three times, if implemented. Whether this will be sufficient for cellular to continue its exponential growth and achieve projected penetrations is still a somewhat open question.

The approach championed by Millicom and others for PCN is to go to an entirely different type of modulation, which in conjunction with the use of microcells, appears to offer the possibility of tremendous gains in capacity when measured in terms of conversations per unit of area. This is the technique known as spread spectrum or code division multiple access (CDMA).

In actuality, spread spectrum is a modulation technique in which the modulating signal is mixed with a unique spreading signal and "spread" across a wide frequency band rather than concentrated into the narrowest band possible, as is the goal of most other modulation techniques.

One advantage of the widely spread signal is that the signal power contained in any part of the bandwidth is very low and thus causes lesser interference to a more narrow band signal receiver associated with a different modulation scheme. The interference caused to external systems by spread spectrum signals is thus less and in some instances may be undetectable by these systems.

Another advantage of spread spectrum is that as each spreading signal can be made unique it is possible to use a single frequency for multiple signals and separate them at the receiver by using the spreading code of the desired signal to pull it out of the other signals received. In a spread spectrum system far lower carrier-to-noise ratios (C/N) can be accepted than in other systems. By using carefully chosen spreading codes, a form of multiple access is achieved, hence the term CDMA.

Spread spectrum signals are also believed to be more resistant to propagation-related problems like multipath and to be able to be used to provide an improved form of "soft" handover between microcells. One of the key aims of the experimental licenses is to

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determine the reality of the claims for spread spectrum in the real-world environment in which the PCN system will operate.

Critical items to be determined include the code gain, or number of simultaneous spread spectrum signals which can be tolerated; interference from spread spectrum systems to other systems, including CATV distribution systems; interference between spread spectrum systems; and how well radio signals propagate into and within buildings.

The other technical issue of particular importance to the cable industry is how to join the many microcell base stations to the PCN switch. A number of techniques are available, ranging from existing microwave transmission systems in urban areas, as presently provided by LOCATE in New York and a number of other major cities across the nation, to standard digital transmission circuits provided by the local exchange carriers in most locations, but at greatly varying costs, to the nearly ubiquitous CATV plant running through most urban, suburban and rural areas.

Finally, there are future prospects of atmospheric optical transmission which are under investigation by several manufacturers.

If the microcell base stations are assumed to be distributed evenly in a honeycomb-like grid across most suburban and rural areas and in some three-dimensional manner in the urban areas the magnitude of the connector network required to join them all to the PCN switches becomes apparent.

The connector circuits provided will need to be high-quality, full duplex digital circuits and of at least DS-1 capacity to each microcell. Depending upon the architecture of the microcells and how cells may be tandemed together via the connector circuits, even DS-3 circuits to multiple points may be required.

A technical issue particular to cable is how to take maximum advantage of CATV infrastructure to provide these connecting circuits, as most existing backbone cable plant is based on analog transmission over coaxial cable bearers with closely spaced repeaters. While the capability for additional digital transmission over these systems is inherently limited, trial systems for digital transmission are certainly possible and several license applications, such as those of Casco Cable Television Inc. mention the testing of techniques for the coupling of PCN signals using coaxial cable as well as fiber optic plant.

If a fiber optic transmission backbone is assumed able to provide both analog video channel distribution from headend to customers and multiple duplex digital circuits along the route, the situation becomes much more attractive to the CATV system operator.

Experiments using combined analog and digital techniques over fiber have been underway for a number of years. In the French fiber optic wired city of Biarritz, not only analog video for both entertainment and duplex video teleconferencing but also duplex 64 kbit/s digital telephony and data channels run to thousands of homes.

In the U.S., research is underway as to how best combine the signals; wavelength division multiplexing where a different laser frequency is used for different services, sub-carrier multiplexing, and even the use of separate fibers are under study.

The recent experimental license application of Linkatel Communications Inc., a Sn Diego company engaged in building a metropolitan area fiber optic alternative access, mentions the video development activities of its sister, Tacan Corp. Here, one organization seems to be assembling the various components required for an effective answer to the PCN connection problem.

The potential goodness of fit between CATV plant capabilities and placement and the need for connector circuits has not been lost on the cable industry. Nor has the revenue potential represented by these circuits been overlooked. In an era when bypass of local exchange facilities is a serious consideration, the provision of PCN connection circuits could be the largest bypass "plum" of all. Even participation as PCN providers is a possibility for the cable industry. The number of experimental license requests from cable companies in recent months is an indicator of the importance of participation in PCN for the cable industry.

Players and trials

Figure 2 shows the universe of PCN and CT-2 experimental license applicants and the status of their application. Figure 4 provides a bit more detail on the cable industry applicants applications and plans. These, and perhaps several other cable-related trials, can be expected to take place if the licenses are granted. The number and distribution of those involved show the importance attached to PCN by major industry players.

At another level the cable industry as a whole is becoming involved in PCN via Cable Televison Laboratories. In mid-January, CableLabs and Millicom announced an agreement to cooperate in the development of PCN systems for the U.S. market. The agreement provides for the exchange of technical information relating to the interfacing of PCN to cable networks. This cooperation is significant as the development of standard interfaces and techniques would allow individual operators to enter the PCN support business quickly and efficiently.

Cable's potential role

The cable industry appears well positioned technically to participate in PCN in at least the role of microcell base station to PCN switch connection provider. Cable has the infrastructure, the staffing, the rights of way, the electrical power, the pole attachment rights, the local presences, and the many other elements which will be required to be successful in this role.

However, a number of questions remain to be answered about what the exact role of the individual CATV operators should or will be. At one extreme the local operator can provide digital connectivity on a "common carrier" basis to two or more PCN providers in a utility role. At the other extreme, the operator could become a PCN provider in its own right and provide microcells and even switched services. Each extreme and all gradations in between have an individual business case to be examined in light of the circumstances of the particular operator.

From a strategic viewpoint, the industry must examine carefully whether or not it wishes on a broad scale, or any scale whatsoever, to become involved in the massive bypass of the local exchange carrier at a time when the local exchange carrier might wish to move toward video distribution and fiber to the home.

There is a certain irony that broadband distribution is place specific while PCN is person specific, yet the two could easily work together to form a full alternative to the present local exchange carrier distribution networks. One conceivable scenario could have two PCN providers, one wireline and one CATV-based. Perhaps when PCN reaches equilibrium by the end of the decade this scenario will not seem as extreme as it might today. ■

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Personal communications and CATV

Observations on the opportunities and challenges

The PCN/S phenomenon is certainly a fascinating one to observe, but will it generate for those who chose to participate in it a mega-dollar loss or profit? The PCN/S bulls base their optimistic enthusiasm on predictions of 60 million customers 10 years after market introduction and tens of billions in annual revenues. The bears remember the costly lesson of videotex and remain concerned over unproven demand, undeveloped technology, unknown costs, uncertain competitive reactions, and yet-to-be-determined significant government "help."

Will PCN/S go the way of videotex—that is, be a seductive lure that encourages firms to invest millions to end up gaining nothing—or is it truly the future of telecommunications throughout the world?

This paper suggests some of the market, business, technical and regulatory questions that need to be answered before one can accurately state whether PCN/S is to be a bust or a boom.

(One point of clarification or definition: PCS are the services a customer will receive over PCN, the equipment deployed to provide those services.)

The PCS market

What are the PCS that PCN will deliver?

Depending upon the individual, descriptions of PCS can range from quite mundane ("it's nothing more than cordless telephony") to better than Dick Tracy ever imagined. For this paper, let's assume that PCS has the following key attributes:

- Digital
- Wireless
- Person-to-person voice communication service (i.e. its potential data applications are not its primary niche)
- Uses small radio cells

If the above are its key attributes, then PCS will have to be competitively positioned against the following established telecommunications services:

- Cellular
- Paging
- PBX & Centrex
- Residential telephony (e.g. wired loops and cordless phones)
- Pay telephones

In spite of this array of established, potential competitors, there are some very bold predictions for the future of PCS:

- A.D. Little states, based on their focus group research, that 10 years after market introduction there will be 60 million PCS users in America.
- Impulse Telecommunication Corp.'s study predicts PCS revenue of $30 billion to $35 billion in the year 2010.

Will PCN/S go the way of videotex, or is it truly the future of telecommunications throughout the world?

If there is to be a growing market demand for telecommunications services of a more "personal" nature, than it should not be ignored that each of those existing services can be modified to meet some (perhaps all) of that "new" demand.

Therefore, from a PCS market perspective, the following are some of the questions that need to be answered:

- What do residential and business telecommunications customers buy now and what do they want?
- Can customer needs be adequately met via current or enhanced existing services?
- What are the forecasts for existing telecommunications services?
- If PCS is to enter the market, how will it be competitively positioned against each existing service?
- What PCS features and benefits will attract customers?
- Will PCS be sold on an added value or a reduced price basis vs. existing services?
- Will PCS capture the growth potential of existing services, create new growth or replace existing services?
- What are the best PCS market segments?
- If developing technologies and standards (such as TDMA, E-TDMA, CDMA and GSM) make cellular more "personal," what will that do to PCS demand?
- Why should PCS demand be so much more phenomenal than what cellular has experienced?
- What can be learned from cellular's experiences in the U.S. and CT2/Telepoint's experience to date in the U.K. to help insure PCS success in the U.S.?
- How much customer perceived value is there in portability vs. full mobility?

PCS as a business

Assuming that the answers to the market questions indicate a legitimate opportunity to provide a service that customers will want to purchase, then what is the best business construct to provide that service? This question cannot be answered independently of the technical issues that will be mentioned later, but there are some overriding critical business challenges.

For example, if either the A.D. Little market forecast or Impulse Telecommunications Corp. study is accurate, then 60 million PCS customers will exist 10 years after market introduction and/or PCS revenues could be $30 billion to $35 billion in the year 2010. Therefore, within 10 years, a national communications network (with a mind-boggling database requirement) will have to be built that rivals, and in some ways exceeds, both the existing telco and cellular networks. Few, if any companies, have the ability independently to finance, plan and/or execute

By Thomas F. Gillett, Media Management Services

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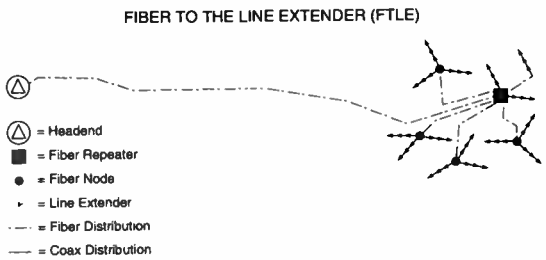

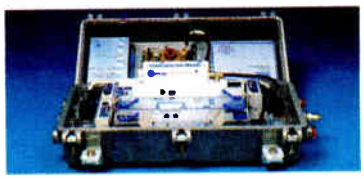

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such a huge capital effort.

(Maybe the telcos will switch from their theme song of "Let's put $200 billion in the rate base for fiber, in order to save America," to a "Let's put $200 billion in the rate base for PCS, in order to save America." A facetious comment that might come true.)

Therefore, it seems to be critical that anyone hoping to participate in PCS will need to develop strategic alliances. These alliances need to be assembled in order to make certain that all of the PCS provisioning challenges are met. Those include:

- Financing
- Service sales and distribution
- Operations
- Construction
- Network connectivity
- Billing
- etc.

Further, those alliances will have to make certain that all of the technical pieces of PCN (see the next section) are properly established and operated. It seems likely that firms or industries that may have viewed themselves as competitors, might now need to become cooperative partners in order that together the full PCS opportunity (whatever it might be) can be realized.

In probably all metropolitan areas, the following firms are each deploying telecommunications networks:

- Cable TV
- Telcos (LECs)
- IXCs
- Cellular
- Alternative access providers
- Private networks

Should each provide PCS, or are there some logical and valuable alliances among them? An excellent way to test the value of various alliance partners is to trial them during the running of the FCC experimental licenses.

In the midst of all of that, these are some of the key PCS business questions that need to be answered:

- Should cable TV plan to be a full service provider of PCS (i.e own, operate and sell all aspects of PCS)?
- If not a full service provider, then what is the best niche or niches (if any) for cable TV to concentrate on?
- Does Cable's PCS participation decision vary by geographic and/or demographic market?
- What is the value to PCS provisioning of cable's established presence in 60 percent of America's homes?
- Will cable's image help or hurt if cable offers PCS?

At this point in the market development of PCS, it appears that there is one niche that is fundamental to all of cable's PCS options—and that is *transport*. Especially and specifically the building incrementally upon existing cable systems in order to offer the telecommunications link between the PCN base stations and the network intelligence/switching points (a transport service that could also be marketed to cellular companies).

No matter who is the eventual PCS retail provider (whether it be cable or others), cable should be aggressively working now to explore the alternative of establishing itself as the best choice, throughout the nation, for PCN transport. Transport will either be the only logical niche for cable to pursue and establish as a highly profitable service that it sells to PCS (and cellular) providers or transport will be the building block to whatever level of PCS participation cable will enjoy.

Transport for wireless providers can be viewed in a very similar way to the alternative access business (i.e. the interconnection of discrete points, whether they be base stations to switches or business customers to POPS (alternative access), is the transport business.) Thus, perhaps a telecommunications business development route for cable companies to consider is:

1) build an alternative access business

2) provide transport to cellular companies

3) provide transport to PCS providers; and

4) to be determined.

PCN technology

The technical delivery of PCS (i.e. PCN) can be segmented into these areas:

- Database
- Switching
- Transport (both from the switch to base stations and the connectivity between switching)
- Base stations (RF transmitters/receivers)
- Handheld units

Each of those areas has its own design, equipment engineering, traffic engineering, network management, construction, deployment, maintenance, operations, quality control and other issues—none of which have been answered to date! (There may currently be more technical uncertainty about PCN than ISDN, HDTV and videotex combined.) Being involved with answering such questions has historically been a very expensive proposition. There is every reason to expect that the PCN learning curve will also be a costly one.

In the morass of so many technical unknowns, cable TV must be careful not to attempt independently to have to foot the bill to develop the answers to all of them. Because transport (as pointed out above) is the most obvious niche for cable to concentrate on now, then that should be the area where cable places its current technical attention so that it might take the "high ground" as the expert in that area.

As cable evaluates its overall role in the technical development of PCN (whether via FCC experimental licenses or other research efforts), it should remain focused on the transport niche. Good research/experimentation work done even at this early stage of PCN development can build a positive, long-term, credible reputation for cble's transport ability.

Cable needs not only to answer as quickly as possible, but also show other players (and the government) that it is the source to rely on to answer the following transport questions:

- What will be the two-way PCS traffic requirements between the PCS switch and residential and/or business (wireless) PBX base stations?
- What will be the voice transport standard (64Kbps, 32Kbps ADPCM, or ???)?
- What is the relationship and dependence between the physical transport scheme and the RF (base station to handset) one?
- Can cable TV's existing coax tree-and-branch networks be cost-effectively modified to provide the network reliability and quality required?
- What network monitoring and management techniques are going to be needed to operate a PCS network?
- What network architecture and topology is best suited to PCN?
- How much will cable's PCN transport cost (and how does that compare to other competitive transport alternatives)?
- What additional fiber (cable and electronics) equipment is needed to support PCN?
- What will be the transmission and traffic quality standards for PCN?
- What is the maximum coax amplifier cascade that can be used and still maintain voice quality standards?

Cable, via the use of its experimental licenses and other developmental work, must be able to show that it has the capability not only to answer those

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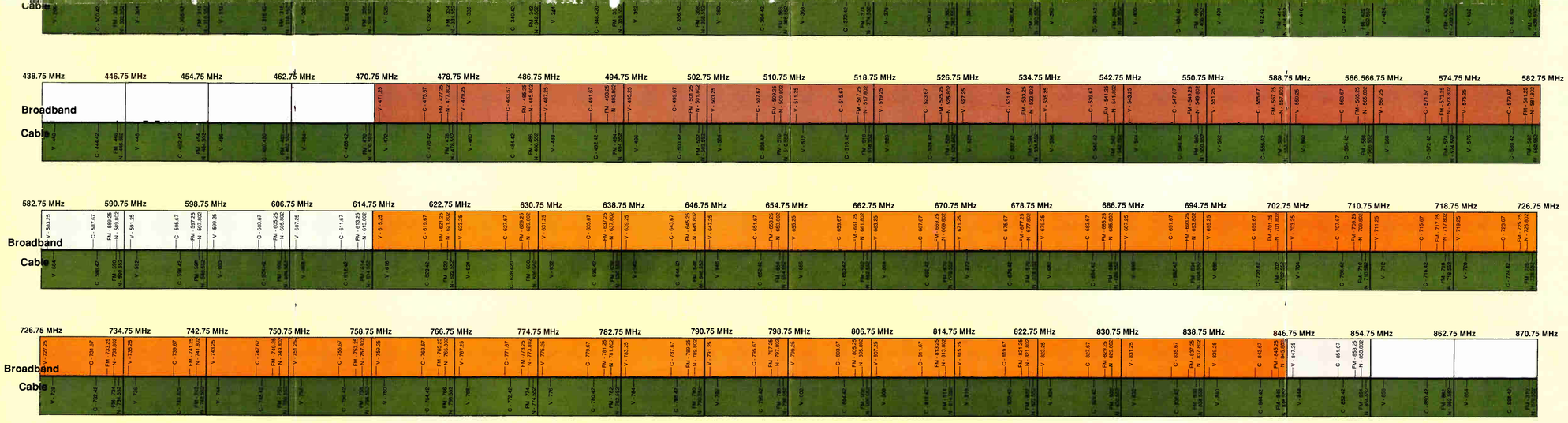

CED United Kingdom Frequency Chart

UHF Broadcast and HRC cable channels for PAL/I System

The use of vision/sound/pilot carriers and color sub-carriers in this frequency range is prohibited. Further, the radiated levels of any sidebands or of any intermodulation products or spurious frequencies on the system falling within this frequency range shall not exceed 21 dB (µV/m). For more information, consult the Department of Trade and Industry (DTI) document MPT-1510.

FM broadcast band | Band IV | Band V

V = Video carrier frequency
C = Color carrier frequency
FM = FM sound carrier frequency
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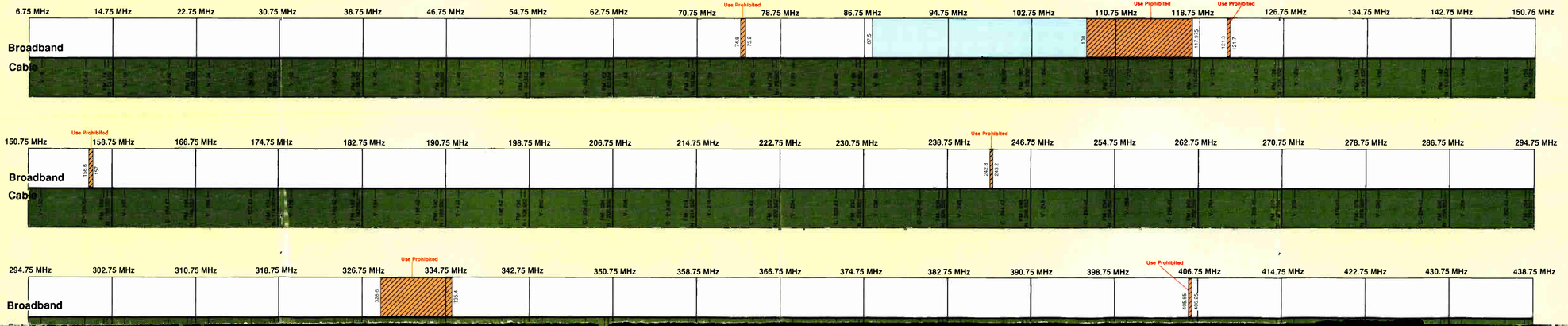
Note: Channel numbers are not standardized.



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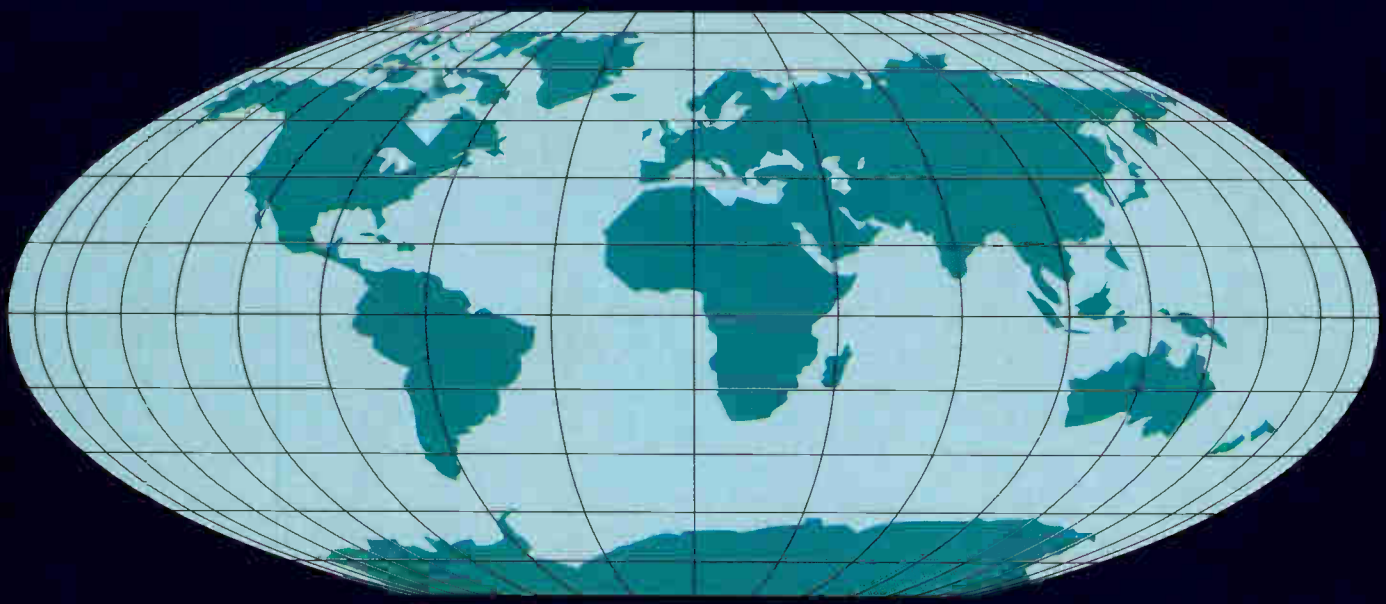

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questions, but also the potential to be the "carrier" of choice for PCN transport for anyone who needs it.

Meanwhile, as cable focuses on becoming the source for answering the PCN transport issues, it can (and should) continue to learn about the total PCS picture from its participation in appropriate alliances, the operation of its own FCC experiments, funded research and continued observation of the national and international efforts to answer the rest of the PCN/S puzzle.

Regulatory and legislative issues

While cable, and other industries, are trying to quantify the legitimate PCN technical capabilities and PCS market demand, regulators (particularly the FCC) are moving ahead to answer regulatory concerns. Cable is challenged with trying to develop a regulatory strategy, while technical and market issues are still to be answered.

While the many important national regulatory issues about PCS are weighed, cable needs to remain concerned that it is not prematurely offered participation in PCS as a quid pro quo to further telco entry into cable. It is impossible to evaluate such an offer prior to an accurate development of the market value of PCS. For example, if PCS eventually falls victim to the technical advances, new marketing strategies and competitive pressures from cellular, then being given the PCS telephony opportunity (for the price of telco entry) has no long term value for cable. In short, it seems appropriate to work in the regulatory scene to keep any "entry" decisions in abeyance as facts are developed.

Therefore, it is absolutely critical that as quickly as possible facts be developed from the PCN/S experiments and other developmental work so that the value of these and alternative strategies for cable can be accurately judged. Cable's regulatory negotiators need educated opinions supported by quantified study and experimentation developed soon. ■

About the author

Prior to joining MMR, Thomas Gillett was vice president of business development and technology transfer for Cable Television Laboratories Inc., where he was responsible for the business analysis and planning of the operational, functional and technical performance of cable distribution networks.

Before joining CableLabs, Gillett was director of advanced operations testing for GTE, where he was responsible for the conception, planning and execution of the fiber optics/video test bed project in Cerritos, Calif. Prior to that, Gillett held a number of titles with GTE with a variety of responsibilities related to marketing, business planning and network engineering. He also has 10 years of experience with the Bell System.

Thomas Gillett

Gillett has a masters degree in management and a bachelors in management engineering. He was named 1988 Fiberoptics Man of the Year by Fiberoptics Marketing Intelligence *newsletter for his work in Cerritos.*

Pocket deployment of interdiction

With over 17 months of field installation behind, surviving the elements of weather and power companies, interdiction continues to prove its reliability and functionality. And as the "does it work?" question is put to rest, more attention is being focused on the operational implication of deploying interdiction within a system. This article examines one of the many "partial" deployment strategies designed to maximize the operational benefits of interdiction.

The uncompromising consumer friendliness and the unmatched flexibility offered by interdiction make its revenue generating potential boundless, limited only by our marketing community's creativity.

By Mike Hayashi, Director of Marketing, Sub Systems Div., Scientific-Atlanta

Unrestricted marketing to the entire consumer base within any given system clearly makes a total system rollout the desirable deployment strategy. However, with limited capital availability, we are forced to become more prudent in our objective of maximizing our return on investment. Relative to interdiction, the key question is: Can the technology be *partially* deployed allowing a gradual rollout? And if so, how and what are the economic drivers?

Pocket deployment

One proposed partial deployment option is to introduce interdiction to a small geographic segment within a system. In "pocket" deployment, an area of a system is isolated by means of a separate cable run from the headend, technically permeating different signal security schemes to be mixed within the existing system. For interdiction, pocket deployment permits non-scrambled signal delivery to the designated area while the rest of the system continues with traditional scrambling based signal security. Fiber-to-the-serving area (FSA) offers a perfect technical and marketing fit allowing a narrower segment to be defined and targeted. Regardless of the approach, clear signal delivery is key for interdiction, given the technology jams channels not authorized as compared to descrambling a scrambled channel in the case of addressable converter systems.

Churn management

In order to determine what or where

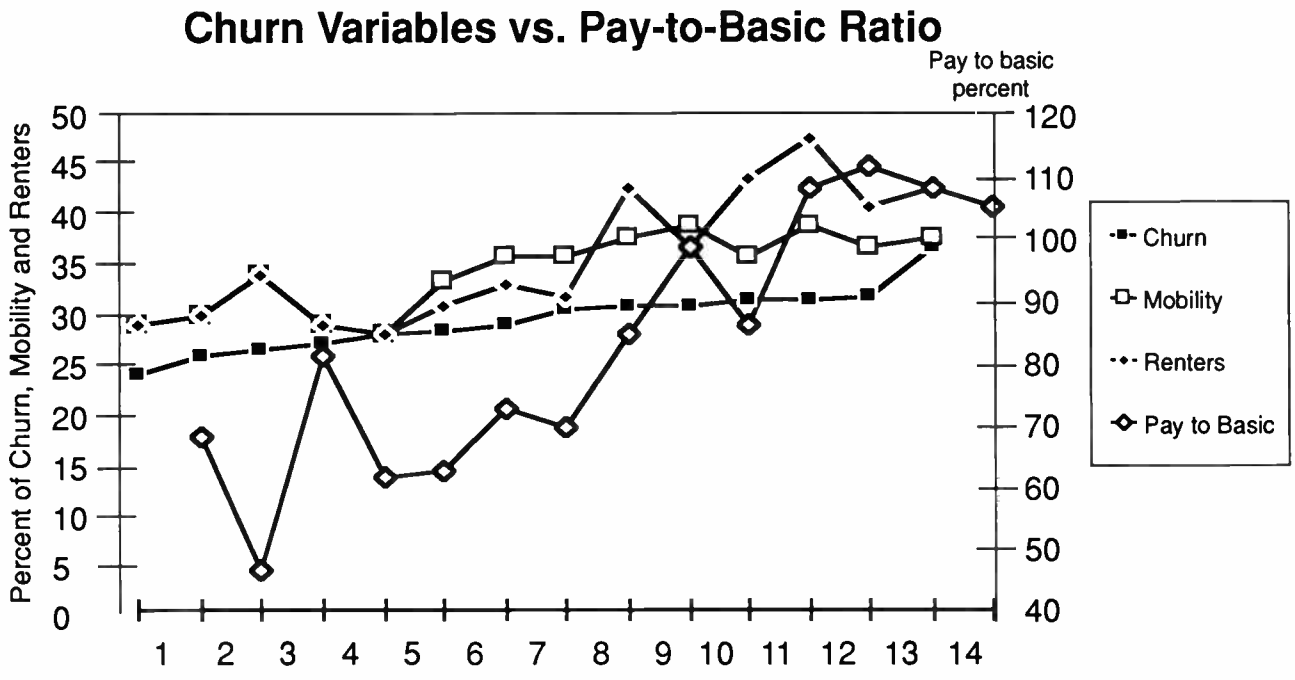

Figure 1

the pocket should be, we must first review interdiction's key operational benefit—churn management. The effects of churn ripple through every aspect of a cable system's operation.

Truck rolls occur for both connects and disconnects. A 30 percent annual churn translates to visiting 60 percent of your subscriber base every year. Addressable converters promised to reduce truck rolls associated to *spin* (switching) on subscription pay channels; however, with spin amounting to less than three percent annually after discounting activities associated to new connects and full disconnects, the original expectations were never really fulfilled.

Converter maintenance costs are still a major part of the operating cost, despite significant improvements in product reliability. The primary culprit is once again related to churn. Although every effort is made to retrieve the addressable converter, losses due to port handling, vandalism and theft add up to two percent to three percent annually of the installed base. One cycle is still not complete even after converter retrieval. Every disconnect triggers screening and refurbishment of the converter for the next new subscriber. Refurbishment cost is estimated to be in the neighborhood of $2 to $4 per unit.

Set-tops will not be completely eliminated with interdiction. Although the cumulative number of cable ready televisions are estimated to be over 80 million, there are over 170 million televisions still in use. Older sets have migrated to the den, children's rooms, etc. One fundamental operational difference is the choice the operator has with interdiction whether to continue to be in or out of the set-top maintenance business—a choice not available with earlier technology.

Reliability from a consumer perspective is measured in terms of a) "Do I have a picture?" and b) "Is the picture good?" Numerous operator research studies indicate that over 30 percent of the subscriber maintenance calls are related to the drop cable. With frequent connects and disconnects, our ability to maintain consistent high quality remains a never ending training and auditing challenge.

As discussed earlier, the ripple effect of churn is evident here. Failures are hard to plan for and consequently cost a premium to fix. With the addressable tap port connect and disconnect capabilities offered by most interdiction systems, hardening of the drop cable

Economic Model: Operational Cost Module

Basic Assumptions					
Homes passed	1000				
Penetration	60%				
Subscriber	600				
Annual growth	0%				
Addressable converter penetration	50%				
Basic gross margin per sub-month	$16.00				
		Addressable Set-Top		**Interdiction System**	
		System Average	MDU-High Churn	System Average	MDU-High Churn
Churn Variables		1	2	3	4
Annual churn ratio		30%	45%	30%	45%
Total new connects		180	270	180	270
-Outside the home		90	135	0	0
-Inside the home		90	135	45	40.5 (1)
Total disconnects		180	270	180	270
-Outside the home		90	135	0	0
-Inside the home		90	135	0	0
Cost of truck roll					
-Outside the home	$10.00	$1,800	$2,700	$0	$0
-Inside the home	$20.00	$3,600	$5,400	$900	$810
-Transaction costs	$1.00	$360	$540	$360	$540
Total		$5,760	$8,640	$1,260	$1,350
Converter Maintenance					
Refurbishment cost/set top	$2.50				
-Incidence of refurbishment		180	270	0	0 (2)
-Total refurbishment cost		$450	$675	$0	$0
Annual set top loss		2%	5%	0%	0%
-Set top losses		6	15	0	0
-Set top replacement cost	$110	$660	$1,650	$0	$0
Total		$1,110	$2,325	$0	$0
Reliability					
Annual Failure Rate		2%	2%	2%	2%
-Incidence of failure		6	6	12	12
Cost of truck roll for repair					
-Requires appointment	$30	$180	$180	$0	$0
-No appointment	$15			$180	$180
Drop cable failures		12%	12%	6%	6%
-Incidence of failure		72	72	36	36
-Drop repair cost	$15	$1,080	$1,080	$540	$540
Total		$1,260	$1,260	$540	$540
Powering					
Kilowatt-Hour cost	$0.14				
Powering cost		$2,016	$2,016	$1,109	$1,109
Percent paid by the operator		0%	0%	95%	65%
Total		$0	$0	$1,053	$721
Basic Theft					
Basic theft ratio		2%	2%	0%	0% (3)
Lost cash flow		$2,304	$2,304	$0	$0
Operating Cost Total		$10,254	$14,349	$2,853	$2,611
Per subscriber per year		$17.09	$23.92	$4.76	4.35

Note:
(1) Consumer education and lack of in home cable wiring will require some percentage of truck roll for new installs. The model assumes 50% for system wide and 30% for MDU's.
(2) Interdiction will require basic set tops for older sets, particularly 2nd sets. However, the operator now has the freedom to divorce from being in the set top business.
(3) Not all thieves are expected to become paying customers.

Table 2

Eagle's Outdoor Addressable Trap System

Try One "On the House"!

Eagle's new outdoor addressable Trap system is available, **now!** After conducting our own intensive lab and field tests for over eighteen months, we discovered this system offers so many benefits to cable systems and cable subscribers that the only way you can possibly appreciate them is to allow you to field test one in **your own system.**

That's why we've decided to make this offer. For a limited trial period, **We will install an Eagle Outdoor Addressable Trap Test System in your cablesystem at no cost or obligation to you!**

If you currently use a trap system or you're looking to replace your converter/descramblers don't miss this opportunity to try the most "user friendly" addressable system ever developed for the cable industry!

A "short list" of Outdoor Addressable Trap System features includes:

- 4 or 8 tiers of negative, positive or multichannel addressable filters; 256 combinations selectable
- Consumer friendly with VCRs, cable ready TVs and remote controlled TVs
- Controls signal delivery to multiple TVs from one trap switch
- Allows you to use your present negative or positive traps
- All service disconnect capability; over 80dB isolation
- No need to enter home for audits
- IBM PC or compatible computer control
- Compatible with billing systems
- Optional **Impulse Pay per View** unit allows subscriber to order premium programming without calling cable system
- Auto-dialer transmits customer usage back to system using store and forward techniques
- Pre-authorize customers for limited amounts of pre-paid programming
- Parental control of premium channels or all service

☐ **YES!** [illegible] system or I am replacing my existing converter/descramblers.

☐ **YES!** I would like to take advantage of your FREE OFFER. Please contact me to schedule a **FREE trial installation** of Eagle's Outdoor Addressable Trap system.*

FREE TRIAL OFFER!

[illegible] trial period is subject to approval of Eagle Comtronics

Name _____

Cablesystem name _____

Address _____

City _____ State _____ Zip _____

Phone ( ) _____

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Reader Service [illegible]

now becomes permanent.

Theft of service is typically associated to pirate boxes; however, basic theft accounts for over two percent of the subscriber base. How many "coffee shop" disconnects take place every day? One solution offered today would be to scramble every channel but with the sensitivity to consumer friendliness at an all time high, it is not a viable alternative. So we tolerate basic theft. Interdiction offers uncompromising security to all levels of service, basic and premiums.

Interdiction technology is clearly positioned as an effective tool to manage the cost associated with churn. The pocket deployment target should thus be the high-churn segments within a system. Our next step is to understand the dynamics of churn.

Churn dynamics

What causes churn? The biggest factor is not poor marketing, bad customer service or hatred of converters, but mobility. People simply move. Fifty to 60 percent of churn can be attributed to the mobility ratio. Churn cannot be eliminated. As basic penetration increases, all things considered equal, churn volume will continue to rise.

The second largest contributor to churn is the "special" new subscriber acquisition campaigns. Consumers today are more value conscious. As we inch closer to the most elastic price points for basic cable rates, retention of newly acquired subscribers becomes more difficult once the campaign is over.

Pocket deployment criteria

Figure 1 is a graphical representation of churn, spin, mobility ratio, residential types, penetration and pay-to-basic statistics compiled from quarterly CTAM databases[1]. Although the data is only a "snapshot" quarter, it helps demonstrate the relative cause and effect between mobility and churn as well as pay availability and churn. Some of the noteworthy trends are:

- Mobility drives churn.
- The higher the MDU/renter ratio, the higher the churn.
- The higher the pay-to-basic, the higher the churn.

Choosing high churn as our initial interdiction target, we can safely conclude interdiction will be most effective in multiple dwelling units (MDUs). Likewise, systems which actively promote subscription pays repeat their benefits through higher pay-to-basic; however, they pay more to support churn activity. While MDUs permit geographic segmentation, pay specific segmentation requires a more subscriber-specific deployment strategy.

Defining an MDU product

The next logical question relative to deploying into the MDU segment is the question of product mix. Unfortunately, the world is not neatly cut up into areas with only MDUs or only residentials. There will always be a certain mix. Naturally, a product line which can support both MDUs and residentials must be a prerequisite.

Within an MDU, there are several variations relative to size, unit count and powering methods. We can quickly establish powering must be outside the home given the anticipated high churn. Therefore the product must either be plant powered and/or have the capability to extract power from other indoor sources.

The vast variety of MDU types present the greatest degree of challenge in defining a single product to fit all

types. A quick survey of operators indicated the following MDU facts:

- Garden house apartments encompass 80 percent of the MDU market. Typical port count is six to 12 ports; typical location is outdoors (90 percent.)
- High rise MDUs represent 20 percent of the MDU market, with 100 percent indoor powering, 50 percent home run wiring by floor (typically eight to 16 ports) and 50 percent central signal distribution (typical port count 80 or higher.)

For 90 percent of the MDU market, a combination of four-port and eight-port interdiction devices with either cable or 110 VAC powering offers the best fit. It is the remaining 10 percent, the central signal distribution, that requires the greatest degree of challenge and creativity given the typical physical space constraint.

Developing an economic model

The components of most economic models include revenue expectations, cost of goods (programming, in our case), operating costs and required investment. For the scope of "pocket" deployment, it would be most appropriate to concentrate on the operating cost now that we have established churn to be the most significant variable in our formula of operating cost.

Table 2 is the operating cost model which compares all the elements of churn discussed earlier within a hypothetical system. Columns one and two compare the net effect of higher churn within a 50 percent addressable penetrated system and columns three and four make the same comparison, using interdiction.

The average system churn is assumed at the current national average of 30 percent. And if we further assume residential churn is about 23 to 24 percent, in a 70 percent residential/30 percent MDU system, churn within the MDU segment is a staggering 45 percent. With these initial assumptions, we see that there is an approximately 40 percent increase in operating expense as a result of the 15 percent higher churn and three percent higher set-top losses in an MDU setting. Contrasting the addressable converter system to an interdiction system, we find a 72 percent decrease in operating expenses system-wide. The gap further widens to an 82 percent decrease when comparing the hypothetical MDU high churn environments. The most significant factor is the difference of the direct costs of churn management. Although economic models are only as good as the assumptions made, it is curious to note here that interdiction may actually cost less to operate in an MDU environment than single family homes due to two factors reflected in the model:

- More apartments are prewired and the residents tend to be more "cable-ready."
- Although the model assumes cable powering of interdiction, units can still receive power from the MDU/ apartments.

As interdiction technology evolves, more creative deployment strategies are certain to emerge. Pocket development is one such example. And with FSA technology, it is now a viable deployment option, allowing us to economically tap the previously hostile multi-dwelling markets. All this, without even discussing revenue opportunities! ■

Reference

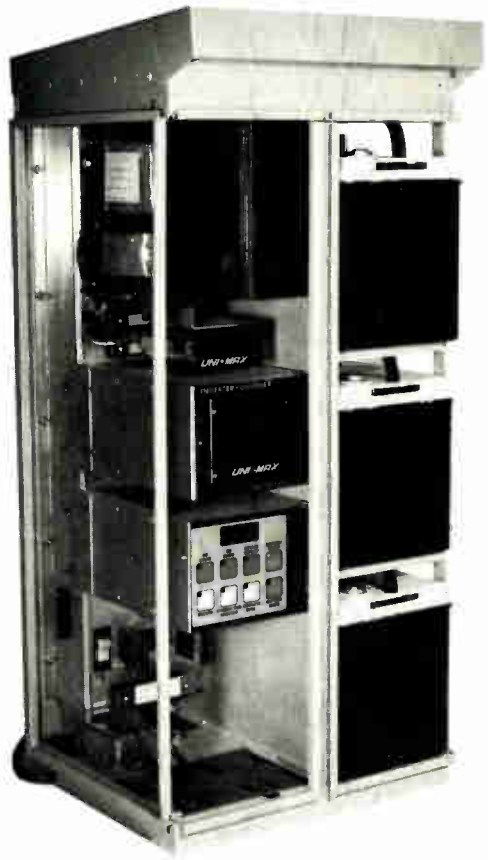
[1]CTAM database, 1990, first quarter.

Lectro's

Newest Addition...

UNI-MAX

Designed for the Future



Modularity in a Common Ferro Standby Power Unit

UNI-MAX, the newest addition to the Lectro family has everything you always wanted in a common ferro standby power unit - and more. It's **91% efficiency** and unique design save you money and reduce heat. That helps extend battery life, saving you even more. And **Lectro's** exclusive **"Cool Core"** heat sinking technique ensures the coolest running transformer available.

Like all **Lectro** standby power units, **UNI-MAX** is **modular** with totally enclosed electronics. Modules are easily removed without tools providing safe and easy servicing without losing power. A full range of **plug in options** is available.

Call **1-800-551-3790** to learn more about **UNI-MAX**. Another dependable product from Lectro, a leader in power supplies for the cable industry since 1972.

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Reader Service Number 34

Battery life test

Many times you hear cable systems complain about the premature failure of their standby power supply (SBPS) batteries and when investigated, the cause can't really be discovered. These failures could be due to defective batteries, or the incompatibility of battery and power supply with respect to charging and venting during hot temperatures. In any case, MSOs are spending a lot of money on battery replacement each year and the CATV industry needs some definitive answers on batteries in standby powering applications.

In a joint effort with United Artists and Cable Television Laboratories, a first step has been taken in an attempt to improve our understanding of SBPS batteries. We have contracted a company named Shelly-Ragon to carry out a controlled battery test plan formulated by United Artists, CableLabs and battery manufacturers.

By Jim Haag, Evaluation Engineer, United Artists Cable Corp.

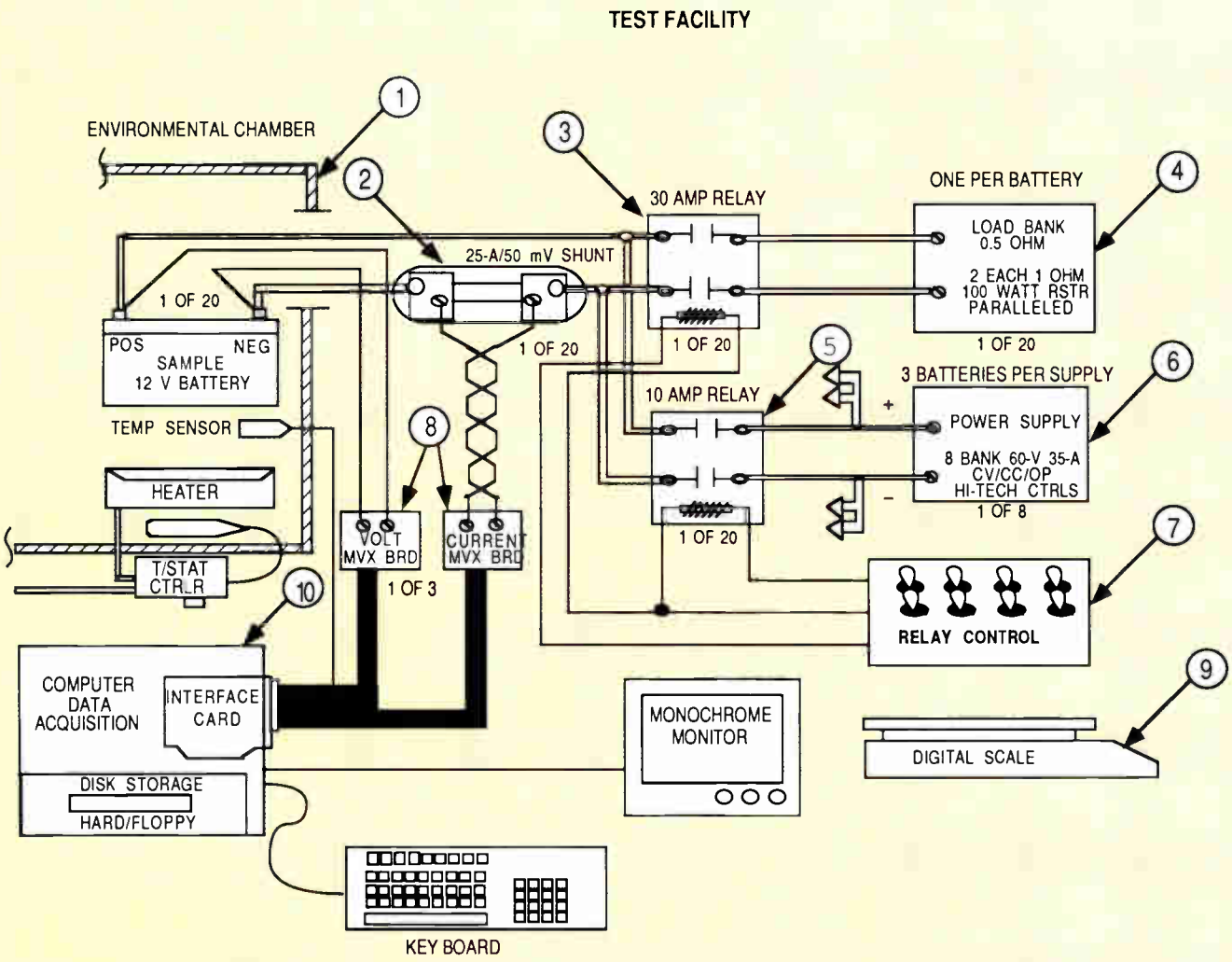


Figure 1

Test description

This testing we call the "Battery Life Test," was formulated to measure the performance of batteries exposed to hot temperatures over a 10-week period. The three different battery technologies chosen for this test represent a large percentage of all battery technologies presently utilized by the CATV industry.

Every week for a total of 10 weeks, each battery was discharged (20 amp rate) for three consecutive hours and then charged for the remainder of the week at the 45 degree C (115 degrees F) temperature level. The charge current was monitored on each battery for charge acceptance and to determine the possibility of thermal run-away. After every discharge, once a week, each battery was weighed for loss of electrolyte and during the entire 10-week period there was no additional electrolyte added to any of the batteries under test.

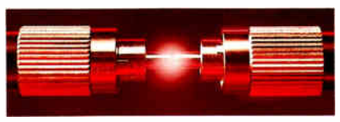
1. **Charge rate:** On-demand float charging with a tapered current (8 - 0.0 amps) and constant voltage rate of 41.0

DEPTH OF RESOURCES.

Only Sumitomo designs, builds, installs and supports everything you need for video fiber optics.

Sumitomo makes a full range of fiber optic cables. Choose from matched clad or depressed clad fiber in either loose tube or LitePipe™ cable construction.

As a result, you don't get a runaround: questions get answered, problems solved, deadlines met, network goals achieved. ■ We design, manufacture, install and support everything optical you need for video transmission. Including a full line of optical VSB-AM and digital video transmission equipment, matched clad VAD-type fiber pioneered by Sumitomo. Loose tube and economical LitePipe™ optical cables. Fully automated fusion splicers. Plus optical connectors and patch cords, all made by Sumitomo. ■ Hardware, though, is only half the story. Using our own in-house resources and expertise, we offer engineering services and turnkey construction: single-source responsibility for your project, from initial design to turn-up. ■ Then there's training programs, ongoing support, maintenance/repair with loaners–whatever you need. Whatever you want, all or any part. Including peace of mind–one reason we've been a leader in fiber optics *and* cable television for nearly 20 years. ■ Call us at (800) 358-7378. Discover the optical advantage anyone can see, but only Sumitomo can deliver.



We manufacture a full line of multi-mode and single mode cable assemblies in standard or custom lengths.

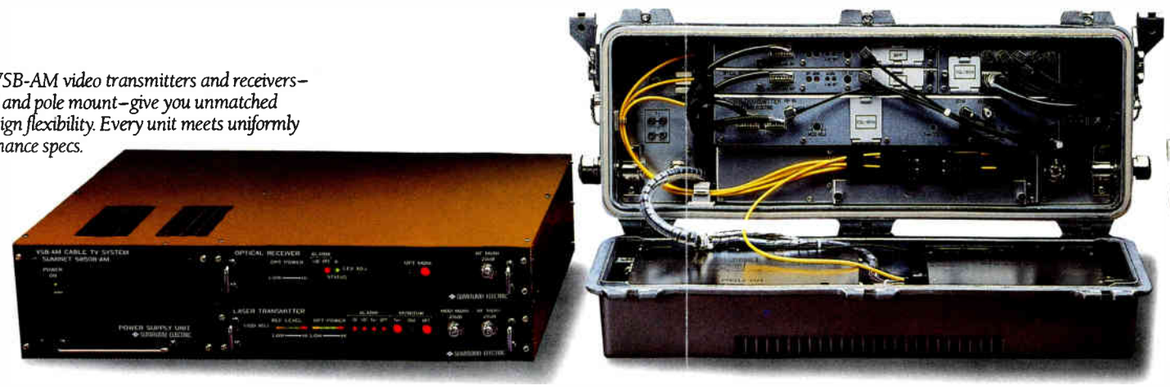
Sumitomo digital transmission equipment is cost competitive with FM. Get up to 24 video channels on a single fiber without compression or wave-division multiplexing.

Our compact, lightweight T-35 fusion splicer is fully automated. You get advanced features because we pioneered fusion splicing.

We do it all, including engineering and construction–entire turnkey newbuilds and rebuilds, plus ongoing maintenance, repair and support.

We think you have a big future with fiber optics, so we invested $100 million in our North Carolina research and manufacturing headquarters facility.

Sumitomo VSB-AM video transmitters and receivers–rack, strand and pole mount–give you unmatched network design flexibility. Every unit meets uniformly high performance specs.



Our new, economical VSB-AM strand mount optical receiver frees you to create fiber-to-feeder and fiber-to-line-extender architectures.

Reader Service No. 110

Sumitomo Electric, your light-support system.

VIDEO TRANSMISSION EQUIPMENT

ANALOG
Choose from our full line of rack, strand and pole mount equipment. Optical transmitters and repeaters are available with 4 or 6 mw lasers at 1310 nm, rack or strand mount. The rack housing accommodates up to 2 transmitter or receiver units within 2 mounting spaces. One strand-mount trunk station provides 30 dBm V output and accommodates up to 4 receivers or 2 transmitters or 2 receivers and 1 transmitter with an A/B switch plus status monitoring. Our secondary-node receiver provides 48 dBm V for fiber to the feeder architectures.

DIGITAL
Simple to maintain, our equipment consumes far less space and power than FM — and requires fewer optical fibers. Sumitomo systems transmit, without compression, NTSC, PAL and BTSC baseband video/audio signals at 2.4 GBs, 24 channels on a single fiber; 1.2 GBs, 12 channels; or 400 Mbs, 4 channels. Up to 72 channels fit in a single 6-foot rack. Channel capacity can be doubled via Wave Division Multiplexing. Transmission distance: up to 80 km without a regenerator. Express and drop regenerators available. Systems meet RS250C medium haul specifications.

CONNECTION SYSTEMS

FUSION SPLICERS
Sumitomo pioneered fusion splicing, which produces economical, high-quality splices. Advanced features include high-speed imaging in two directions, self-diagnostic arc test and high-accuracy splice loss estimation, plus easy-to-use tools for fast stripping and cleaving. Sumitomo Type 35 is an industry standard, and our Type 51 splices up to 12 fibers at once. Our splice sleeves provide optimum protection.

CONNECTORS
We make a full line of optical multimode and single mode cable assemblies with connectors such as Biconic, ST, FC, D4, mini-BNC and SC. We provide custom lengths and can make Super PC Polish connectors, even FDDI.

DEPTH OF RESOURCES

We're part of $6-billion Sumitomo Electric Industries, Ltd. Group. Our $100-million, 350,000 sq. ft. manufacturing complex in Research Triangle Park, North Carolina employs more than 350 people dedicated to meeting all your optical network needs.

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FIBER OPTICAL CABLES
We manufacture cable with your choice of matched clad or depressed clad fiber. We offer loose-tube cable in fiber counts of 4 to 216, plus our new, economical Lite-Pipe™ cable in counts of 2 to 24. Reel length: up to 12 km. Sumitomo pioneered vapor axial deposition (VAD), the matched clad fiber-making process that set the record for low loss. We offer optical cable sheath construction from all dielectric to double armoured suitable for all installations (lashed aerial, duct and direct buried) and environments.

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We provide any level of service including entire turnkey newbuild or rebuilds. Our in-house experts work closely with your people to evaluate design alternatives, select methods of construction, perform installation, and do turn-up, testing, fusion splicing, repair and maintenance. We offer single-source responsibility, assuring your project gets done right.

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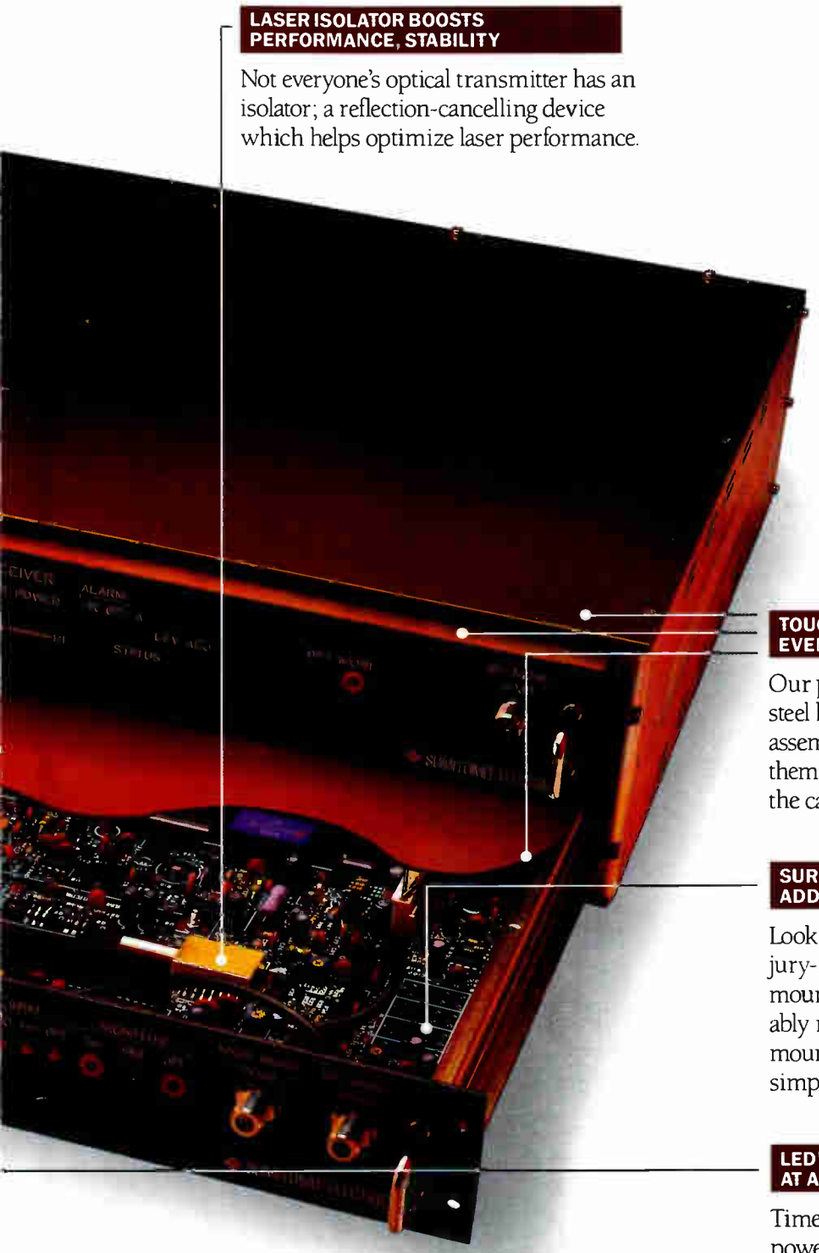


LASER ISOLATOR BOOSTS PERFORMANCE, STABILITY

Not everyone's optical transmitter has an isolator; a reflection-cancelling device which helps optimize laser performance.

TOUGH STEEL COVERS PROTECT EVEN THE SUBSYSTEMS

Our philosophy: everything matters. Such as steel housings for added rack-unit durability. The assemblies have a carefully finished look about them, inside and out. It reflects good workmanship: the care and thought we put into every detail.

SURFACE-MOUNT ELECTRONICS ADD NETWORK RELIABILITY

Look for neat, orderly packaging: no jumpers, no jury-rigs, no confusion. Our advanced surface-mount electronics, all on one board, are measurably more reliable than conventional wiring and mounting. All of which minimizes downtime, simplifies network management.

LED'S SHOW LASER POWER AT A GLANCE

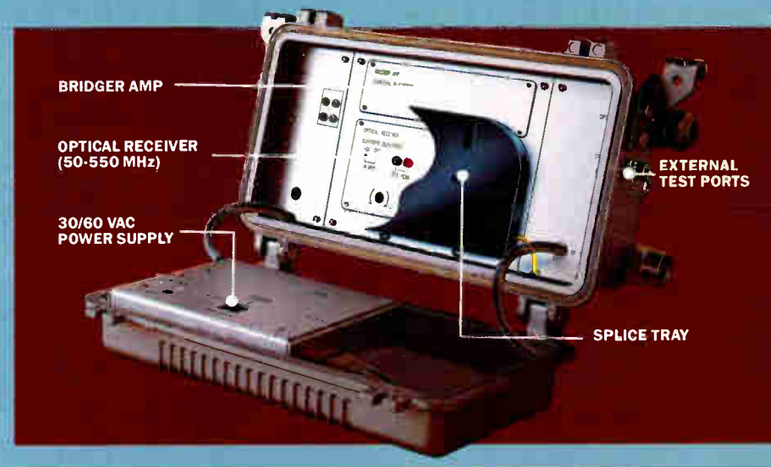
Time is money. Don't waste it monitoring laser power. Indicator lights automatically show optimum laser power output — your quick reference to laser performance.

Reader Service No. 110

Build Better Networks. Expand On The Strand.

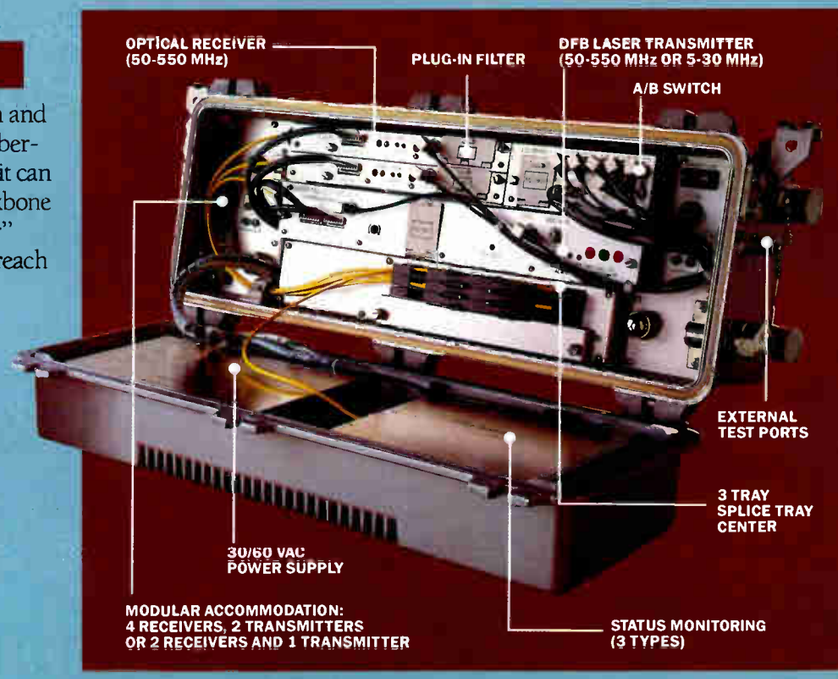
ECONOMICAL RECEIVER OPENS DOOR TO "FIBER TO FEEDER" ARCHITECTURE

Fiber in, RF out. Use this cost-effective unit as a secondary node outputting 48 dBmV directly to feeder lines. "Fiber to feeder" eliminates trunk amplifiers, dramatically reducing active cascades. The result: better picture quality, reduced maintenance and improved service to subscribers. Status monitoring available.

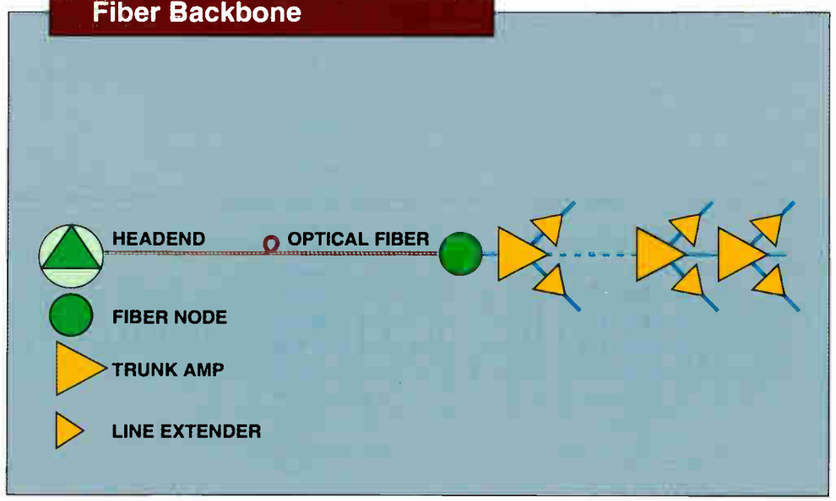


MODULAR RECEIVER/TRANSMITTER OFFERS DESIGN FLEXIBILITY

Gain new freedom for today's design and tomorrow's expansion. Unit offers fiber-in, fiber-out, and local RF drops. Unit can be used with conventional fiber backbone as a mini-headend in "fiber to feeder" architectures, or repeated extended reach to remote hubs.

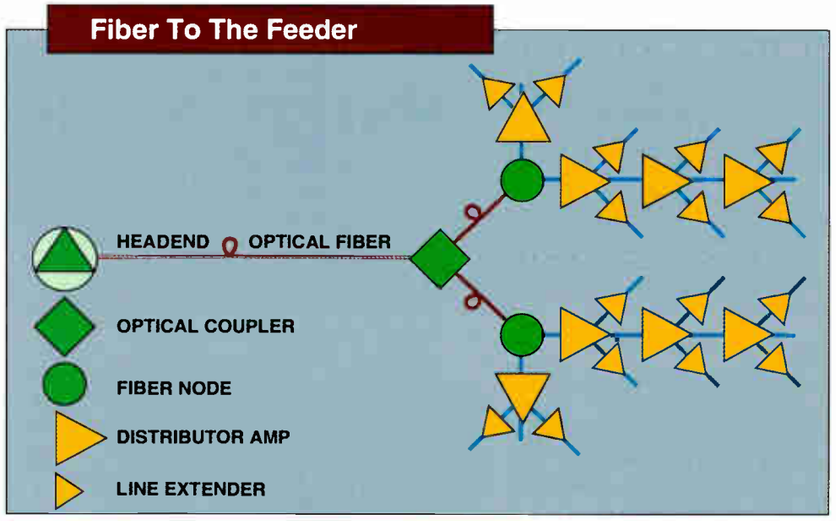


Fiber Backbone



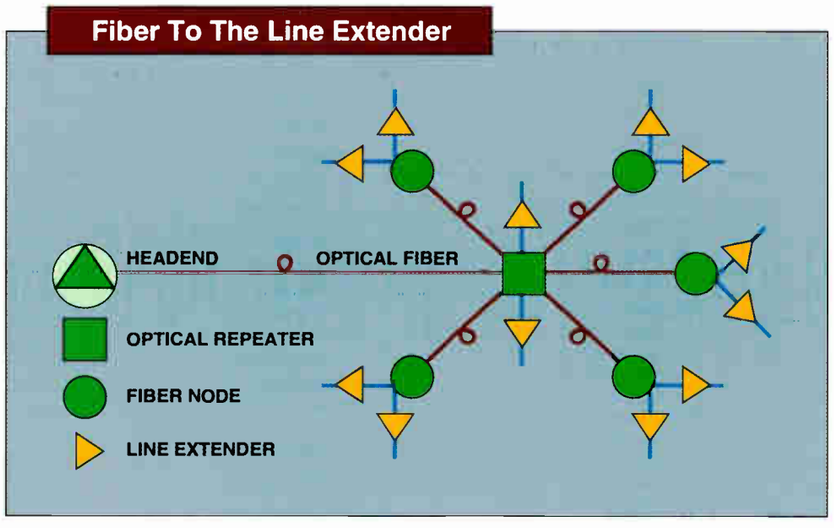
Conventional fiber backbone reduces active cascades as compared with coaxial trunk system. This improves picture quality and service reliability while extending system range. Sumitomo full bandwidth transmission and plug-in filters provide flexible split-channel loading. A/B switch provides system redundancy.

Fiber To The Feeder



Optical coupler, and economical Sumitomo receiver serving as a secondary node, provide unprecedented network design freedom. Fiber-to-feeder architecture further reduces active cascades and reduces maintenance by eliminating RF trunk amplifiers.

Fiber To The Line Extender



Sumitomo strand-mount optical repeater and secondary-node receiver eliminate need for trunk and distribution amplifiers. Resulting fiber-to-line-extender architecture minimizes active devices between headend and subscriber. Advanced design also minimizes maintenance, and allows expansion without backbone redesign or rework.

SPECIFICATIONS — SUMINET 5850 SERIES II

RACK UNIT

	COAX RF		OPTICAL	
	IN		**OUT**	
Transmitter	Bandwidth	50-550 MHz	Source	DFB-LD
	Level	25 ± 5 dBmV	Wavelength	1310 nm
	Impedence	75 ohms	Isolator	Yes
	Return Loss	14 dB Min	Avg Power	4 mW
	Connector	F-Female	Output	Pigtail (5 m)
	OUT		**IN**	
Receiver	Bandwidth	50-550 MHz	Detector	PIN-PD
	Level	30 ± 5 dBmV	Wavelength	1310 nm
	Impedence	75 ohms	Performance	SEE GRAPH
	Return Loss	14 dB Min	Input	Pigtail (5m)
	Connector	F-Female		

NOTE: Rack Mount Chassis Accommodates Two Units — Either Transmitters or Receivers or one of each.

STRAND UNIT

	COAX RF		OPTICAL	
	IN		**OUT**	
Transmitter Forward	Bandwidth	50-550 MHz	Source	DFB-LD
	Level	30 ± 5 dBmV	Wavelength	1310 nm
	Impedence	75 ohms	Isolator	Yes
	Return Loss	14 dB Min	Avg Power	4 mW
	Connector	Standard ⅝ x 24	Output	Pigtail (2 m)
	OUT		**IN**	
Receiver Forward	Bandwidth	50-550 MHz	Detector	PIN-PD
	Level	30 ± 5 dBmV	Wavelength	1310 nm
	Impedence	75 ohms	Performance	SEE GRAPH
	Return Loss	14 dB Min	Input	Pigtail (2 m)
	Connector	Standard ⅝ x 24		
	IN		**OUT**	
Transmitter Return	Bandwidth	5-30 MHz	Source	DFB-LD or FP
	Level	25 ± 5 dBmV	Wavelength	1310 nm
	Impedence	75 ohms	Isolator	Yes
	Return Loss	14 dB Min	Avg Power	4 mW
	Connector	Standard ⅝ x 24	Output	Pigtail (2 m)
	OUT		**IN**	
Receiver Return	Bandwidth	5-30 MHz	Detector	PIN-PD
	Level	25 ± 5 dBmV	Wavelength	1310 nm
	Impedence	75 ohms	Performance	SEE GRAPH
	Return Loss	14 dB Min	Input	Pigtail (2 m)
	Connector	Standard ⅝ x 24		

NOTE: Strand Housing accommodations: Up to 4 receivers, one transmitter (Forward or Return) and two receivers or two transmitters, an A/B switch plus status monitoring. Also, it can be configured as a repeater with one receiver and transmitter.

SECONDARY NODE

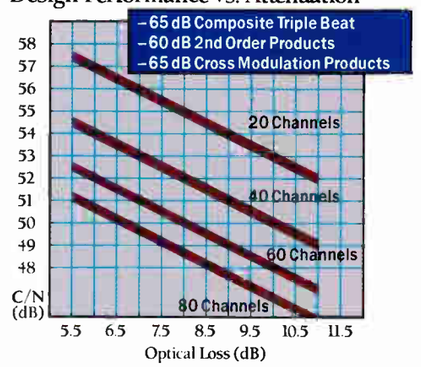
	OUT		IN	
Receiver Forward (FTLE)	Bandwidth	50-550 MHz	Detector	PIN-PD
	Level	46/43 dBmV	Wavelength	1310 nm
	Impedence	75 ohms	Performance	SEE GRAPH*
	Return Loss	14 dB Min	Input	Pigtail (2 m)
	Connector	Standard ⅝ x 24		

GENERAL	RACK UNIT	STRAND UNIT
Power	110/220 VAC 50/60 Hz 30 W/RCVR 60W/XMTR	30/60 VAC 50/60 Hz 30 W/RCVR 60W/XMTR
Operating Temperature	0° C to 40° C	−20° C to 50° C
Operating Humidity	Max 85% RH	Max 100% RH
Dimensions	EIA 19″ Rack Mount 3⁹⁄₁₀″ High (2 RU)	18¾″ L x 8″ H x 7″ D
Weight	25 lbs Max	25 lbs Max
Splice Ctr	—	3 Tray (12 Fibers)

Specifications are subject to change without notice.

VSB-AM Optical Transmitters And Receivers

Single Transmitter/Receiver
Design Performance vs. Attenuation



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VDC for three battery sets or 13.67 VDC per battery was used throughout the entire test period.

2. Discharge rate: A 20-ampere resistive load was applied to each battery for a period of three hours or until the 10.5 VDC level was achieved.

3. Internal cell inspection: At the end of the 10-week test period, each battery was opened and inspected for corrosion on both positive and negative plates. Also, electrolyte level and the plate thickness of each cell was measured.

Test samples

A quantity of six of each battery was randomly selected by United Artists from each battery manufacturer. Each type of battery chosen for this test has approximately the same capacity, or Ampere-hour rating. The battery's manufacturers will not be identified, but here is a brief description of each of the three types of batteries as designated:

Battery A: (Samples 1 through 6) Excess Water (mobile)/Electrolyte, Lead Calcium Plates, Sealed, 68 AH rating (20 amp load).

Battery B: (Samples 7 through 12) Gelled (immobile)/Electrolyte, Lead Calcium Plates, Sealed, 65 AH rating (20 amp load).

Battery C: (Samples 13 through 18) Absorbed AGM (immobile), Electrolyte, Lead Calcium Plates, Sealed, 65 AH (20 amp load).

Test facility

A description of the test facility is shown in Figure 1.

1. Environmental chamber. Six-foot by six-foot by seven-foot room capable of handling temperatures from 70 degrees F to 130 degrees F (future capability of 30 degrees F to 130 degrees F).

2. Current shunt. 25 amp/50 mv shunt for monitoring both charge and discharge current levels.

3. Relay - load. 30 amp, SPST relay for switching in load bank.

4. Load bank. 0.5-ohm, 200-watt resistors.

5. Relay - charge. 10-amp DPDT relay for switching in charger.

6. Charger. 60 VDC/35 A charger will feed three batteries in parallel (3 x 13.67 VDC).

7. Relay control. Relay switch box.

8. Current/voltage multiplex board. PC interface for multiplexing battery voltage and current during charge and discharge cycling.

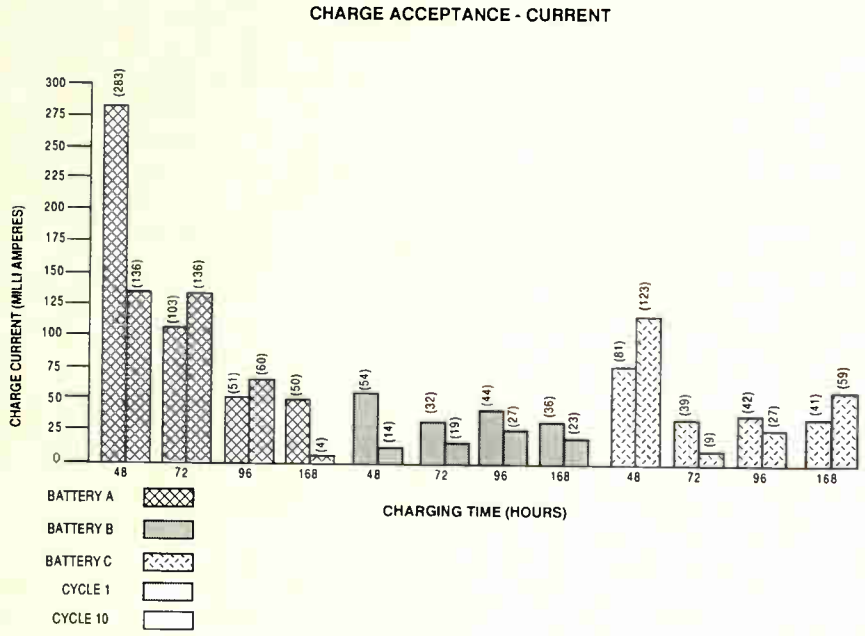

Figure 2

compared to other technologies tested. Remember, all of the batteries tested are sealed and additional electrolyte cannot be added. Loss of electrolyte or drying of plate material will most certainly result in loss of capacity

D. Internal cell inspection. At the end of the testing, each battery was opened and inspected for corrosion on the plates and the thickness measurement of both the positive and negative plates. Battery A showed signs of corrosion on the positive plates and formulation in the bottom of the battery case. Batteries B and C did not show any signs of corrosion. The plate thicknesses of each battery type can be found in Figure 6.

Conclusion

The 10-week test period did not allow for the opportunity to compare the loss of capacity of each battery. This loss of capacity or discharge time would certainly drop over an extended

9. Digital scale. Measure battery weight loss.

10. Personal computer - interface card. Epson PC (Equity It) and strawberry tree data acquisition software. (Note: Not shown here is the lab area used to open each battery for inspection.)

Test results

A. Charge acceptance. We monitored the current and voltage acceptance during recharge of each battery to determine thermal runaway and recharge time. Throughout the testing we did not encounter a single failure due to thermal runaway. In Figures 2 and 3, you can see a comparison of cycle 1 to cycle 10 current and voltage charge acceptance. It is interesting to see the time required to reach the 100 percent charge state at 13.67 VDC (41.0 VDC in a string) and the charge current required to maintain the battery at the 100 percent level.

B. Discharge rate. Because we only exposed the batteries to a short 10-week period, the comparison of batteries in cycle 1 to loss of capacity at the end of the test period (cycle 10) was not a factor.

C. Weight loss. Figure 5 shows a comparison of each battery with the loss of electrolyte and reflection on battery weight loss. The Battery A Group (1 through 6) is a water electrolyte type battery and as shown has the most dramatic change in weight loss

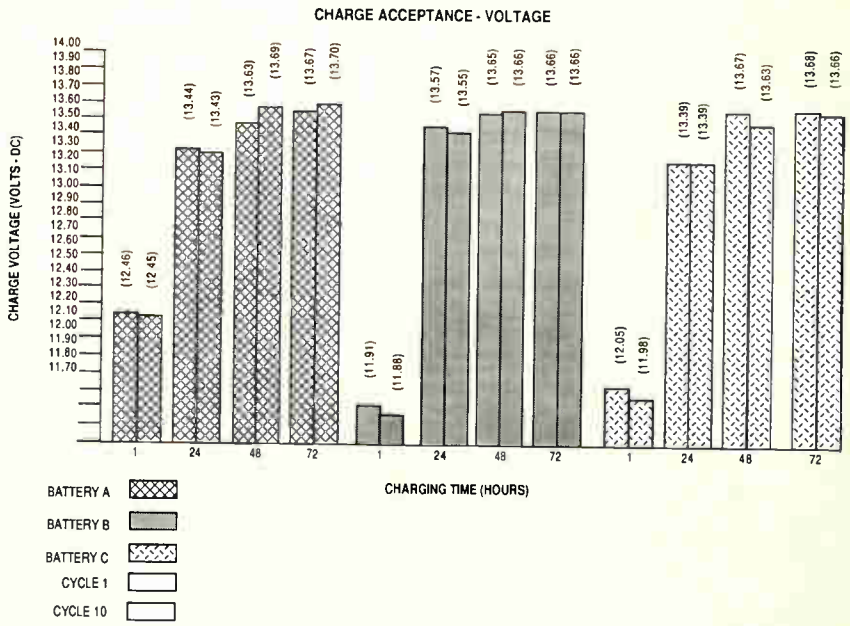

Figure 3

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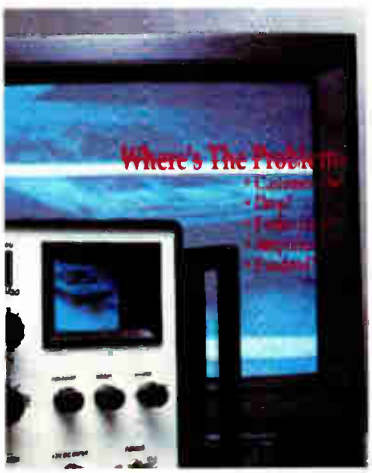

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life test period (greater than 10 weeks). However, we can see the weight loss caused by venting of electrolyte is a sure cause for loss of capacity and shortened battery life. When enough of the plate surface area is exposed, in the absence of electrolyte, the corrosion process will increase.

Secondly, charge acceptance of each battery is very important with respect to how the cells should be charged. With the end-of-charge or 100 percent level, it is important to understand the amount of current required to maintain the 100 percent level. Another area of importance will be the time it takes to charge up to the maximum voltage (13.67 VDC) provided by the charger.

Lastly, in the final inspection of the batteries at the end of the life test, we found corrosion and varied thicknesses of positive and negative plates. The only corrosion was found on the positive plates and the bottom of the case in the Battery A group (1 through 6). This corrosion could have come as a result of electrolyte loss and/or charging technique or even high temperature. The plate thickness measurements served as a guideline in monitoring production tolerances and comparing the thickness to longer battery life.

Recommendation: The performance and durability displayed by the batteries in groups B and C (immobile electrolyte) throughout the test period are worthy of acceptance. I would only recommend batteries from Group A (mobile electrolyte) to users who are not in hot geographical areas and who closely monitor the charge rate of the associated power supplies.

The "Battery Life Test," as presented here in this abbreviated 10-week period, has been a good place for us to start with a better understanding of SBPS batteries. There is certainly room for the industry and MSOs to perform more testing and learn more about battery technology. The test facility Shelly-Ragon has put together to perform these tests should serve as a reference for the CATV industry. We can continue to test these and other batteries so that we can be cost effective with the marriage of batteries with standby power supplies. ■

Acknowledgements

I would like to acknowledge a number of people who provided assistance in making this article possible. Thank you to Mike Morrison of Shelly-Ragon; John Figal of United Artists; and Tom Elliot of CableLabs.

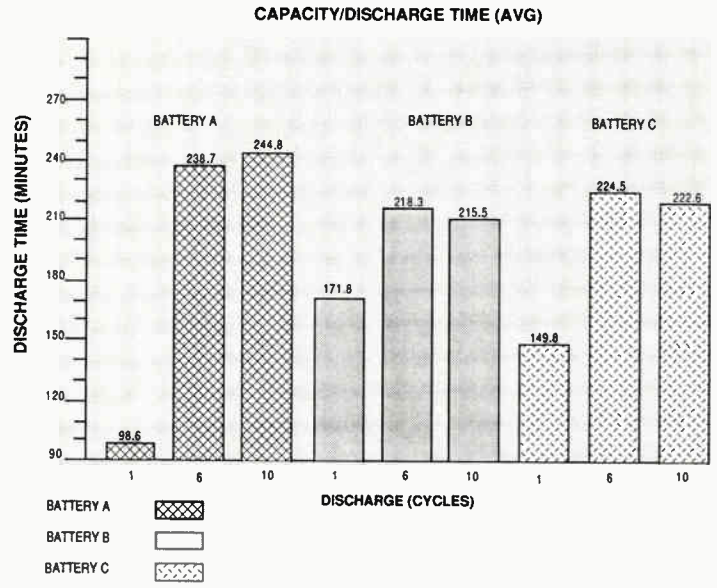

Figure 4

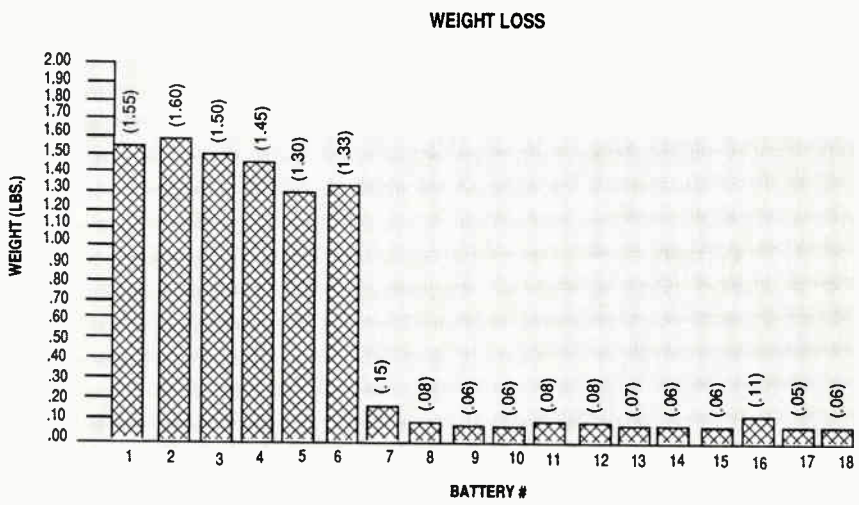

Figure 5

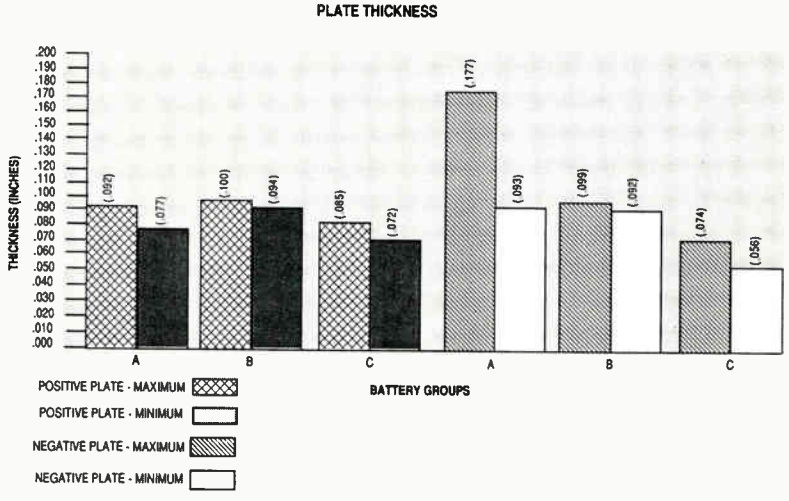

Figure 6

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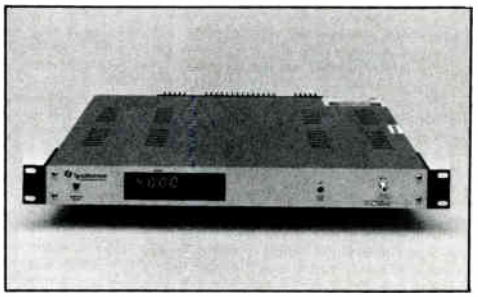

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HBO transmission test

For the past 15 years, Home Box Office has been conducting a monthly 5:30 a.m. signal test on every satellite transponder it uses to distribute pay television programming. The HBO transmission test has two purposes. The first is to provide on-line test signals to cable headends for verification of receiving stations' operating parameters. The second is to allow for evaluation and adjustment of equipment used to originate programming at HBO's uplink in Hauppauge, N.Y.

Transmission tests used to occur much more frequently that they do today. Television stations would start and end the day with the classic Indian-head test pattern and use it to keep equipment within allowed tolerances. Only recently have transmitters and transmission equipment become stable enough to provide 24-hour per day performance without constant attention.

As important as stability and proper performance of equipment are, more is now required. In addition to comparing satellite-delivered signals to over-the-air and locally generated programming, many cable subscribers are now able to make comparisons to alternate technologies that provide high quality signals independent of cable. Super-VHS VCRs and videodisc players, which have a higher video bandwidth, no transmission path and do not require signal modulation and demodulation, provide excellent pictures to a monitor.

Direct view large screen televisions (27-inch to 35-inch diagonal) led last year's television market growth. Noise, distortion and NTSC artifacts that were not observed on smaller receivers are often objectionable on larger sets.

Maintaining quality

This increased awareness of video and audio quality can result in a rise in service calls. With a commitment by the cable industry to provide a high level of service to subscribers, identifying and correcting potential problems before they become objectionable can help maintain customer satisfaction.

For these reasons, the delivery of high-quality video and audio is more important than ever before.

By John Vartanian, Home Box Office

The HBO transmission test provides a way to perform on-line testing that would be difficult or impossible to achieve any other way. The test is divided into four sections: satellite, audio, video and descrambler operation.

TESTING ADVISORY

00:00:00--00:02:00 (2 minutes)

Two minutes countdown, with testing advisory shown on the screen

SATELLITE TVRO CARRIER-TO-NOISE TEST

Carrier Off	Carrier On (no modulation)*
00:02:00--00:05:00 (3 minutes)	00:05:00--00:08:00 (3 minutes)
00:08:00--00:11:00 (3 minutes)	00:11:00--00:14:00 (3 minutes)

*During this time, even though the program content is removed, the "dispersal signal" is still present. This triangular waveform, 30 Hz modulation, is necessary to desperse the signal, thus keeping the power flux density emitted by the satellite within the levels specified by the FCC Rules and Regulations.

Figure 1

AUDIO TESTS (Video = Colorbars)

00:14:00--00:15:00 (1 minute)	1kHz at 0 dBm	Insertion Gain/Loss
00:15:00--00:16:00 (1 minute)	1kHz at (-10 dBm ref)	Frequency Response
00:16:00--00:17:00 (1 minute)	20 Hz (-10 dBm)	Frequency Response
00:17:00--00:18:00 (1 minute)	50 Hz (-10 dBm)	Frequency Response
00:18:00--00:19:00 (1 minute)	100 Hz (-10 dBm)	Frequency Response
00:19:00--00:20:00 (1 minute)	4 kHz (-10 dBm)	Frequency Response
00:20:00--00:21:00 (1 minute)	8 kHz (-10 dBm)	Frequency Response
00:21:00--00:22:00 (1 minute)	12 kHz (-10 dBm)	Frequency Response
00:22:00--00:23:00 (1 minute)	15 kHz (-10 dBm)	Frequency Response
00:23:00--00:29:00 (6 minutes)	1 kHz (+10 dBm)	Distortion
00:29:00--00:35:00 (6 minutes)	Terminated input	S/N Measurement
00:35:00--00:37:00 (2 minutes)	1 kHz at 0 dBm	Crosstalk
00:37:00--00:39:00 (2 minutes)	1 kHz at 0 dBm	Phase Tests

Figure 2

Satellite

The satellite segment of the test allows for accurate measurement of the downlink carrier-to-noise ratio. A decrease in C/N reduces the baseband video and audio signal-to-noise ratios, so it is important to maintain a high C/N ratio. There are several ways to calculate received C/N, including measuring with a power meter, using a spectrum analyzer, reading the level from a calibrated receiver C/N meter or estimating the signal-to-noise ratio and converting that to a carrier-to-noise ratio.

The most accurate way of measuring C/N is to measure both the carrier power and the noise power with a power meter and calculate the ratio in dB. Noise in this context is defined as the sum of all noise and interference sources, including thermal, solar, ground and atmospheric noise, as well as adjacent satellites, cross polarization and terrestrial interference.

If C/N is measured with active programming, it is not possible to accurately measure the noise, since energy from the carrier masks the noise. One way of getting a close approximation of the noise is to move the TVRO away from satellites or the sun until the signal level is at a minimum. This measurement technique would result in the disruption of programming normally received from the dish and is a method that is only

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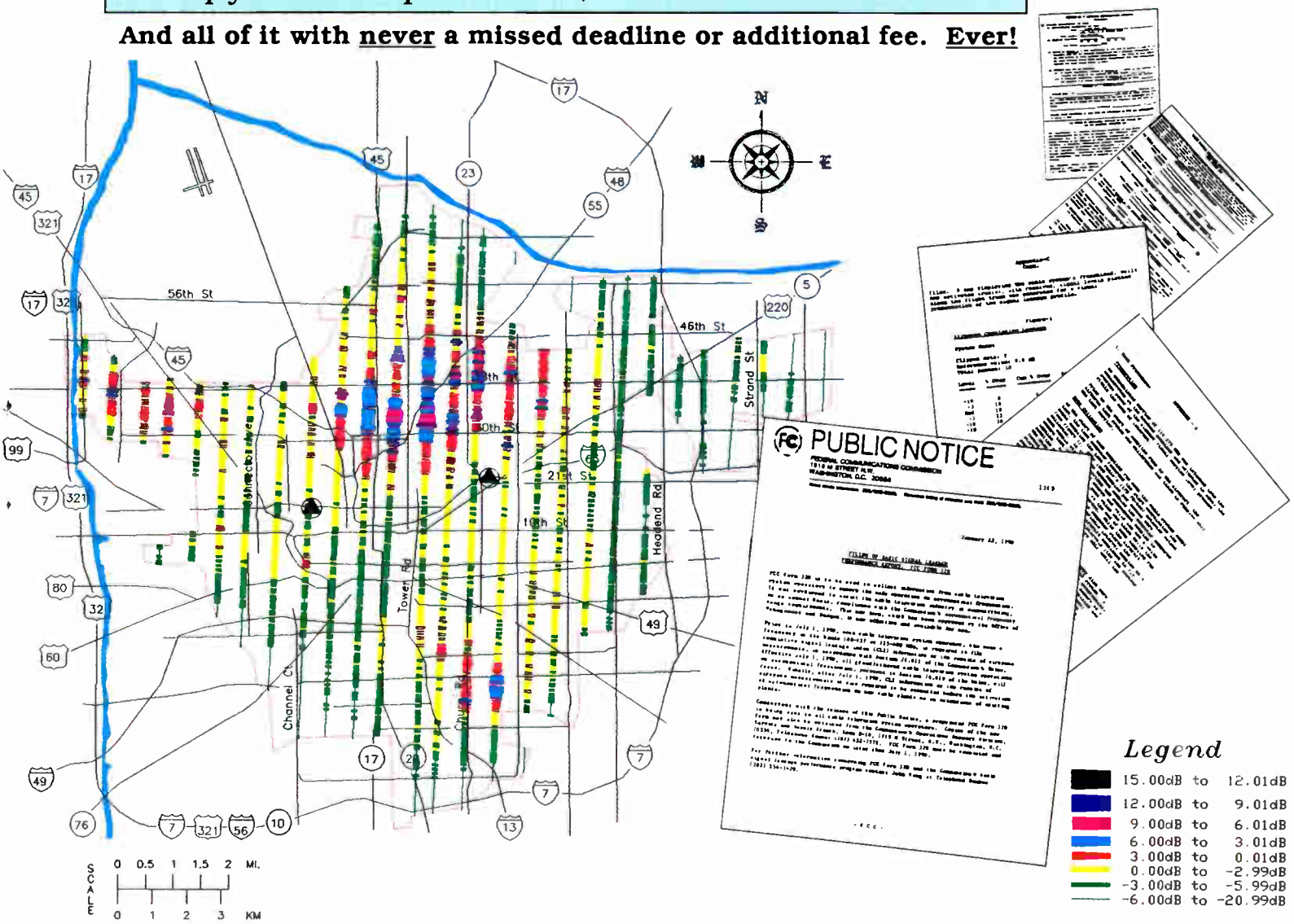

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Video Measurements

Parameter	Signal
Insertion Gain Sync Amplitude Burst Amplitude	Bar Sync Burst
Line-Time Waveform Distortion	Bar
Short-Time Waveform Distortion	2T Bar Edge
Chroma-Luminance Gain Inequality	Chroma Pulse
Chroma-Luminance Delay Inequality	Chroma Pulse
Differential Gain	Staircase
Differential Phase	Staircase
Gain/Frequency Distortion	Multiburst
Chroma Nonlinear Gain Distortion	3-Level Chroma
Chroma Nonlinear Phase Distortion	3-Level Chroma
Chroma-Luminance Intermodulation	3-Level Chroma
Field-Time Waveform Distortion	Square Wave
Signal-to-Random-Noise Ratio (weighted)	"Grass" Estimate

Figure 3

practical when installing a new satellite antenna.

The monthly transmission test allows for an on-line test of C/N by temporarily removing the satellite transponder carrier, leaving only noise and interference from various sources (see Figure 1). Not only does this allow for easy measurement of noise, but any adjacent satellite interference can be immediately seen on a spectrum analyzer.

After the carrier has been removed for three minutes, it is reinserted and modulated with only the FCC required 20 Hz triangular waveform dispersal signal. The power meter reading taken here would be a sum of the power and all undesired noise and interference. The formula C/N (dB) = 10 log ((C + N) − N)/N results in the receive site carrier-to-noise ratio.

To make accurate C/N measurements with a power meter, several precautions must be taken. First, the receiver must be operating in the linear portion of the manual gain control mode. This assures that the receiver's amplification stages do not change the relative values of the carrier-to-noise ratio.

The power meter's bandwidth must be wide enough and its sensitivity high enough to accurately measure the noise. Measurements are made at the receiver's final IF stage, so the power meter's input frequency must be matched to the receiver's IF. In addition, the input impedance of most power meters is 50 ohms, so it must be matched to the receiver's 75 ohm IF output impedance.

FULL-FIELD VIDEO TESTS (Audio = 1 kHz at 0 dBm)

00:39:00--00:42:00 (3 minutes) Square Wave (window)
00:42:00--00:45:00 (3 minutes) Composite
00:45:00--00:48:00 (3 minutes) Combination
00:48:00--00:51:00 (3 minutes) Modulated Stairstep

Figure 4

DESCRAMBLER TESTS

00:51:00--00:53:00 (2 minutes)	Tone & Colorbars (unscrambled)	Descrambler Transparency
00:53:00--00:55:00 (2 minutes)	Tone & Colorbars (scrambled)	Spare Testing

Figure 5

Audio tests

On-line audio measurements with active programming are virtually impossible to make, so a significant portion of the transmission test is dedicated to audio evaluation. Tones of several frequencies and levels (see Figure 2) are transmitted to allow for measurements of various audio parameters. Most audio measurements can be made with an audio RMS voltmeter or an oscilloscope, using the monaural, left and right outputs of the descrambler as audio sources.

The first audio test measures insertion gain. A 1 kHz tone at zero dBm should be received from each of the three audio outputs. Audio levels should be adjusted at the rear of the descrambler to maintain unity gain.

The next series of audio tones allow for measurement of the audio frequency response. Eight audio signals of constant amplitude and varying frequencies are transmitted. An amplitude vs. frequency plot of the received audio signals shows the audio frequency response.

Harmonic distortion, which is caused by nonlinearities in the transmission system, is the next audio parameter used. The audio peaks in active programming occur about 8 dB to 12 dB higher than what is indicated on a standard VU meter. To test this region between the peaks indicated by the VU meter and the true program peak excursions, a 10-dB "headroom" is allowed. An audio distortion analyzer is used to measure distortion levels of a 1-kHz tone transmitted at 10 dB above normal set-up level.

For the next test, the audio sent from the uplink is terminated, allowing for audio signal-to-noise ratio measurements. The voltage level with the 1-kHz, zero-dB tone is compared to the terminated audio voltage level when only noise is present. Audio signal-to-noise ratio is calculated with the formula S/N (dB) = 20 log (Vref ÷ Vnoise). This test is similar to the carrier-to-noise test performed in the satellite section.

Crosstalk, or the isolation between the left and right stereo channels, is then evaluated. This test is only relevant to cable systems delivering stereo audio to subscribers. A 1-kHz, zero dBm tone is inserted on one audio channel while the other is terminated. This test measures the amount of audio leaking from the channel with the test

signal to the other channel.

The final audio test measures phase shift between the two audio channels. Severe phase differences between stereo channels may cause undesirable cancellations in the reproduced sound, resulting in a lack of realism of fidelity.

This test is especially important for the delivery of stereo matrix systems such as BTSC and surround sound. A dual trace oscilloscope is handy for measuring phase shift.

Video

Most video parameters can be measured using a good waveform monitor or oscilloscope and the Vertical Interval Test Signal (VITS) that is present during all programming. On-line measurements during active programming can easily be made, so the portion of the transmission test that is devoted to video is limited. This is not to lessen the importance of high quality video, only to recognize the value of VITS.

Figure 3 shows the video parameters to be measured and the test signals required. All of these parameters can be measured during the transmissioin test or at other times with VITS.

The final video parameter, signal-to-random noise ratio, can be measured in several ways, including the grass estimate or with noise insertion on an unused line in the vertical blanking interval.

There are some picture defects that cannot be measured with active video present. Field time distortions and some kinds of modulation problems can only be accurately measured by using test signals designed to analyze them. For this reason, various full field video test signals are sent during the video portion of the transmission test. These are listed in Figure 4.

Descrambler operation

The final scheduled portion of the transmission test examines the switching capability of primary and spare descramblers (see Figure 5).

In the first part of the descrambler test, an unscrambled color bar test signal and 1-kHz, zero-dBm audio tone on the 6.8 MHz aural subcarrier are sent. The descrambler will switch to the bypass mode and audio and video from the satellite receiver will be routed to the descrambler output. Audio and video levels should be set at the satellite receiver, if necessary. When tests of the spare descrambler are completed, turn on the primary descrambler.

Throughout the transmission test, all descramblers are temporarily authorized, which allows for easy testing of spare descramblers. Once the transmission test is completed, only the descramblers originally authorized will remain authorized.

The monthly transmission test is scheduled to last approximately 90 minutes. The final 30 minutes is left for various uplink testing that changes on a monthly basis.

Conclusion

The HBO Transmission Test Manual explains in detail how the various measurements are performed, the equipment required and the parameters' acceptable limits. A manual can be obtained by calling the HBO Scrambling Hotline at 212-512-5666.

Interactive TV gets a jump start

If the average consumer was old enough and remembered the 1920s, he might chuckle at a question asked back then: "What is television and why do I want it?" To those having grown up with, or born into, an age where television is a household commodity, the idea of not having a TV set seems ludicrous. But the concept of television, like any new venture, had to be explored, defined and, finally, accepted before it could take its place among the tried and familiar.

To those struggling to inform and gain consumer acceptance of interactive television, the path is similar to that taken by such giants as television, copiers and fascimile machines. Once the initial doubt has been replaced, once the consumer has the chance to interact, and once the red tape has been cleared, many feel interactivity will also become part of everyday life.

Unfortunately, the concept of interactivity has traveled down a much rougher road. Earlier failures of 1980s developments such as videotex and teletext attached a negative connotation to the much-touted "interactivity." It was not until recently that action by the Federal Communications Commission (FCC), in response to a petition filed by TV Answer Inc., turned the tables and inspired new hope for an industry that feels it has a viable, and worthwhile, product.

"At least (the proposal) will provide the spectrum," says Lewis Martinez, president of Radio Telecom and Technology (RTT), a California-based company that proposes to work on adjacent, vacant television channels without interference. "A half a megahertz is quite adequate to make discoveries as to whether the economics and the user interest, the utility, is there. It's a very good step in the right direction."

An interactive service

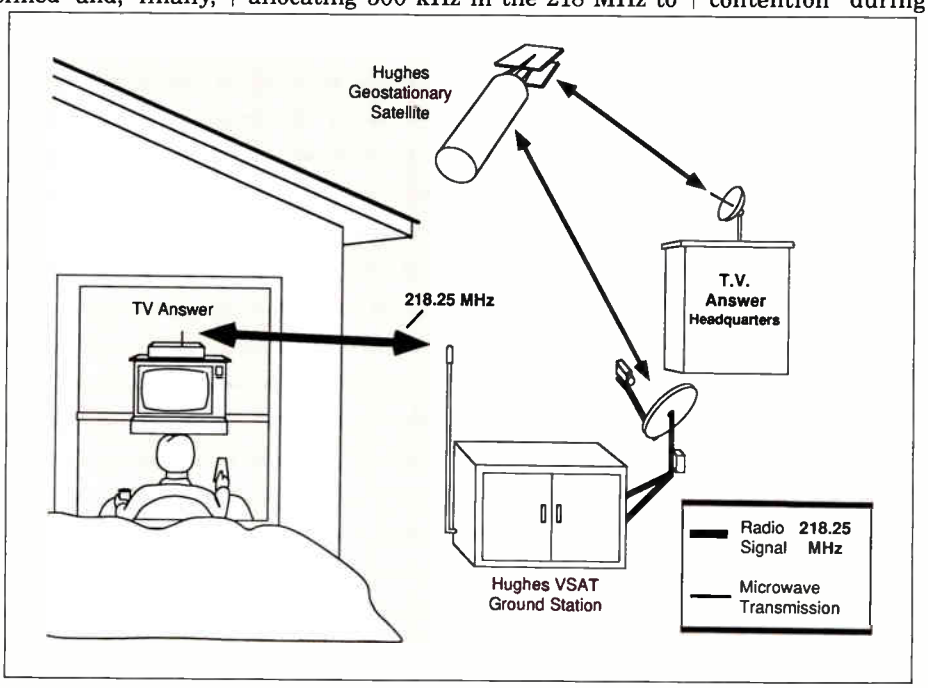
The proposal referred to is the Commission's proposed establishment of an interactive video data service (IVDS) allocating 500 kHz in the 218 MHz to 218.5 MHz band. The allocation, which would be split into two 250-kHz segments, would allow viewers to respond to queries associated with television programming, as well as ordering of products and downloading of educational and other information. Licensing would be done locally on a first-come, first-served basis, with a lottery being held in areas where competition became a factor.

The proposal came after a long interplay between TV Answer Inc. and the broadcast community, with the FCC acting as a mediator. The point of contention during the several-year timeframe concerned interference with Channel 13, which operates at 216 MHz. However, both the National Association of Broadcasters (NAB) and the Association for Maximum Service Television (MSTV) believe their concerns are now being met.

"MSTV has been very active in actually assessing the technical ramifications of the proposal relating to interference with channel 13," says Victor Tawil, vice president of MSTV. "They (TV Answer) agreed to the technical parameters we discussed. So in essence, we don't have any concern with TV Answer's technical presentation to the commission to protect the service.

"I will have to caveat that," adds Tawill. "The (service) is not out yet. Most of our discussion has been with TV Answer and how we would like a service like this to operate in a spectrum adjacent to the broadcast spectrum. We have not seen what the item is yet, so we wouldn't be able to tell you how good it is until we see it."

Bu TV Answer is aware of broadcasters' concerns and is committed to being a non-interfering service. "We have to recognize," says Rich Miller, vice president of communications for TV Answer, "and we've asked the broad-



LEWIS MARTINEZ

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casters to recognize, that this is a system designed to benefit them. So it would be suicidal on our part to cause them interference problems when in fact they are one of the primary beneficiaries of the system."

Lynn Claudy, director of advanced engineering and technology for the NAB, doesn't see a problem. "It's our understanding," says Claudy, "that the FCC has taken interference concerns into account. When they release the notice of proposed rulemaking, those details of how the interference question is being dealt with will be set forth."

Yet, the actual means of implementation are not seen as the real issue here. "Once we get beyond that," says Claudy, "we're all very excited about it. Interactive video has been talked about for the past 15 years, mostly with cable services because their pipeline has inherently a two-way nature. The broadcast medium hasn't really had a way to capitalize on interactive video except through phone lines, which is ultimately an awkward and unappealing medium for interaction. So maybe something will come of this."

Not for everyone

Hoping something does come out of this is the wish of many of the interactive companies trying to get their foot in the consumer's door. However, for many of the familiar names, Minitel, Interactive Network, Interactive Systems, Videoway and ACTV, the proposal doesn't directly impact the technology each company is using to deliver interactivity.

"(The proposal) could affect an easier method on the backend," says Craig Kelley, director of marketing for Interactive Network. "There's not many of us doing true two-way but to get the information out of the house, this ruling could have an affect on making it much more cost effective to do that."

"I think it helps," says Leonard Shaier, president of ACTV Domestic, "in that what we've been saying for a long time is certainly coming to fruition—people want to have interactivity and people want to interact. Anything that gets people out there to realize that consumers want to interact, that they want to be free to make choices, certainly helps, whether it's going to have a real significant impact on any particular technology."

Opening doors

But for other companies that needed the spectrum, the proposal is the key to a door. And for the broadcasters, "it opens the possibility of an auxilliary revenue stream," says Claudy, "for the broadcaster to at least get some piece of the action in an interactive service, depending on what it is. And it's a value added service, it would add to the quality and the product that the broadcaster is able to supply."

"One of the primary benefits to broadcasters," says Miller, "is they now have a two-way means of communication that they can tie to their video and audio."

RTT's Martinez agrees that the proposed allocation has opened doors "except for the amount of spectrum—half a megahertz—is relatively small," says Martinez. "It's quite adequate for initial applications but if any significant volume or user interest begins to develop it would be saturated rather quickly."

Martinez's company instead proposes, and has filed a petition with the FCC, to operate on vacant television chan-

nels, not simply 218 MHz to 218.5 MHz. In business and operational for the past five years, RTT currently has a license in the Los Angeles area for channel 67. Its T-Net, which coordinates signals to occur only in the horizontal and vertical blanking interval, allows a subscriber to sit with a remote control device and push buttons. The communication is sent from the subscriber out to an antenna to the studio location or some other central location.

"We're promoting the notion of real-time interactive, in conjunction with a local data base, if that's desirable," says Martinez. "And that's the unique aspect of T-Net. The return path is a single, vital ingredient that we contribute."

LYNN CLAUDY

'A lot of (cable) money has been spent, yet public acceptance of two-way services has been extremely slow.'

So for RTT, the FCC proposal is a first step. "We're happy to see the commission take some moves now, first recognizing the importance of interactive television, and making some provision for spectrum for its use," says Martinez. "(Spectrum) which we could very well employ and which we believe, have the significant advantage that we're not interfering."

TV Answer's Miller sees the proposal in much the same light. "Our reading on this," says Miller, "is that the FCC wants to see an industry developed in fairly short order and from our perspective, that is exactly what needs to happen. The broadcast industry has to see this as a viable industry from the beginning—participate in a big way in the very beginning. And I think that's the message from the FCC."

What about cable?

And the benefit to cable? Well, that remains to be seen. Although many view the proposal as a step in the right direction, there is still the question of the consumer and the need or want for interactivity. "In the cable side, there's been a lot of money spent and a lot of experiments tried and yet public acceptance of two way services has been extremely slow," says NAB's Claudy. "I don't think anyone is convinced that the mass market of interactive video may develop, it may not....I hope that the right application is found and we're able to use it."

"We really don't have a position one way or another," says Tawil. "I think people in the marketplace will decide whether that technology is desired by the public or not."

But for those who have worked to get spectrum, the question at this point isn't of public acceptance. Instead, the allocation is seen as a move in the right direction: a beginning. "It is a recognition," says Miller, "on the part of the commission that interactive television has now reached a level of maturity where it could be a major benefit to both the broadcast industry and the consumer." ■

—Kathy Berlin

Improving commercial insertion operations

In the past few years, the cable industry has seen local advertising revenue increase from 1 percent of cable corporations' total revenue to what is now an average of about 6 percent, with some entities reporting as much as 10 percent of revenue generated by local ad sales. It is rational to expect that corporate pressure to increase this contribution will continue and will increase many-fold should re-regulation occur.

With re-regulation, advertising is expected to be one of a few entities that can help produce the kind of growth that stockholders expect. Of course, at the same time, operators will be expected to reduce costs.

To achieve these goals, operators will need to put into place a sound strategy that will result in improving today's product offering.

By Gil Moreira, Vice President, ARVIS Corp.

Plenty of improvement

The commercial insertion industry has progressed considerably from its early days (the early 1980s). In a short time span, manufacturers have brought full random access of individual spots, deck sharing across networks, two-way communication between trafficking and insertion equipment, on-line diagnostics, self-diagnostics, same day make-goods, SMPTE time code control of decks, automated off-hour polling, off-hour automated recording of commercials, simplified tape preparation methods, compiling, switching improvements and many more features.

Currently, the innovators of commercial insertion system design are preparing products with features that will provide operators with the tools to give them the competitive edge. Meanwhile, there are measures operators can take today, with their existing equipment, to improve their systems.

These measures address:

- The reduction of downtime and increasing maintenance costs because of mechanical failure.
- The reduction of the potential for human error.
- Maintaining a consistent high-quality on-air look.
- Meeting the need for accurate and timely information.

Reduction of downtime

The mechanical failure of equipment not only increases maintenance costs but also leads to unhappy customers, lost revenue and lost inventory. A vast majority of failures are eventually traced to tape decks and/or videotape.

To alleviate some problems, the following actions can be taken today:

- Mandate that a *preventive* maintenance schedule for decks be initiated and *adhered to*.
- Assure that fresh, high-quality tape is used.
- Have a video-experienced engi-

neer on staff and clearly designate an individual as having responsibility for the operation of the equipment.

- Ensure that the equipment is protected from potential lightning and electrical damage.
- Consider keeping a "hot spare" at your central office. A hot spare would entail keeping a spare controller actively working off-line in a central location. In this case, a spare controller, in perfect working order, is ready to be switched with any controller that becomes inoperable.
- To reduce downtime and shipping costs, a set of replacement parts should be kept at a central location.

Recently, commercial insertion equipment manufacturers have introduced systems utilizing optical disc technology. The optical disc features fewer moving parts and has a video head that never comes in contact with its media. It is therefore expected that maintenance costs and downtime related to mechanical failure will be dramatically reduced.

Because vendors have already designed and implemented software which can share decks among multiple networks, the incremental cost of adding, mixing or fully switching to optical disc will be less than first expected. Because of the players' high speeds, perhaps fewer optical players will be needed than tape decks to perform the same functions. And with the advent of the erasable disc recorder and player, the overall cost of media (platters) can be substantially lower than costs for tape because of the predicted lack of degradation of video quality, even after tens of thousands of erasures.

In addition to the reduced downtime expected of videodisc players, the eventual introduction of tandem controllers will further reduce system downtime. Tandem controller philosophy incorporates one controller backing up a primary controller to automatically replace the primary controller should it fail.

In an environment where one controller controls multiple networks, this approach can prove cost-effective. Software with greater diagnostic capability and remote alert systems that alert personnel to ocurring problems will also emerge over time.

Reducing human error

Human error and video deck failures are the two major causes of revenue loss due to system failure. To reduce the potential for human error, follow these guidelines:

- Both the trafficking and technical personnel should be well qualified and experienced in their field.
- The traffic operator should have computer and traffic experience. Avoid the oft-repeated error of hiring the most promotion-worthy person in the office or assigning trafficking as an additional task to someone on the office staff.
- Attention to detail and constant checking and rechecking are essential requirements to assure a successful operation.
- Take advantage of any training seminars offered by vendors.

The industry is improving its automated diagnostic capabilities. Methods of reducing man/machine interface are available and more is to come. Loading of video over satellite feeds, communication of operating data by telephone lines and the advent of products like the optical disc will contribute to reducing the instance of human error, which causes loss of revenue.

The near future will bring systems with increased error checking capabilities and many manual entry functions will be automated through the use of more sophisticated software programs.

Continued on page 108

Words to the wise on fiber wavelengths

In just a matter of months, video transmission at the 1550 nanometer (nm) operating wavelength has become one of the year's hottest cable television technology issues.

Trade magazines have devoted considerable editorial space to "1550" coverage. The wavelength debate dominated the Society of Cable Television Engineer's Fiber-Optic Conference held earlier this year. And, at least one MSO already has committed to 1550 nm for a series of upgrades.

Several equipment suppliers also have followed suit, and are actively investigating how to harness 1550 nm technology. Many industry observers speculate that the 1550 operating window represents the "wave (length) of the future" for cable TV.

But if that prediction is accurate, what's to become of the 1310 nm operating region, the industry's *de facto* transmission wavelength? Will 1310 nm go the way of the Edsel, the great woolly Mastodon and the five-cent cup of coffee?

Certainly not. In fact, it's far more likely that 1550 nm technology represents the latest stage in cable's optical fiber evolution, the emergence of another operating option, rather than a rejection of an existing transmission format.

Simply stated, the 1310 nm operating protocol, currently utilized in virtually all fiber-based cable TV networks, should remain the industry's "wavelength of choice" well into the future.

At the same time, cable TV engineers owe it to themselves and their subscribers to investigate the 1550 nm format now. Once some fundamental obstacles are overcome, this technology promises tangible benefits for a range of cable TV applications.

1310: Here to stay

The 1550 nm operating window, over the long term, is likely to complement, not compete with, 1310 nm technology. The 1550 nm wavelength can enhance, not obsolete, a cable system's fiber investment.

Moreover, there's no need to delay the installation of optical fiber until the industry embraces a "preferred" wavelength. Cable TV engineers will not compromise their systems for tomorrow's applications if they install optical fiber at 1310 nm today.

Currently, the 1310 nm amplitude modulated (AM) system over standard single-mode fiber offers excellent performance at a competitive price. So, ultimately, the choice between 1550 nm and 1310 nm will come down to a design decision by the cable TV engineer, who can best determine the operating wavelength that fits the needs of his or her system.

This article will examine why 1550 nm transmission has sparked the interest of cable TV engineers and will review the limiting factors and likely applications for this technology. We'll also investigate methods of "future proofing" a cable TV system with optical fiber.

Why 1550?

Today's AM fiber systems, operating at 1310 nm, provide typical optical power budgets of 7 to 12 decibels (dB). This corresponds to a maximum system length of approximately 25 to 30 kilometers (km). Assuming equivalent power output from 1310 nm and 1550 nm lasers, by operating at 1550 nm, cable systems can take advantage of standard fiber's lower attenuation rate, (the reduction in signal strength over the length of a fiber) to extend link distances to 40 to 50 km. In addition, the commercialization of 1550 nm optical amplifiers could enable more receivers to be shared by a common laser transmitter.

Single-mode fiber's low attenuation rate at 1550 nm can enable cable operators to extend their systems while eliminating downstream active components. The anticipated result: an improvement in signal reliability and a reduction in system costs. Yet, certain challenges must be overcome before widespread adoption of the 1550 nm transmission method can be discussed.

Currently, if cable TV operators wish to upgrade to 1550 nm over installed standard single-mode fiber, the signal quality of an AM system degrades unacceptably after only a few kilometers. Why? The problem is dispersion, a key optical performance parameter for single-mode fiber.

The effects of dispersion are used commonly in digital transmission to determine the maximum data rate or information-carrying capacity of a single-mode fiber link. It refers to the spreading of each pulse of light as it travels along a fiber. As the pulse of light travels along the fiber, it spreads due to the different wavelengths that make up the pulse traveling at different speeds. Eventually, the pulses can overlap one another and become unrecognizable, thus limiting the received data rate.

In analog transmission, the effect is slightly different. Dispersion causes a slightly distorted analog waveform to become significantly distorted more rapidly. This is due to different wavelengths of light traveling at different speeds within the waveform. In AM systems, this distortion shows up as second order harmonics (or "beats") and is commonly referred to as composite second order (CSO) distortion.

On standard single-mode fiber, dispersion values are much higher at 1550 nm than at 1310 nm, and will result in a reduction in picture quality more rapidly. Tests conducted by Corning and several other suppliers conclude that unacceptable CSO levels occur after a few kilometers when operating at 1550 nm over standard single-mode fiber. Contributing to the severe signal degradation is the relatively poor performance of 1550 nm AM lasers available today when compared to their 1310 nm laser counterparts.

Design options at 1550 nm

When 1550-nm AM systems do become more commercially and technically viable, equipment manufacturers likely will rely on electrical compensation to offset performance degradation due to dispersion.

Another alternative may involve the use of multiple fibers to distribute video channels in a way that minimizes any distortions caused by their interac-

By Douglas E. Wolfe, Senior Applications Engineer, Telecommunications Products Division, Corning Inc.

tions. This technique transmits channels by octave and virtually can eliminate CSO distortions.

Both options would enable cable operators to upgrade to 1550 nm AM systems on their existing single-mode fibers. In the future, single-mode dispersion-shifted (DS) optical fiber may be appropriate for 1550 nm AM applications requiring long fiber runs. Dispersion-shifted fiber is designed to minimize the dispersion at 1550 nm and take advantage of the lower attenuation rate at that window. This may allow greater AM transmission capacity over longer distances than conventional single-mode fiber.

Optical amplifiers also hold much promise for 1550 nm operation. The first generation units may be available for system testing within the next few months, but widespread commercial distribution is likely to be 12 to 18 months away.

1550 nm applications

Two 1550 nm AM applications typically are appropriate for cable television. First, it's likely that the initial use of the 1550 nm operating window will be for trunking applications, requiring longer fiber runs that cannot be achieved using current 1310 nm systems. Under these circumstances, it may be advisable to install single-mode dispersion-shifted fiber to counter the effects of dispersion at 1550 nm.

As discussed, electrical compensation also could allow for successful operation at 1550 nm over standard single-mode optical fiber. Another alternative could be to design channel loading per fiber by octave, thus eliminating the CSO distortions that are accentuated by dispersion.

The second 1550 nm AM system application would rely on the optical amplifiers to reduce overall system costs. In this situation, optical amplifiers would generate high output power levels, allowing for optical branching, which shares the laser output among several optical receivers.

In fact, if 1550 nm AM systems incorporating amplifiers are installed at a system's headend, then electrical compensation could be used at the receivers to minimize CSO distortions. Along with reducing total system cost, this approach would bring fiber, with its attendant system reliability and picture quality benefits, closer to the home.

Deploying 1550 nm AM systems and optical amplifiers as an extension to existing 1310 nm systems, in an optical branching architecture, may result in acceptable dispersion levels, since the maximum fiber lengths would average less than two kilometers. Lower performance requirements at the home also may contribute to use of standard single-mode fiber at 1550 nm.

The future...and 1550

The search for a cost-effective method to push a video signal deeper into the communications network is the driving force behind cable TV's continued deployment of optical fiber. That's why the industry is examining 1550 nm transmission so closely. Any technology that can maximize fiber's benefits while reducing overall system costs is worthy of scrutiny.

But for all its performance potential, the 1550 nm wavelength seems likely to remain a niche transmission method, with specific operating advantages in certain environments.

The 1310 nm window continues to be cable's proven transmission protocol. And, as 1310 nm laser output increases due to technology advancements, power budgets and corresponding maximum distance capabilities will increase as well.

When 1550 nm AM technology does become commercially available, several types of electrical compensation will allow for the rapid upgrade of the existing fiber network. Wavelength division multiplexing also offers the prospect of using 1310 nm and 1550 nm lasers over the same fiber, literally doubling capacity.

In the meantime, cable operators may elect to install a small percentage of single-mode dispersion-shifted fiber, in the appropriate portions of the cable plant, along with their standard single-mode fiber to provide a 1310 nm system with the potential to upgrade to 1550 nm.

So, if you're a cable operator about to commit to a fiber-based system, congratulations. You're making a wise investment in technology that will bear dividends today and well into the future. And, if you're a cable operator who's already made the move to fiber, don't worry. Your current operating wavelength will continue to deliver the excellent performance you've come to expect.

Cable television's commitment to fiber will be rewarded, no matter what operating window the industry chooses to look through.

VideoCipher plans roll-out of 'smart cards'

Encryption technology remains strong in face of competition

Faced with an historically hostile CATV clientele and a rash of new competitors, General Instrument's VideoCipher Division is taking bold new steps to develop and implement new scrambling schemes designed to wipe-out the widespread piracy problem it has faced since it was introduced six years ago.

VideoCipher II-Plus

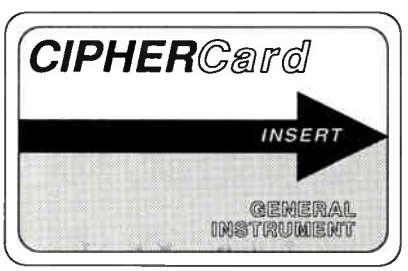
Already, roll-out of consumer VideoCipher II-Plus descramblers is underway, with more than 400,000 units already shipped, according to Michael Meltzer, VideoCipher's vice president of sales and marketing. Authorizations of consumer descramblers processed by the DBS center at VideoCipher's San Diego headquarters are running at about 25,000 to 30,000 per month, Meltzer adds.

The VC II-Plus is a new encryption technology that makes it much more difficult and expensive for pirates to alter descramblers (or "clone" them—a process that results in unauthorized reception of satellite programming). Estimates vary, but industry observers have said that anywhere from 75 percent to 90 percent of the older generation VC II devices have been illegally altered. The result has been rampant piracy, an issue which has raised the ire of satellite programmers.

Since its introduction more than a year ago, programmers have been transmitting their signals in VC II-Plus as well as the standard VC II formats. Plans now call for programmers to eventually switch feeds to VC II-Plus only, and shut down VC II transmissions, something expected to occur within the next 12 months.

VideoCipher has already announced plans to institute a program to upgrade new buyers of VC II-Plus decoders, in the event "most cable/satellite TV programmers switch to a higher level of VideoCipher II-Plus technology." The Consumer Security Protection Program will protect buyers for three years from date of purchase. However, VideoCipher and the programmers have to agree on who will foot the bill to upgrade legitimate VC II backyard customers with new descramblers. Meltzer recently said agreement on that issue is expected soon.

Movement toward VC II-Plus only transmission can't be far off, judging from two recent announcements. Jerrold Communications (also a division of General Instrument) and Wegener Communications have both "agreed in principle" to become licensees. The



VideoCipher's new Cipher Card

two companies will manufacture a new line of low-profile (1 3/4-inch) commercial VC II-Plus descramblers. Both companies expect to have units available by this summer.

Cable operators can use the new unit to upgrade to VC II-Plus, as well as save valuable headend rack space. The previous VC II commercial descramblers caused consternation within the CATV technical community because of its large size (it was taller than five inches) and reliability problems.

(Later versions of the commercial descramblers will allow the units to interface with remotely tunable receivers to handle ESPN, and other, switch-and-retune functions related to sports blackouts.)

'Renewable security'

Although VideoCipher officials say VC II-Plus has not yet been compromised, they refuse to stand still waiting for the day when widespread piracy again takes hold. Executives have publicly stated that they learned a valuable lesson from pirates in that nothing is secure forever. "The question no longer is 'if' but 'when' will piracy occur," said J. Lawrence Dunham, who until last month was president of the VideoCipher Division. "Because of piracy it is only reasonable to expect that programmers will eventually demand...new generations of VideoCipher II-Plus technology."

Satellite programmers and cable operators will perhaps wonder "What took 'em so long" but VideoCipher engineers are presently finalizing the design of VC II-Plus RS (for renewable security), which uses "smart cards" to authorize home descramblers.

After taking a long, hard look at the piracy issue, VideoCipher officials settled on the smart card approach because it was the only way to truly control security. "We could *assume* the only places that security exists was in the smart card and the uplink site," said a VideoCipher engineer.

The concept of smart cards isn't new, and it's an idea many cable engineers (among others) have had for years. Legitimate backyard dish owners will use the plastic card, approxiately the same size as a credit card, (see rendering) by placing it into a slot located in the back of new VC II-Plus descrambler. Without the card, which VideoCipher has dubbed CipherCard, the descrambler will be useless.

And if the new encryption technology is ever cost-effectively defeated, VideoCipher can simply deauthorize the old cards and issue new ones in the span of a few weeks and at a cost considerably lower than rolling out a new line of descramblers.

With the advent of DigiCipher (a digital video compression scheme) and other all-digital methods of video delivery, the question of how consumers, programmers and cable operators upgrade from VC II-Plus to a digital means of encryption and descrambling has emerged. But VideoCipher officials have foreseen the question and propose a solution: a VC II-Plus/DigiCipher integrated receiver/descrambler, planned for a 1992 introduction.

Meltzer admits a straight upgrade from VC II-Plus to DigiCipher "isn't prudent" because of the size of the C-band market. However, if a popular

pay-per-view or other programming event (the 1992 Olympics?) is sent via digital transmission, it could help spur the introduction of such a descrambler, Meltzer believes.

In spite of all VideoCipher's improvements, many have wondered if it will be enough to keep the some 58 programming services on as VideoCipher customers. If not, will some other scrambling scheme take over? Cable-TV seems firmly entrenched in VideoCipher technology, but will a DBS service utilizing some other technology ever get off the ground?

Public indications so far suggest that at least one programmer—Home Box Office—is still committed to VideoCipher technology. Robert Caird, president of HBO Satellite Services and chairman of the Satellite Broadcasting and Communications Association, told SBCA attendees last January that efforts were underway to switch from VC II to VC II-Plus as the first step toward "cleaning the environment." He then added that the second step provision of "recoverable security" in the event VC II-Plus is compromised.

In fact, most satellite industry veterans admit that VideoCipher will continue to have a lock on the C-band market. But the picture is much more murky on the Ku-band side of the coin. However, with the recent problems DBS services like SkyPix and SkyCable have had raising the capital necessary to launch (or staying organized), the issue could simply be moot.

Primestar, the consortium of cable operators that launched a low-power Ku-band DBS service, opted to use B-MAC instead of VideoCipher. And TVN Entertainment, the proposed 10-channel C-band PPV service, initially chose D-Code, an encryption standard developed by Leitch and Uniden. However, TVN eventually rescinded its decision (leaving Uniden with thousands of useless decoders) and embraced VC II-Plus in response to concerns over multiple encryption technologies. The result has been virtually no loss of marketshare for VideoCipher because nine of the 10 Primestar services are available via VC II.

What seems clear is that VideoCipher is taking the necessary steps to remain the encryption technology of choice for cable and other satellite programmers for many years to come. ■

—Roger Brown

Scrambling hotlines

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CBN/Family Channel	(804) 420-9015
Discovery Channel	(301) 986-0444
The Disney Channel	(818) 842-2877
ESPN	(203) 585-2264
FNN	(800) 366-4046
HBO/Cinemax	(212) 512-5666
Lifetime	(718) 706-3629
Playboy (until 6 p.m.)	(213) 652-7197
(nights and weekends)	(805) 266-2837
Showtime/Movie Channel/ Nickelodeon/MTV/Viewers Choice/ VH-1/Ha!	(516) 435-4961
TNN	(203) 965-6200
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Cable and corrosion

System reliability and picture quality are two of the most important services to the subscriber in today's systems. In the early days of CATV, if an operator could provide several channels to the home he was a hero; today he's asked to provide 99.999 percent reliability—and good pictures—all at the cost of a few video rentals.

To achieve these goals, an operator must install the outside plant in a way to assure the signals put on the cable are of the highest quality with the greatest reliability. Most cable manufacturers today offer the best cable designs with the highest quality standards ever. However, improper installation, connectorization or poor environmental protection can negate this quality and create headaches for the system engineer. This article addresses some of the issues that degrade plant quality and reliability.

Corrosion is an example of a problem that can appear over time.

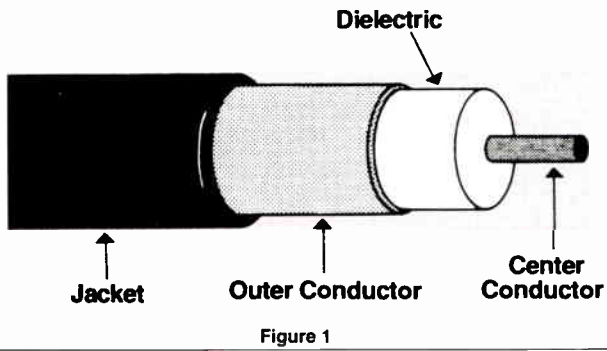

Figure 1

Coax components

As is widely known, coaxial cable is made up of three principal parts, namely the center conductor, the dielectric material and the outer conductor. Each of these components has a fixed relationship in size and placement to maintain the characteristic impedence fixed at 75 ohms and the attenuation consistent throughout the cable length. A cutaway of a typical coax cable is shown in Figure 1.

Cable manufacturers publish the physical dimensions of the various components in their catalogs. The attenuation and characteristic impedence parameters are defined by the formulas shown in Table 1.

When the coaxial cable is manufactured, these dimensions and characteristics are guaranteed to be within the specification listed by the manufacturer. However, during the installation of the outside plant, it is possible for the installer to immediately change these characteristics (kink or dent the outer conductor) or even worse, create a situation that will create a change that takes place over time.

Formula 1

$$\text{Attenuation} = (K^{I} (Pi\ f)\ ^{\wedge}.5/di) + (K^{I} (Po\ f)\ ^{\wedge}.5/Do) + (K^{II}\ f\ D\ e/\text{Log}\ (Do/di)))$$

Formula 2

$$\text{Characteristic Impedance} = \frac{(138 \times (\text{Log}\ (Do/di))}{(e)\ ^{\wedge}.5}$$

Where:

di = diameter of the inner conductor in inches
Do = inside diameter of the outer conductor in inches
e = the dielectric constant of the plastic ($1/V_p^2$))
D = dissipation factor of the plastic (0.00013)
f = frequency in MHz
Pi = resistivity of the inner conductor (1.724)
Po = resistivity of the outer conductor (2.824)
K^{I} = 0.00439
K^{II} = 1.5047

Table 1

Corrosion and its causes

Corrosion is an example of a problem that can appear over time. Soon after the system is cut in, balanced, etc. the engineer may think his problems are solved. But, if moisture got into the cable prior to connectorization, his problems may have just begun to grow.

To see what could happen is moisture gets in, review the basic formula for attenuation at RF frequencies (Formula 1). Above a few kilohertz, the RF electrical signal is conducted on the outer surface of the inner conductor and the inner surface of the outer conductor. This phenomenom is called "skin effect."

The outer surface of the inner conductor on all CATV coaxial cables is, of course, copper. The cost of copper is considerably higher than aluminum and since the signals only travel on a thin layer of the inner conductor, it is more cost effective to have a copper-clad center conductor, as compared to a solid one.

Figure 2 illustrates the relative contribution of the loss of each of the three compoents to the total attenuation as a function of frequency. Note that as the frequency increases, the attenuation of the center conductor continues to represent the largest contribution to the total: roughly 65 percent to 70 percent.

If water or moisture vapor is allowed to contact either or both of the conductors, corrosion (copper oxidation of the inner conductor and aluminum oxides on the outer conductor) immediately begins to form on the surfaces and, therefore,

By Paul Wilson, Comm/Scope Inc.

resistivity begins to increase. The copper oxide will have a dark bluish to black coloring and the aluminum oxide will have a white powdery appearance. It will appear first in spots, but in an advanced stage, could color the entire

The 'skin effect' occurs when the RF electrical signal is conducted on the outer surface of the inner conductor and the inner surface of the outer conductor.

conductor surface.

A growing problem

Typically, the center conductor is the main problem area in the beginning. At first, the corrosion may be a small factor in the attenuation of the span. However, if the ingress path continues to allow oxygen and moisture to reach the conductors, the corrosion continues to migrate throughout the span.

Looking specifically at the inner conductor, as the corrosion grows, the resistivity of the inner conductor continues to increase and the attenuation begins to increase. This increase starts to show up in the higher frequencies and signal levels in amplifiers may begin to roll off. Subscribers may find that higher-level signals have degraded pictures (increased noise) because the

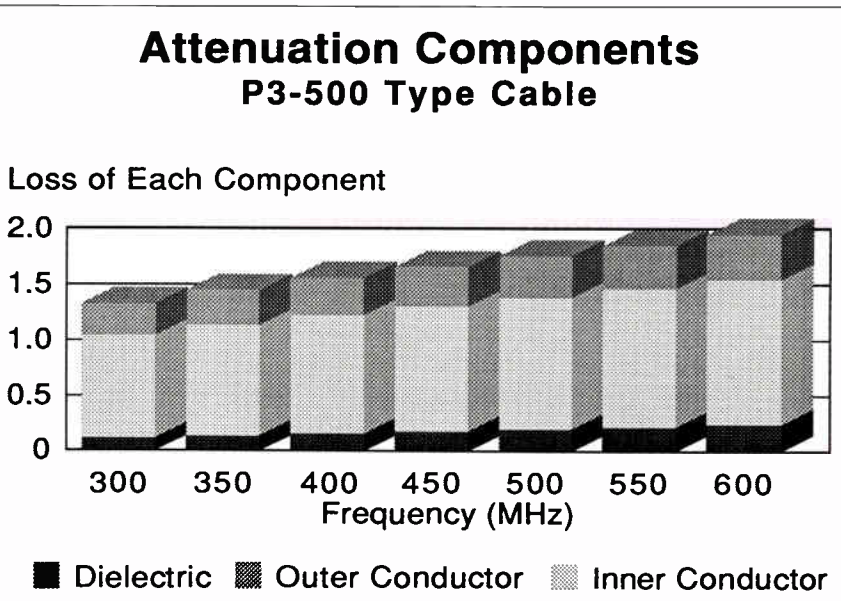

Figure 2

amplifier's AGC or AFT circuits are trying to compensate for the tilt change caused by the decreased high-frequency signal levels at the input of the next amplifier. This will, in effect, create a degradation of the carrier-to-noise out of the amplifier. If the corrosion gets bad enough, the high-end signals will continue to get worse until the office switchboard starts to light up.

In troubleshooting this problem, an operator may try to use a TDR to see if there is a discontinuity in the span. Depending on the degree of the corrosion, the problem may, or may not, be detected.

However, corrosion will probably show up at the connection if that is the moisture ingress point. There have been cases, however, where a cable span had a hole shot in it, providing moisture ingression at mid-span. In either case, frequency roll-off was present and should be an operator's primary test area.

Preventing the problem

Unfortunately, the only solution to this problem is to replace the cable span. The corrosion cannot be removed or compensated for. So the question becomes, "How can moisture ingress be prevented?"

The manufacturer tries to help in several ways. All cable shipped has the end caps installed at the factory. Most manufacturers pack with each cable reel (or make available through customer service) additional end caps for the cable. As the cable is placed in the field, these end caps should be used at each point where the cable is cut and splicing is to take place at a later date.

> As a rule, operators should have installation crews constantly on the lookout for cable ends left unsealed.

Another way the manufacturer tries to help is by providing a sealing material around the inner conductor at the factory. This material can take the form of a chemical coating or or an extruded compound. As a connector is installed, this material is removed to insure a good electrical contact within the connector. It is very important to put the cable connectors on properly. Connectors normally have two or more "O"-rings for moisture protection. If the connector is improperly installed, these O-rings may not seal and moisture may come in through the back of the connector. Some systems use the heat shrink at the connector cable interface. This will also improve the odds if installed properly. If the heat shrink is not sealed all around the cable, this too could provide a moisture path.

The effects of corrosion on your cable system can vary from being annoying to being catastrophic. The best solution is to prevent the problem. As a *rule*, operators should have installation crews and technicians constantly on the lookout for cable ends left unsealed. As the cable is placed on the poles, as amplifiers/taps are being installed (or even in the reel yard), all cable ends should be protected from moisture ingress. ■

WHAT'S AHEAD

SCTE

Following is a list of SCTE technical seminars with contact name. If known, location and seminar topic are listed.

April 4 *Upper Valley Meeting Group* "Construction techniques" presented by Ron Goff of Henkels and McCoy (tentative). To be held at the Holiday Inn, White River Junction, Vermont. Contact Matt Alldredge, (802) 885-9317.

April 7-8 *Razorback Chapter* To be held in conjunction with the L'Ark Show in Little Rock, Arkansas. Contact Jim Dickerson, (501) 777-4684.

April 9 *Central Illinois Chapter* "Headend maintenance." Contact John Heck, (309) 353-8777.

April 9 *Chattahoochee Chapter* BCT/E examinations to be administered. Contact John Williamson, Jr., (404) 376-5259.

April 10 *Great Plains Chapter* BCT/E examinations to be administered. Contact Jennifer Hays, (402) 333-6484.

April 10 *North Country Chapter* "Terminal devices." To be held at the Sheraton Midway, St. Paul, Minn. Contact Rich Henkemeyer.

April 10-11 *Dakota Territories Chapter* "CARS band microwave systems" with Randy Karr of ChannelMaster. Consecutive sessions to be held at the Radisson Inn, Bismark, North Dakota and April 11 at the Ramkota Inn in Pierre, North Dakota. Contact Kent Binkerd, (605) 339-3339.

April 13 *Boulder Dam Meeting Group* Contact Brian Nebeker, (702) 384-8084.

April 14 *Old Dominion Chapter* BCT/E testing, all categories, and installer examinitions to be administered. To be held in conjunction with the Virginia CTA show in Williamsburg, Va. Contact Margaret Davison-Harvey, (703) 248-3400.

April 16 *Florida Chapter, Central Meeting Area* Lakeland, Fla. Contact Keith Kreager, (407) 844-7227 or Pat Skerry, (904) 735-1571.

April 16 *Greater Chicago Chapter* BCT/E examinations to be administered. Contact Bill Whicher, (708) 438-4423.

April 17 *Golden Gate Chapter* "CLI Update." Contact Mark Harrigan, (415) 785-6077.

April 17 *North Central Texas Chapter* "Back to Basics" with Richard Covell of Texscan. Contact Terry Blackwell, (214) 578-7573.

April 20 *Rocky Mountain Chapter* "Distribution systems and distortions," with Richard Covell of Texscan. Other ATC Training Center speakers also slated. To be held at the ATC Training Center. Contact Radiene Watson, (303) 790-7330.

NCTI

The following training courses have been announced by the National Cable Television Institute (NCTI):

April 9 Fundamentals of Supervision Seminar for CATV Personnel, San Francisco, Calif.

April 10-11 OSHA Compliance Seminar for CATV Operators, San Francisco, Calif.

May 7 Fundamentals of Supervision Seminar for CATV Personnel, Boston, Mass.

May 8-9 OSHA Compliance Seminar for CATV Operators, Boston, Mass.

For more information on NCTI's new training seminars, contact Michael J. Wais at (303) 761-8554, or fax inquiries to (303) 761-8556.

SIECOR

Siecor Corp. will sponsor a four-day, hands-on fiber optic training program designed for craftsmen and contractors who install, splice and test fiber optic cable. Following are the dates for the program "Fiber Optic Installation, Splicing, Maintenance and Restoration for Cable TV Applications."

April 16-19
May 20-23

For info call (800) 634-9064.

Trade Shows

National Show **March 24-27** New Orleans, La. Contact NCTA, (202) 775-3669. *SCTE Cable-Tec Expo* **June 13-16** Reno, Nev. Contact SCTE, (215) 363-6888.

Cabletelevision Advertising Bureau (CAB) Show **New York City** April 7-9 Contact CAB, (212) 751-7770 Ext. 29.

The CABLE POLL™

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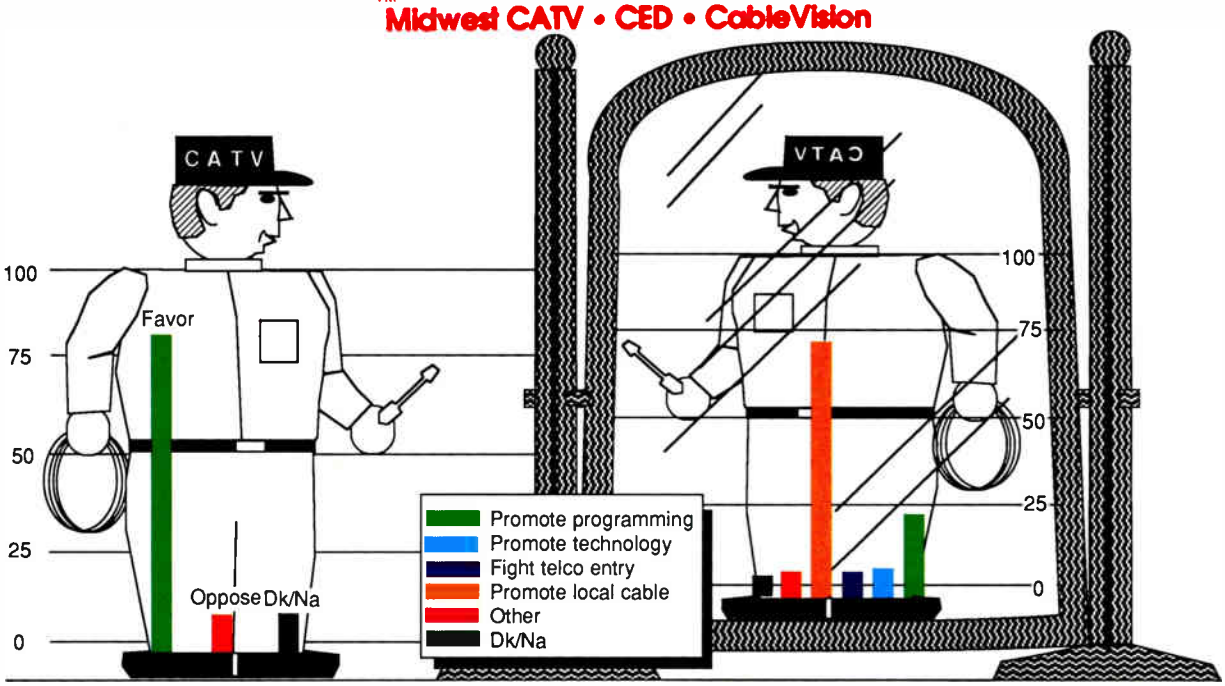
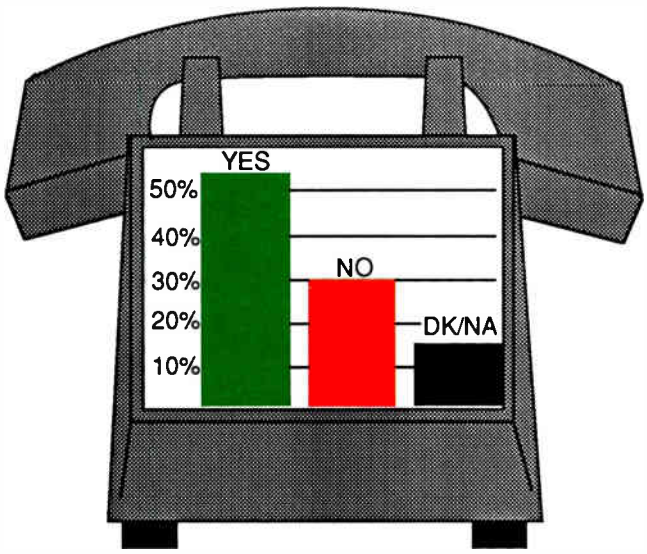
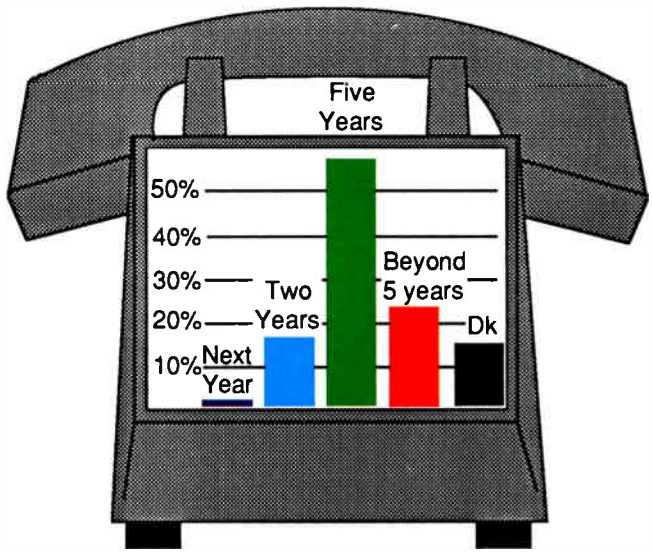


Do you favor or oppose a national image campaign conducted by the cable industry?

What should be the main mission of an image campaign?



Do you believe telcos will eventually be given permission to operate cable systems in their own service areas?



Do you believe they will receive permission within...

Whither cable's image

A move by the NCTA to establish a national image campaign to promote cable television would receive overwhelming support among general managers, especially if the offensive focused on cable at the local level.

According to the most recent edition of Cable Poll, conducted just last month, 83 percent of 400 GMs polled said they strongly favor the creation of a nationwide promotional effort.

Backing was strong in all segments, but mid-sized operations—those with between 10,000 and 50,000 subscribers—were the most avid supporters. By contrast, operators in the West were least likely to ratify an educational effort.

Managers were vocal about where the campaign should concentrate. More than 63 percent said they believed strategies should center around local efforts; only 20 percent said cable programming should receive the spotlight. This relatively low total probably reflects the notion that National Cable Month already provides programmers with national attention. The remainder divided up their responses saying strategies should revolve around promoting technology or fighting possible cable entry by the telephone companies.

The endorsement of plans to boost cable's image mirrors two key concerns. First, many GMs say they believe cable will likely be subject to new federal rate regulation in the near future.

Secondly, a majority also say they believe telephone companies will get the green light to operate cable systems in their own service areas. The figures:

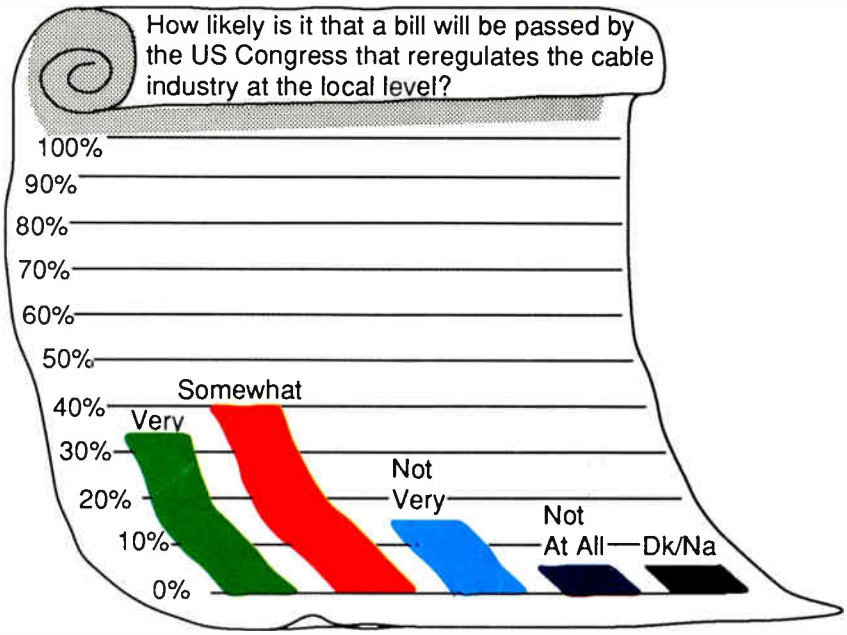
- Regulation: Three out of every four system executives say it is either very or somewhat likely that the U.S. Congress will re-regulate basic rates in the near future.
- Telco entry: More than half say telephone companies will receive the go-ahead from the courts to compete with cable. Almost 20 percent think the green light will be given with the next 24 months.

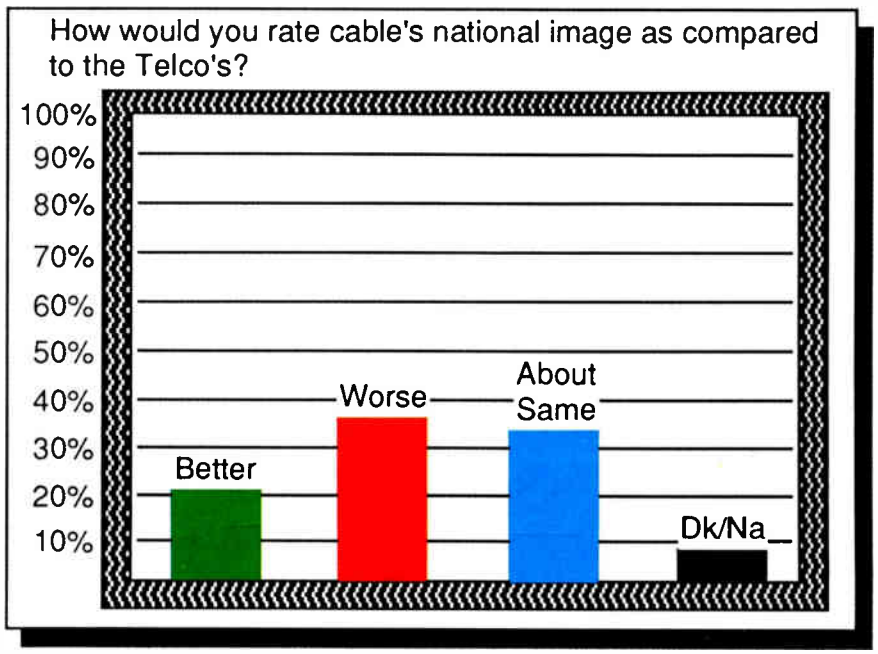
A cable-orchestrated public relations offensive wins approval from GMs for another key reason, directly related to the telco question. More than a third—37 percent—say that telephone companies enjoy a better image among consumers than does the cable industry. Only 21 percent give the nod to the cable industry, while 34 percent think cable's national image is no better or no worse than the telcos'.

Even if system executives demonstrate concern about consumer and legislative perceptions of cable, they are far less worried about how well industry trade groups perform as they represent cable before federal lawmakers.

Indeed, 85 percent of the Cable Poll sample said groups such as NCTA and CATA rate grades of either excellent or good when it comes to telling cable's story to congressional representatives.

Of those who are less enamored of these organizations' strategies in Washington, most—31 percent—felt the trade groups weren't aggressive enough. Another 15 percent said they believed national groups were too parochial, while the remainder had a number of other, undisclosed, reasons. ■





No question, fiber has 'arrived'

If anyone needed conformation that fiber optic technology has "arrived" for cable-television use he need not go any further than the 1991 Optical Fiber Conference in San Diego. While the confab, sponsored by the Optical Society of America, IEEE's Lasers and Electro-Optics Society and IEEE's Communications Society, remains largely a highly scientific discussion of breakthroughs at the component level, several CATV engineers were highly vocal about fiber's use in system applications.

Leading the charge were Jim Chiddix and Walt Ciciora from American Television and Communications as well as Alex Best of Cox Cable. Vendors like Synchronous Communications, American Lightwave Systems, Corning Inc., Jerrold Communications and Scientific-Atlanta were also on hand to hear (and in some cases present) the latest about 1550 nm video transmission, fiber amplifiers and coherent transmission schemes, to mention just a few of the subjects covered.

Conference organizers purposely attempted to steer the conference in a more system-oriented direction and invited CATV and telco voices to help component engineers understand the needs of those industries. Through Chiddix, Ciciora and Best, listeners were given a picture of CATV fiber deployment today as well as future plans. In fact, the cable industry presented a clear, understandable evolutionary migration path toward a hybrid fiber/coax delivery mechanism capable of transmitting voice, digital pay-per-view and HDTV and just about anything else anyone wanted to throw at it.

Chiddix opened the conference by outlining his six-stage evolution toward a high-speed, high-capacity, two-way delivery network offering a mix of analog and digital services that combines fiber's virtually unlimited bandwidth with video compression to provide perhaps 1,000 channels of video.

The scenario calls for evolution from today's upgrade of coaxial-based trunks to fiber as operators move to 550 MHz capacity to switched-star architectures driven by new demands for voice and data provision. Stage 3 of Chiddix's vision calls for increased office and operational automation, including an electronic program guide. Stage 4 takes cable systems to 1 GHz bandwidth, vastly increasing the number of channels available for PPV and HDTV. The next stage moves cable operators into near-video-on-demand, made possible by channel capacity leaps via digital compression. The final stage adds media storage capability, switches and fiber into the neighborhood. By then, cable networks deliver a full complement of video, data, voice and information in an interactive environment.

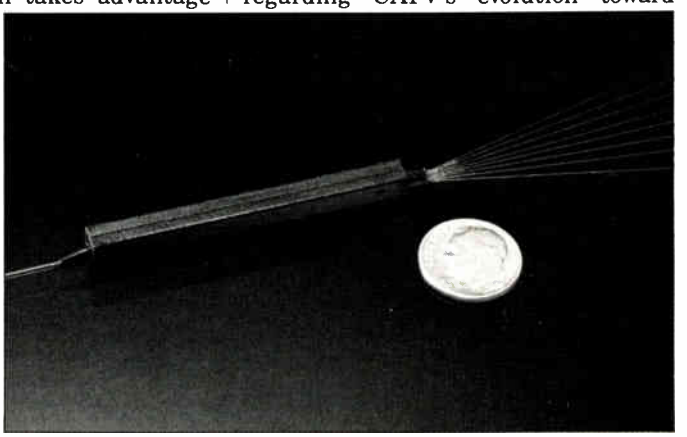
Chiddix's presentation was virtually a replication of one he delivered in early January at the SCTE's Fiber Optics '91 in Orlando. However, Chiddix's slides were updated to show microcells—the foundation of the emerging wireless personal communications networks—located near the fiber termination points.

Chiddix was careful to point out that this migration path takes advantage of emerging technology only when it makes economic sense—and provides a method of payback as enhanced services strike a chord with subscribers. While Chiddix was unsure of when the various stages of evolution would take place, he closed his speech by predicting that CATV would have installed "several hundred thousand" fiber links by the end of the decade, consisting of perhaps 2 million fiber miles.

Alex Best drove home Chiddix's point when he led a tutorial session on "Fiber Optics and Cable TV." An audience consisting of several hundred component manufacturers and equipment vendors heard Best explain the basics of CATV and how the rules are changing with the advent of fiber optics.

Best illustrated the benefits of all-fiber trunking via the Cox San Diego and Ocala, Florida systems—which are in the midst of rebuilds that employ fiber in their foundations. For the benefit of the largely non-CATV audience, Best explained the cost/benefit tradeoffs associated with fiber. In addition, Best noted that "The ultimate fiber deployment scheme appears to be fiber to the feeder" and explained what Cox was planning for its Spokane, Wash. system. Essentially, that system will end up with a star-bus topology that provides a highly reliable, headend quality signal to every home. And with the system segmented into 2,000-home areas, the ability to implement a PCN seems to be inherent, Best said.

The final piece of the puzzle was placed when Ciciora reiterated fiber's economic benefits for cable operators and the quality benefits fiber provides to the subscribers. Speaking during a nighttime panel session on "Video opportunities in fiber optics," Ciciora amplified Chiddix's earlier comments regarding CATV's evolution toward digital switched networks.

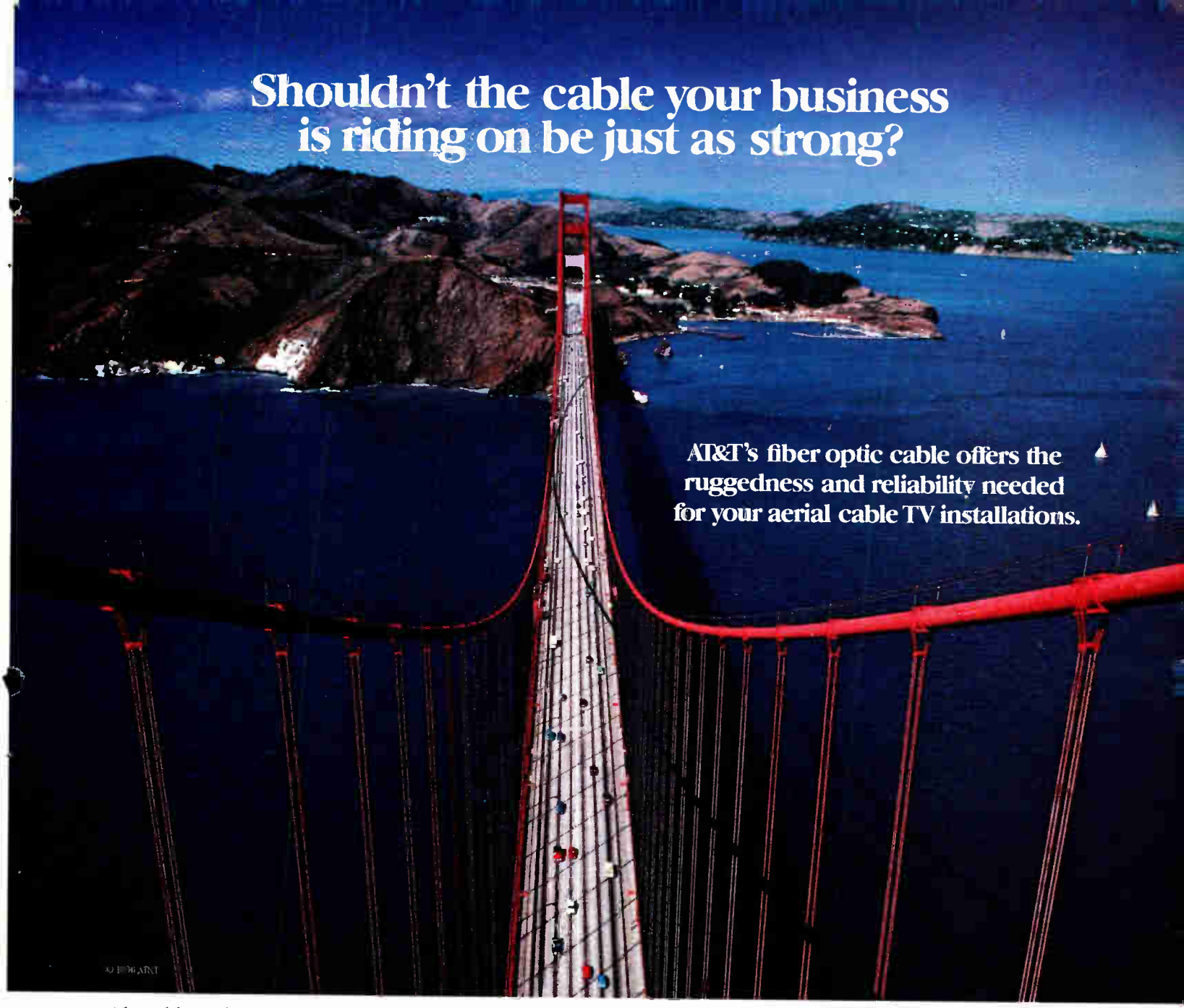


Corning's new miniature 1x8 achromatic coupler

Product announcements

Corning, Inc. has announced what it calls the "market's smallest 1x8 coupler," less than one-hundredth the size of conventional products. The new size makes it an "ideal fit" for passive optical network local loop architectures. However, company officials say, the coupler is also suited for cable television distribution. The device is 56 millimeters long and equipped with pigtails of fiber with a 250-micron acrylate coating. The coupler's small

Continued on page 106



The cable you're installing now may seem great today, but how's it going to hold up against tomorrow's heat? And the ever present gnawing by nature's pests? Install AT&T's fiber optic cable and you won't have to worry.

That's because all AT&T fiber optic cable is designed to withstand harsh temperatures, rodents, lightning, and a host of other environmental stresses.

Take a look at our LXE family of lightguide cable. Available in multiple sheath designs, each is made with a high-density polyethylene jacket to resist abrasions—making it easy to pull and inexpensive to install, too.

The LXE also allows for easy end-prep and midsheath entry. Rip cords lie beneath the jacket and armor, to allow for entry without damaging the fibers.

AT&T's fiber has the smallest mode field diameter of any standard single mode fiber available. Light stays more tightly confined to the fiber core, providing outstanding transmission performance—at both 1310 and 1550 nm.

And our D-LUX™ 100 coating offers excellent stripability, static fatigue performance, and aging characteristics, for superb splicing capabilities.

You'll find, too, that all our fiber optic cable is backed by the design expertise and technology of AT&T Bell Laboratories.

For more on cable that's at its best when the elements are at their worst, call AT&T at **1 800 344-0223, ext. 223.**

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Reader Service Number 51

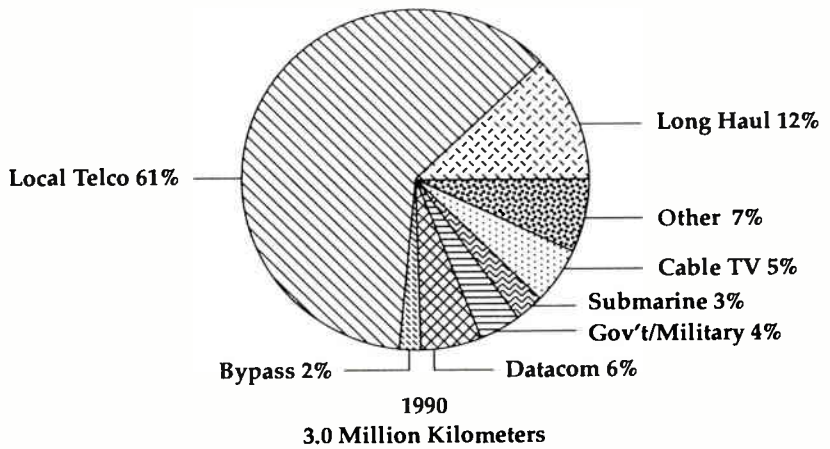
Fiber market continues to soar

Corning Inc. officials were all smiles at its 10th annual media briefing, held at the Optical Fiber Conference in San Diego.

The smiles were appropriate, considering the news Corning brought with it. 1990 was nothing short of an "extraordinary year"with cabled fiber growth driven primarily by unexpected growth in industry and technology, Corning executives said.

Worldwide, the market for optical fiber has doubled since 1988 (from 3.5 million kilometers to roughly 7 million kilometers sold in 1990). To meet the need, Corning and other manufacturers have increased their manufacturing capacities. Corning itself has increased capacity twice in 18 months, each resulting in a 50 percent increase in supply capability.

North American Cabled Fiber
(volume by application segment)



Source: Corning Inc.

In North America, the appetite for fiber grew 20 percent, with growth coming in all market segments identified by Corning. The largest segment, local telephone companies, accounted for more than 60 percent of fiber sales and was driven by telcos installing fiber in their feeder networks.

But the CATV market segment was the growth leader, closing out 1990 with a 60 percent growth in fiber consumption over 1989 numbers, according to Corning figures. Despite the late-year slowdown, fiber sales were driven by threatened competition from DBS and others; possible re-regulation; and fiber's reduced maintenance costs.

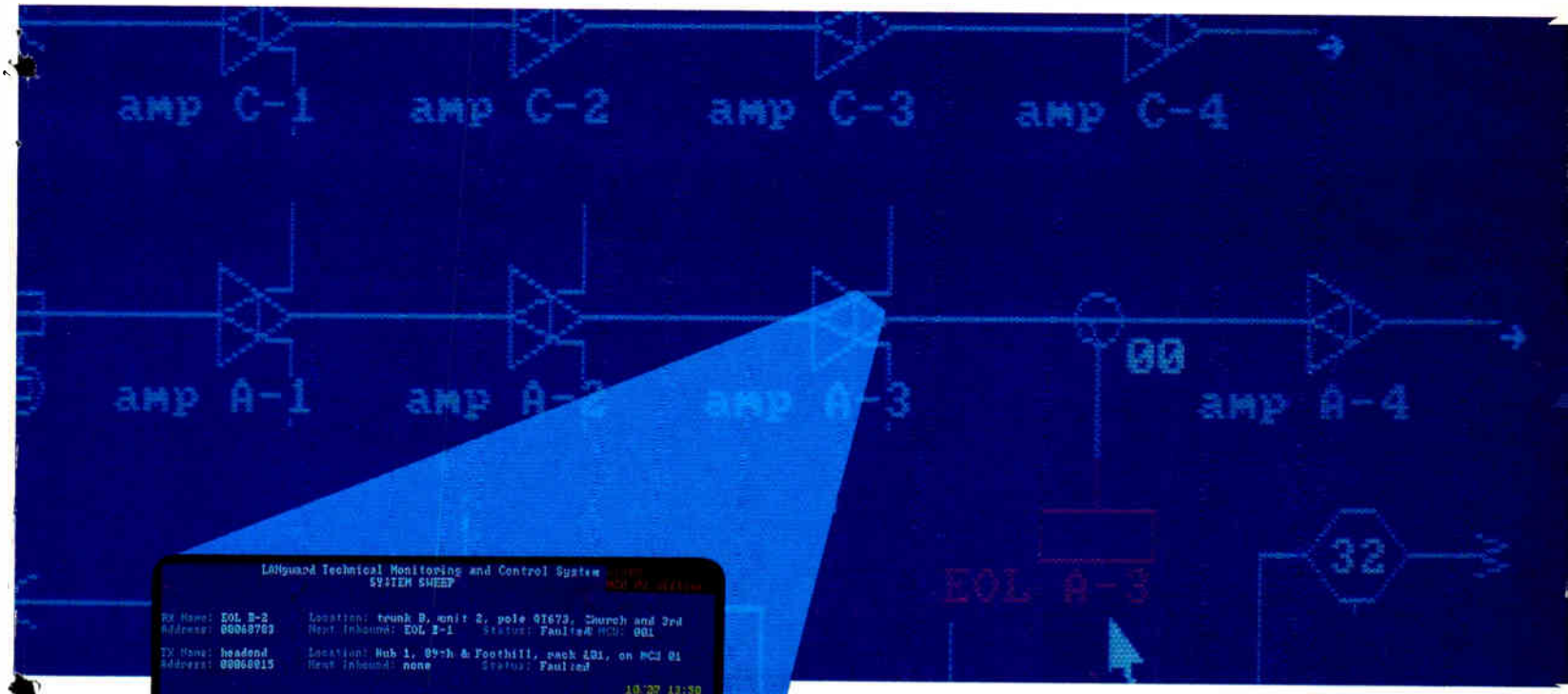
In 1991, Corning executives forecast continued growth for the North American market, ballooning by perhaps another 25 percent (for a total of more than 3.5 kilometers). Also, the growth is projected to continue into 1992 "and beyond," said the Corning officials.

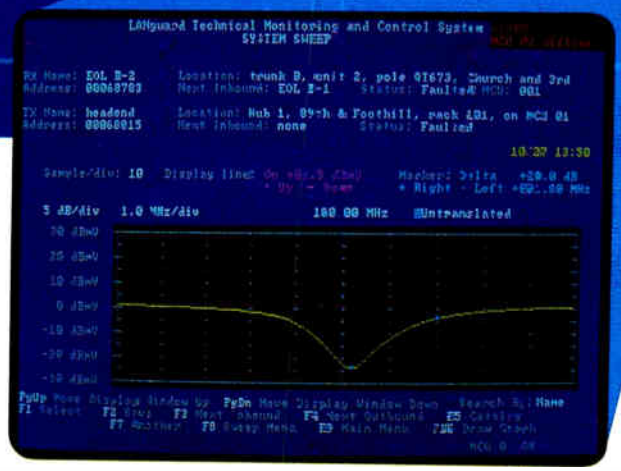
> The CATV segment was the growth leader, closing out 1990 with a 60 percent growth in fiber consumption.

Growth in the CATV market specifically, is forecast to outpace all other segments, doubling in size by 1994 (to 155,000 kilometers). At that time, CATV could account for as much as 10 percent of the entire North American fiber market.

—Roger Brown

Pinpoint Potential Problems *Before* They Happen...





Actual screens from the LANguard™ system depict topology and sweep analysis displays.

...With LANguard™ Status Monitoring

Using LANguard™ can mean the difference between facing irate subscribers due to prolonged service down time and having satisfied customers enjoying quality reception with minimal interruptions.

LANguard's™ ability to spot trouble before it becomes a problem is due to its many sophisticated, yet easy-to-use features including:

- ❑ Support For *All* Amplifiers and Power Supplies
- ❑ Auto Sweep and Spectrum Analysis
- ❑ Agile Frequency Monitoring
- ❑ Ability To Monitor Multiple Systems Simultaneously

plus much more...all without interrupting your signal.

With regulation on the horizon, you realize the importance of service excellence...and you can see the savings potential that comes with knowing exactly where breakdowns occur. More importantly, you have the peace of mind knowing that you can catch problems before they occur as LANguard™ watches each of your signals in relationship to the specifications *you define.*

LANguard™ status monitoring has a proven track record with many large corporations that depend on their network's integrity (downtime can literally cost them thousands of dollars *per minute*).

If you would like this kind of quality assurance for your CATV system, call us at (215) 536-1354 today. A FREE demo diskette is available that shows you, first hand, how powerful and how simple LANguard™ is to use for status monitoring excellence today... tomorrow...and for many years to come.

AM is vendor independent, providing components for virtually every CATV configuration.

Reader Service Number 56

AM Communications, Inc.
1900 AM Drive
P.O. Box 9004, Quakertown, PA 18951-9004
Phone: (215) 536-1354 Fax: (215) 536-1475

size makes it fit easily into a splice tray, and is about the size of a mechanical splice. Specifically, the small size of the coupler facilitates its use in crowded fiber-to-the-subscriber (FTTS) pedestals, enclosures and other tight areas.

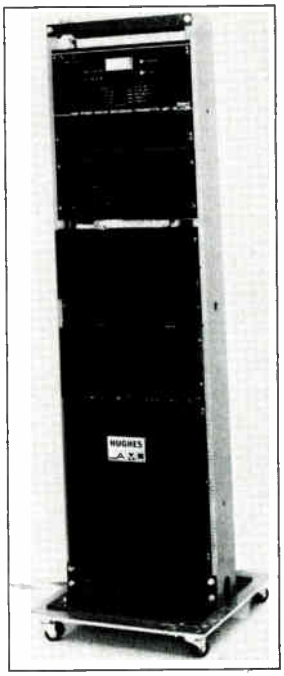
As far as performance, the new 1x8 coupler performs with "low and level losses" within the entire range of single-mode operating wavelengths (850 nm, 1310 nm and 1550 nm). Power splitting between ports of the achromatic couplers remains stable over each of the three passbands, so that extra power is not required to compensate of inconsistent output. For more information on the new coupler, contact Corning at (607) 974-9000, or fax inquiries to (607) 974-7522.

The **Exeltech Corp.** of Fort Worth, Texas has announced the introduction of its new SI-250 Power Inverter. The most significant feature of the SI-250 is that it supplies a true sine output, as opposed to quasi-sine wave output, explained Exeltech president Gary Chemelewski. The unit has a peak current capability of six amps, which gives it the ability to power non-linear, electronic or highly reactive loads—such as electric motors, computers and

Exeltech Corp.'s SI 250 power inverter

test equipment. The SI-250 also features sophisticated protection circuitry as well as precise line and load regulation, which makes it "immune" to damage by overloads, short circuits, over-temperature or input polarity reversal, company officials attest. Compact in size, the SI-250 is 3.5 inches by 4.5 inches by 9 inches and weighs 3.5 pounds. For more information, contact Exeltech at (817) 488-1444.

Hughes Aircraft Company has received FCC approval for the latest addition to the Hughes Aircraft Company's family of AML solid state broadband transmitters, the HIBT-118. Utilizing high-power FET amplifiers and unique microwave circuitry, the new Hughes transmitter is a high-power version of the previously released IBBT-116. It comes close to equaling a single output of a traditional channelize high-power AML unit, company officials say, but at a considerably lower cost and reduced power consumption.


Hughes' HIBT-118

Traditional local distribution and clustering services can be provided by the new broadband transmitter, located in a headend, without towering-mounting any amplifiers or other active devices. The transmitter includes a pilot tone for system phase-locking and

AD INDEX

a transmit monitor for monitoring and maintenance.

Also, the HIBT's +62 dBm third-order intercept point allows its output to exceed by five dB the performance of the IBBT-116, a performance equal to that of a 200-watt system. The inherent flexibility associated with the broadband 1-to-80 channel system, coupled with increased power, provides for supertrunking applications in excess of 20 miles. For more information on the HIBT, contact Hughes at (213) 517-6233.

New from Britain-based **J.P. Micro Services** is an infrared remote control tester, the RXT-2. The unit is designed for use by bench and field engineers, and detects infrared beams, tests continuity and includes a self-test mode to check the state of its internal batteries.

In the infrared mode, the instrument detects static and modulated beams. Its

Industry faces

Claude Olier has been named VP-European operations for **Scientific-Atlanta**. Olier will be responsible for the strategy, organization and growth of Scientific-Atlanta products. He will also be responsible for the company's European subsidiaries in the United Kingdom, Italy, Spain, France and the Netherlands. Before joining Scientific-Atlanta, Olier spent 13 years with Dynatech Corporation, again involved in European activities.

Claude Olier

Sachs Communicationshas announced three promotions. Denver-based **Radiene Watson** has been promoted to sales manager, and will be actively responsible for bringing product awareness and sales support to Sachs-qualified distributors. Also in Denver, **John Schonewill** was named director of marketing and sales. **Sam Wells** was named national technical director for Canada and the U.S., and will oversee the application and training of the company's hardware system in the international market.

Jay W. Carter

At **AT&T**, **Jay W. Carter** was named network cable systems VP for copper apparatus and electronic wire and cable business units. Carter will be located at AT&T's Omaha manufacturing facility. Previously, Carter was AT&T's regional VP for the central region.

David Fibush

David Fibush of **Tektronix** has been appointed SMPTE (Society of Motion Picture and Television Engineers) western region governor after having been involved in the organization since 1978. Meanwhile, **Dave Walters**, district sales manager for **Tektronix**, was also appointed as SMPTE's southern region governor. Walters has been an SMPTE member since 1976.

Boulder-based **Cable Television Laboratories (CableLabs)** has promoted two staffers and added two new employees. **Stephen Dukes** has been promoted to director of advanced network development. His responsibilities include working on the study of personal communications networks (PCN) and designing the next generation of cable network architectures. **Sharon Gurley** has advanced to CableLab's administrative assistant to corporate service from her previous role as executive secretary. **Craig M. Chamberlain** has been named electrical engineer and is slated to work on advanced television projects. Formerly with E-Systems, Chamberlain has extensive electronics experience and holds a bachelor of science degree in electrical engineering from the University of South Florida. Lastly, **Michael Sandgathe** has been named senior electronics technician and will be working with the CableLabs headend and its laboratory facilities. Sangathe most recently worked with Scripps Howard Cable in Longmont, where he was chief technician.

General Instrument Corporation's VideoCipher Division has announced the appointment of James L. Faust to the role of VP, international and special programs. Faust will direct and continue the development for the VideoCipher line for international markets, with a major focus on DigiCipher system introduction abroad.

sensor is placed roughly two inches in front of the emitter of the remote control unit, which is then operated. Modulated infrared produces a clicking or chirping sound on the RXT-2's speaker, and also causes a light-emitting diode (LED) to flash. Steady infrared causes the LED to light continuously. For more information on the RXT-2, contact JP Micro Services at Unit 5, Church Ward Estate, Barrs Court Road, Hereford, England, HR1-1EN or phone (international) at 44-432-356353.

Fiber announcements

Photon Kinetics has introduced its

Photon Kinetics, Inc.'s 4000C HiRes OTDR

new Model 2400-CTG Fiber Coating Geometry Option. The optional module performs transverse-view coating geometry measurements when used with Photon Kinetics Model 2400 Fiber Geometry System.

With the Model 2400-CTG, manufacturers of optical fiber can measure the diameter and concentricity of both the fiber and two coating layers, and then display the results in less than one minute.

Also new from Photon Kinetics is the Model 2500 Fiber Analysis System. The unit performs automated, repeatable measurements of single and multimode fiber parameters. Single-mode tests include spectral attenuation, numerical aperture and core diameter. Pulse bandwidth and differential mode delay options are also available. All measurements are performed in accordance with EIA and CCITT standards to ensure industry-wide compatibility.

Lastly, Photon Kinetics has announced availability of its Model 4000C HiRes OTDR. The Model 4000C incorporates Photon Kinetic's patented electronic masking capability with automatic mask placement for "greater ease and reliability in the installation and verification of optical fiber links," company officials attest. A family of plug-in optical modules are also available for use with the 4000C, including a dual wavelength 428SC, which has a four meter dead zone and a 20 meter attenuation dead zone. The new OTDR also includes a loss table, which enables cable television users to automatically locate features in a fiber, measure splice loss and cumulative loss, and compile this information in a table.

For more information on any of these three new products, contact Photon Kinetics at (503) 644-1960, or fax inquiries to (503) 641-5614.

New from **Plastic Techniques, Inc.** is the 9TB aerial lift box, with both tool box and brackets constructed of lightweight, durable polypropylene. Designed to fit in a variety of aerial lift buckets, the lift box offers five inches of storage space under a lift out tray. A draw-bolt type latch secures tools. The box is designed to hold 20 pounds of tools. For more information, call (603) 645-6800, or fax inquiries to (603) 623-0918.

Two new products are available from **Sachs Communications**. The first, the SC51 meter panel connector, is designed to provide a means of bonding the sheath of the cable television drop cable to the metallic frame of a meter panel when alternative NEC bonding is inaccessible.

The SC51 allows a fixed and positive mechanical contact without interfering with the opening of the meter panel front cover.

Applications include underground installations where the number six copper wire is inaccessible or the conduit is PVC, aerial installations where utility companies will not permit bonding to the mast or riser and wherever alternate NEC bonding is inaccessible or cold water pipe has PVC in the system.

Also new from Sachs is the SC053 aluminum cable tie, designed to support coaxial drop cables on strand, in the pedestal, in the lock box or along the wall in single family units and MDU applications.

The tie is manufactured of malleable aluminum, fire retardant, and can be used over, thus reducing the costly cutting and reinstallation plastic ties. The tie will not kink or crush the cable, eliminating the chance for sheath or dielectric damage, company officials say, and is available in seven inch (SC053-1) and ten inch (SC053-2) sizes. For more information, contact Sachs at (800) 829-SACHS, or fax inquiries to (303) 790-7343.

—By Roger Brown and Leslie Ellis

Continued from page 89

The on-air look

Upcuts, rolls, mispositioning, black, noise, wrong video, make-goods and others are all terms operators want to eliminate from their vocabulary. They can start this process by:

- Scheduling periodic preventive maintenance visits by an authorized dealer to assure that editing equipment and playback decks are consistently operating at peak performance.
- Using fresh, high-quality tape in editing and playback systems.
- Assuring that all feeds to insertion equipment are periodically inspected and proper levels are maintained.

By ensuring that an editing suite is in proper specification, that tape decks are well maintained and that video tape is fresh and of good quality, the on-air look can be improved. Operators should also demand that all networks provide consistent and accurate pre-rolls.

The answer to providing an on-air look that is comparable to broadcast is an eventual switch to optical disc. With frame addressability, faster start-up (little pre-roll required), blink black switching and a media that has a longer on-air life with little degradation, operators can take a big step toward providing a professional on-air look.

Timely, accurate information

Once again, a successful traffic operation must have the right people assigned to it. Be sure they are well-trained and understand all the capabilities of their system. Accuracy can only be assured by checking and re-checking.

Ongoing development will present the next level of trafficking sophistication. Operators can expect to see more accurate, detailed and summarized reports, dynamic scheduling and on-line remote order confirmation. Networking abilities will be increased and mainframe interface will be improved to allow for faster number crunching. Management inquiry terminals will allow for dynamic on-line overviews of certain functions of the trafficking operations. Truncation (elimination of paper) will become a familiar term and methods to further reduce human error will be introduced. ■

This article was adapted from a presentation made at the 1990 Great Lakes Cable Exposition.

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'What is video quality?'

As cable matures and as other video delivery media and formats proliferate, the need to deliver "quality video" will increase. Quality is a very subjective thing. Some aspects of it, such as resolution, brightness, contrast, can be objectively measured. Factoring these measurements into the total quality score is all but impossible.

Other factors

I find I have difficulty judging video quality when watching real video. I tend to get wrapped up in the program. This is especially the case if the program is an action movie. I must force myself and keep reminding myself that I'm to watch the video, not the program.

There are other factors which tend to be neglected in the analysis of video quality. Outages are a serious issue. The most perfect image fails to please when it disappears. A reliable picture of lower image quality might be preferred by the subscriber. There are other irritants which build up a background of intolerance: the problems with the consumer electronics interface, remote controls, inability to use the VCR, long waits for telephone answers, confusing bills. Factors such as these predispose the subscriber to be unhappy and intolerant of image quality problems.

It is important for the video engineer to recognize that perfect video may cost more than the subscriber is willing to pay. Price is a critical component in total satisfaction. From another perspective, resources are always limited. Money spent on improving the image is not available for other improvements, for example: better sound. A balance is required.

Video tape and video disk

A large fraction of viewers really like the pictures they get from video tape. This is in spite of the fact that the pictures lack resolution and are often a bit noisy. However, there are no ghosts, co-channel, ingress, or beats. I think the reason is that loss of resolution and noise are "natural" phenomena. They are part of life's every day viewing experiences. We never see co-channel or composite triple beat while looking out the window. When we see such impairments in a picture, they stand out and are particularly objectionable.

The role of sound

Tests at MIT and HBO, among others, have demonstrated that sound quality plays a role in our impression of video quality. Viewers were shown two video displays built out of essentially identical components. One display was accompanied by relatively poor sound while the other had noticeably better sound. Viewers consistently rated the picture with the better sound as having superior image quality.

The first broadly available exposure to a new variety of video artifacts has been through Improved Definition Television (IDTV) receivers. IDTV attempts to provide better pictures through signal processing in the receiver. The transmitted signal remains essentially unchanged. The source of the new impairments is the digital signal processing used to "improve" the picture. Indeed, resolution has been improved. Flicker was reduced. But the picture generally looked worse. The images contained little squares on edges. The squares multiplied when the edges moved. The appearance was very un-natural and somewhat disturbing. Attempts to reduce noise as measured by test equipment actually made the noise more objectionable. Instead of a fine background noise, the noise became grainy and appeared in large clumps. The noise measuring instrument was pleased, but the eye was not.

By now most of us have seen High Definition Television (HDTV). Most of the demonstrations were done with full bandwidth (30 MHz) or reduced bandwidth (15 MHz to 20 MHz) uncompressed video. If we've seen some of the early attempts at reducing the bandwidth to 12 MHz or 6 MHz, we were appalled to see the horses' legs disappear as the horse turned the corner during a race. Our eyes were offended when text became unreadable while in slow motion. Even more objectionable was the way the text snaps into focus once the motion stops. nearly all of the proponent systems are past these stages. Now the artifacts are much more subtle. In most cases, the video has to be carefully studied to uncover artifacts. HDTV should be more intolerant of imperfections than most video because it sells itself as "high."

Compressed video

Compressed video is another matter. It sells itself as "more" rather than as a particularly high standard of image quality. Here, having a large variety of acceptable quality video will be more important than perfection. Judging "acceptable" will be particularly difficult because compression artifacts, as we discussed last month, are very different from what we are accustomed. Much of what I saw in demonstrations of compressed video is easily masked by a good action movie. In a properly designed system, video will be improved over time with better algorithms in the encoder along with more powerful encoding computers.

The difficult question is how good is good enough? Is this a question whose answer depends on the nature of the programming being watched? Is this an answer that changes over time? What is good enough this year may not be good enough half way through the hardware's service life. How do we compare the "quality" of compressed video with NTSC and then with HDTV? Will the presence of HDTV on a cable system "spoil" the subscriber for anything less than perfect?

Fortunately, cable systems are rebuilt continuously. The best technology at the time of rebuild will be used. A few years later, newer technology will be used in the systems upgraded at that time. The introduction of these new systems will not happen all at once. ■

By Walter Ciciora, Vice President of Technology, American Television and Communications

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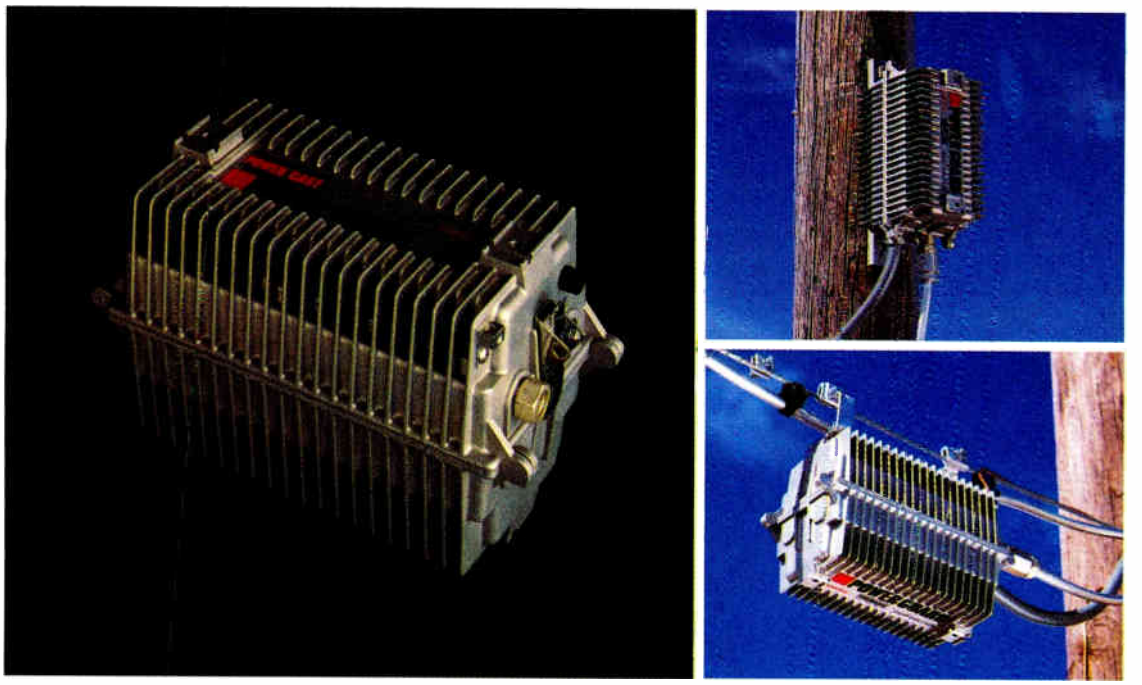

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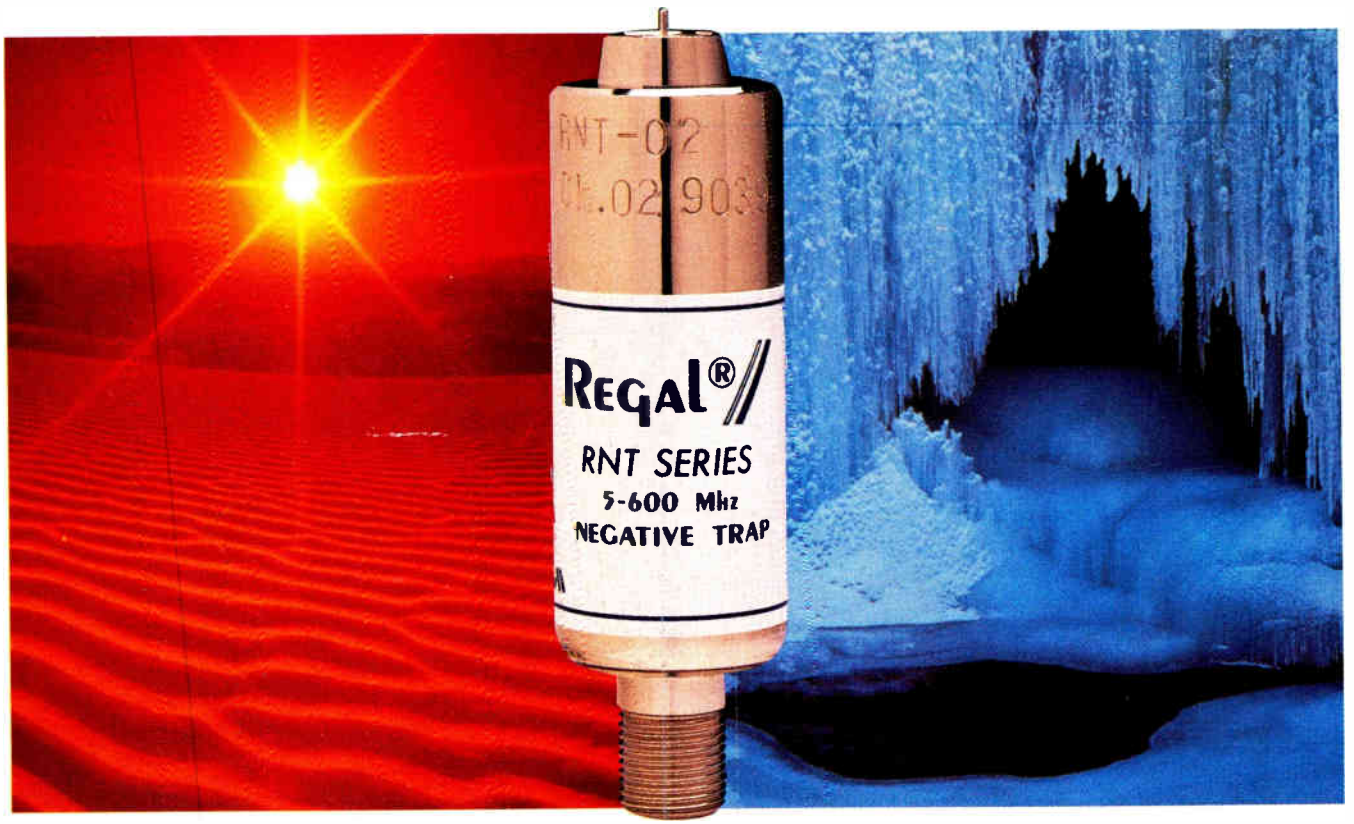

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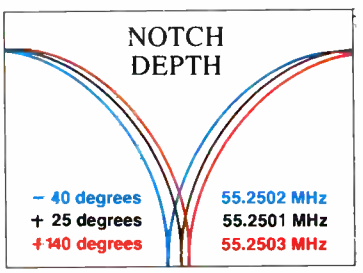

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