THE PREMIER MAGAZINE OF BROADBAND COMMUNICATIONS

CED

MARCH 1998

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Reader Service 1

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Reader Service 2

in perspective

Technology as a business

Welcome to the third edition of the new-look *CED* magazine. We hope you're enjoying the improved aesthetics of the magazine as much as we are creating it and presenting it to you. We've added more color and more graphics. We've opened things up to make them easier to read. We compartmentalized the content to make things easier to find.

In many ways, though, we really haven't changed anything, with one exception. We're now spicing many of our stories with a dash of "business." Why? Because we've recognized what most people in the industry are also coming to understand: that technology and technologists don't reside in a vacuum. Technology doesn't exist for technology's sake alone; there has to be a reason to deploy it, or even the most inventive products will never see the light of day. It's important that you, the reader, understand how technology can be implemented in a way that either saves you money, makes you more efficient, or derives new revenue for your company.

We've recognized that technology and business issues are inextricably intertwined

ROGER BROWN, EDITOR

A case in point: Recently, I received an e-mail from a small cable operator in the Midwest. This person runs a 300 MHz semi-rural cable system that's contiguous to a good-sized Time Warner system. The 10-mile plant is 15-years-old, and the population in the franchise area is growing at least 10 percent per annum. This person wanted to know if there was an article that explained when it was "right" to rebuild.

A pure technologist would say that it is absolutely time to rebuild because that plant is technologically obsolete. But an *enlightened* technologist has to factor in some economics, too. Would anyone advocate a complete rebuild if additional revenue wasn't part of the equation? Doubtful. So, I wrote back, explaining that cable plant hardware can be made to last a long, long time. But if the company was interested in delivering high-speed data, pay-per-view, digital video or any of the emerging technologies in order to compete and bring additional revenue, I said an immediate rebuild to 750 MHz could be justified by these new opportunities. With only 10 miles of plant and nearly 1,000 customers, the business case looks pretty strong to me.

Those are the kinds of stories we intend to bring you in *CED*. Sure, we'll continue to cover technology just as we always have. That will never change. But we're going to bend over backwards to put technology into a context that will help cable operators understand how they can use it to improve their business.

What do you think? Are we on the right track? Pick up the telephone and give me a call, or drop an e-mail to me at RBrowner@aol.com. I'm interested to hear how we can best serve you and provide the information you need to do your job better.

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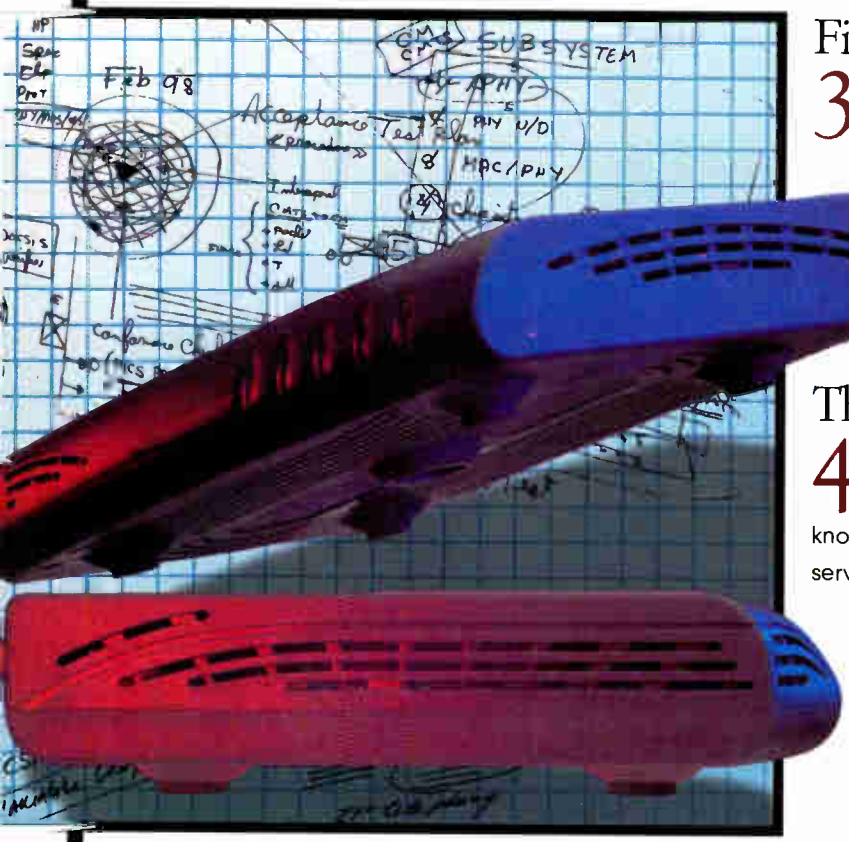
MARCH 1998



Finding data spec growing room

 While the MCNS/DOCSIS has been designed with elbow-room to accommodate new services, operators should begin planning ahead for key Quality of Service extensions to allow for a smooth response to future applications.

The HI_PHY effect

 Several high-capacity modulation methods known as "HI_PHY" may allow operators to plan for future services now, perhaps without paying a cost penalty.

Manhandling interoperability

 The whole megillah of creating interoperable cable modems that can be sold in retail stores is a collaborative effort that represents a milestone for the cable industry's technical community. Now that the process is almost finished, what are MSOs and vendors thinking?

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MARCH 1998

Fiberline

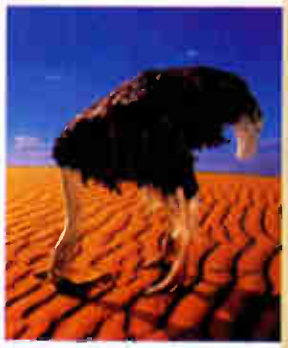
52 Crafting a low-cost upgrade. Traditional cable plant upgrades may not fit the bill when it comes to introducing new, two-way services. Executives with AT&T Labs–Research describe an alternative approach using mini-fiber nodes.

Industry's praise shines on Williamson. Time Warner's Louis Williamson wins the prestigious Polaris Award.

Advanced Networking

72 Digital, data hot issues at Emerging Tech. The SCTE's recent Emerging Technologies conference offered the industry's technical personnel tips on how to construct a digital platform to support new service offerings.

Are operators ignoring the capacity crunch? New fiber-based solutions for expanding bandwidth could pay off, if operators are willing to explore them.



Broadband Business

88 Cable chasing business market with data services. The technological and operational challenges of capturing the business market for high-speed data services.

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Reader Service 6

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upfront

LATEST NEWS AND INSIGHT

Cable modems hit retail shelves

Following through on one of the visions of the data-over-cable standards process, hardware vendors and MSOs alike are making moves to bring high-speed data modems to retail outlets around the country.

General Instrument Corp. struck first, entering into a deal with computer retail powerhouse CompUSA to stock its SURFboard telco-return cable modems. CompUSA stores in Jacksonville and Miami, Fla. and Encinitas, Calif. will be the first to offer the modem.

MediaOne will support the retail launch, with its MediaOne Express high-speed Internet service in Jacksonville, where the company's network passes 400,000 homes. Adelphia Communications will support CompUSA in Miami, where Adelphia passes 140,000 homes, and the Encinitas store will offer modems to subscribers served by Daniels Cablevision and its I-Net Express high-speed Internet service.

CompUSA will initially carry GI's half-size ISA card. GI plans to offer its first two-way MCNS-compliant SURFboard cable modem in the retail channel by year-end.

Meanwhile, Cablevision Systems Corp. decided to simply buy its way into the retail market by plunking down some $80 million to acquire Nobody Beats the Wiz, a financially ailing East Coast electronics retailer. Cablevision execs said the deal gives the MSO direct access to its 2.5 million customers through the 36 stores the company plans to keep open.

Following the buyout, customers will be able to purchase PCs with high-speed modems already installed, sign up for @Home service, pay their cable bill and order other services.

Time to cast your SCTE ballot

If you're a member of the SCTE, it's time to cast your ballot for the national board of directors. At-large candidates include incumbent Ron Hranac of Coaxial International; Brian James of the TAC Test Centre; and Ken Wright, CTO of Intermedia Partners.

Region 3 candidates include incumbent Norrie Bush of TCI of Southern Washington; George Klenck of Chambers Cable; and Tim Templeton of Thomas & Betts.

In Region 4, incumbent M.J. Jackson of Gilbert Engineering is running against Jim Wood of PPC. Region 5 has current director Larry Stiffelman of CommScope pitted against Dick Beard of MediaOne and Dave Clark of National Cable TV.

Over in Region 7, incumbent Jim Kuhns of Comcast is running against Rich Annabaldi of Pioneer, while Region 8 has incumbent Steve Christopher of Thomas & Betts/LRC going up against Don Shackelford of Time Warner Cable. Region 10 has Wes Burton of MediaOne taking on Chris Huffman of Times Fiber Communications and Dick Shimp of ComSonics. Finally, Region 12 incumbent John Vartanian is looking for re-election against Roger Pience of Watson Technologies and Dan Murphy of TCI.

CableLabs, S-A team on OpenCable

Looking for input from real-world experiences, Cable Television Laboratories Inc. has contracted with Scientific-Atlanta to assist the OpenCable project in relation to system integration of new OpenCable devices and services. This work will help ensure that the individual interfaces specified by the OpenCable project will support an integrated network and set of services.

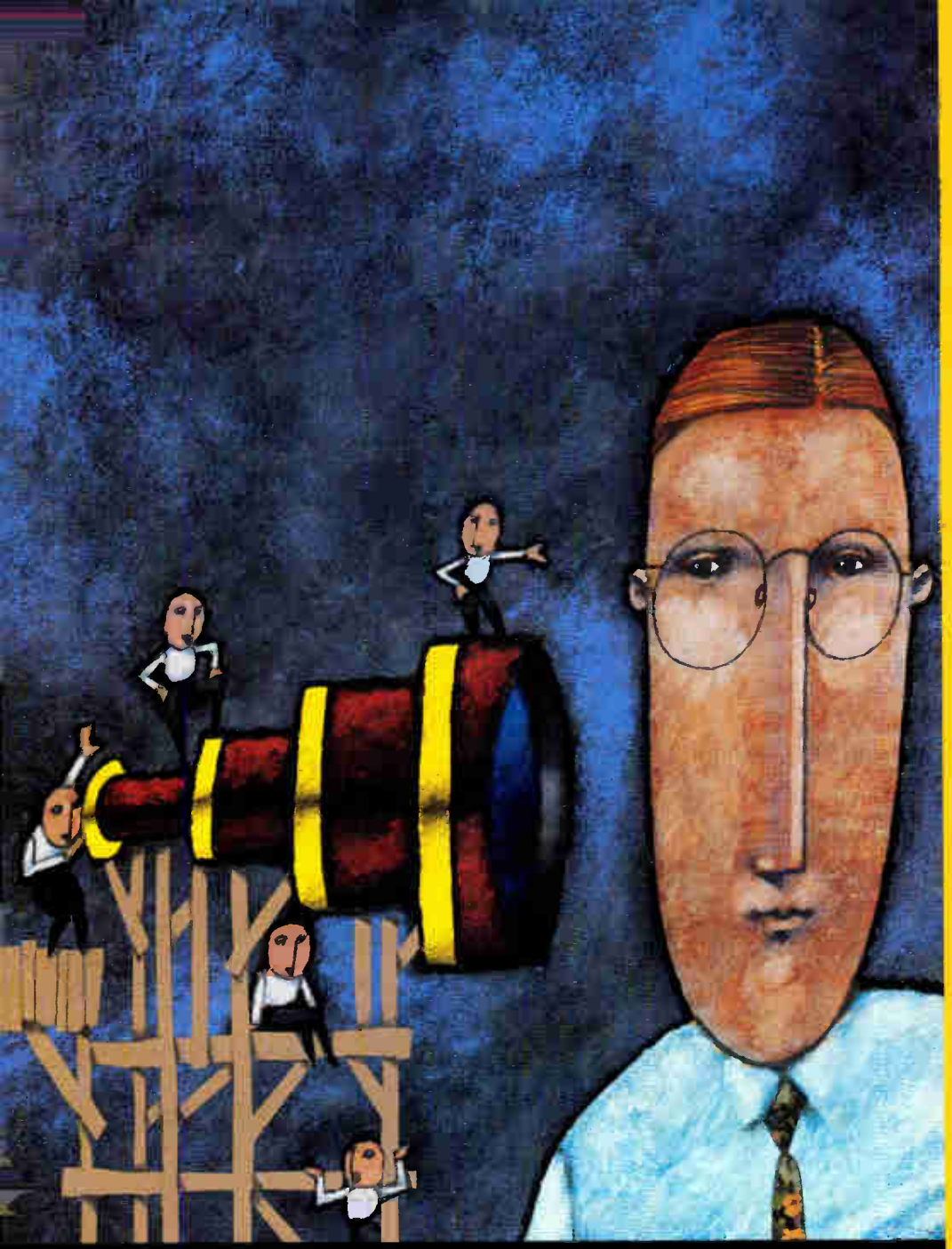
Under terms of the contract, S-A will focus on the end-to-end system integration of new digital services over cable networks.

Further, S-A will produce and document a network architecture reference model; identify scenarios for customer use, billing, and third-party applications; and help define key system/network interfaces, with special emphasis on the physical layer and communication layer interfaces.

OpenCable is a CableLabs-led industry initiative which seeks to obtain and deploy a family of interoperable, advanced digital set-top boxes from various manufacturers. OpenCable seeks to establish specifications for an open architecture to allow for multiple operating systems and microprocessors.

It is anticipated that Scientific-Atlanta will complete its work in the first quarter of 1998, thereby allowing mid-year completion of the OpenCable specification.

S-A was chosen because of its history of integrating technology into interactive TV applications.



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Reader Service 7

upfront

LATEST NEWS AND INSIGHT

New device allows TV shows to be paused

Ever wished you could pause a show you're watching on TV to tend to something? IntelaSync Inc. recently unveiled a technology that lets TV viewers "switch channels" to anything that commands their attention without missing out on their favorite shows.

Shown in public for the first time recently, the technology allows a viewer to put any TV broadcast on hold, then resume watching wherever the show left off. Compatible with all existing TV and Internet standards, IntelaSync technology also features a user-profiling system that paves the way for a new era of television interactivity.

Intelasync executives hail the product as a real breakthrough for interactive TV applications. "Our pause technology offers everyone greater control over the television viewing experience," said Walt Czerminski, president of IntelaSync. "(It) frees you to follow Web links that might appear in a favorite TV show without forcing you to miss the show itself."

Additionally, the technology features a "user-profiling" capability that permits custom delivery of Web content when browsing occurs in conjunction with TV viewing. For instance, by logging which TV shows and Web sites attract a viewer, IntelaSync can help TV producers and advertisers offer that person custom Web content.

IntelaSync technology is available under license for use in PCs and consumer electronics devices.

Relief for the business traveler

Tired of having to move the bed to find the phone plug so you can access your e-mail every time you travel? Microsoft Corp., ATCOM/INFO and CGX Communications Inc. are coming to the rescue as they collaborate to offer high-speed Internet access service for hotels.

ATCOM/INFO's "IPORT" product allows business travelers to access the Internet, e-mail and private networks from their guest rooms, using the hotel's existing telephone wiring. The commercial trials were scheduled to begin in February at approximately 15 hotels, with the system installed in roughly 3,000 guest rooms.

Trying in earnest to stay competitive with arch-rival General Instrument for a major share of the digital set-top box market, Scientific-Atlanta last month announced that nine cable operators have signed agreements to deploy the company's end-to-end digital system that features the Explorer 2000 set-top box.

Joining Time Warner Cable and Comcast Cable as customers are Cox Communications Inc.,

MSOs commit to purchase Explorer units

Adelphia Communications, Marcus Cable, MediaOne, and three Canadian cable operators, which collectively have committed to purchase 850,000 units. The nine operators–representing six of the 10 largest U.S. operators and three of the top four Canadian operators–serve a total of 33.2 million customers.

The Explorer features Internet Protocols, HTML and JavaScript, and is expected to comply with OpenCable specifications. The set-top also features a real-time, open standards reverse-path transmitter, which allows operators to deploy two-way digital capabilities immediately.

Cox plans to deploy the equipment in several of its major systems, beginning in the first half of this year, with deployment to customers in July. Adelphia will roll out in its 165,000-subscriber Buffalo, N.Y. cluster. Marcus plans to introduce two-way digital services in three cities: Glendale, Calif.; Ft. Worth, Texas; and Birmingham, Ala. MediaOne, which is less bullish about digital services, will test market digital video and interactive services in a major system later this year.

In Canada, Rogers Cablesystems Ltd., Videotron ltee, and Cogeco Cable Inc. will also deploy the Explorer this year. The three Canadian cable operators have 4.8 million total customers.

Those MSOs plan to take delivery and installation of Explorer set-tops and digital interactive network equipment for their headends in Toronto, Montreal and Burlington-Oakville (Ontario), respectively, beginning in the second quarter of 1998.

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US West, Ameritech launch ADSL for data

If you think ADSL will never get off the ground, think again. US West Communications and Ameritech, through two different approaches, plan to deploy the service in their service areas over the next few weeks.

First deployed in Phoenix last October, US West executives said the company plans by June 1998 to expand its MegaBit Services ADSL and US West.net Internet access to 226 wire centers, serving 5.5 million customer lines by June.

The ADSL service lets customers maintain a continuous "always-on" digital connection to the Internet or other data networks over a dedicated portion of their existing phone line–with no dial-up required. US West is also incorporating several key upgrades, including NetSpeed's advanced SpeedRunner modem, to provide access at speeds up to 7 megabits per second.

Along with higher speeds, a new "splitterless" technology will allow US West to deploy the service without sending out a technician, while giving customers the ability to connect to their corporate networks by day and the Internet by night. Customers will even be able to link one computer to the Internet and another to a corporate network.

For $19.95 a month, customers receive unlimited Internet access, newsgroup access, two e-mail boxes, two megabytes of personal Web-page storage and 24-hour technical support. For about $40 a month plus installation, occasional Internet or work-at-home users can get 256 kbps access, while telecommuters and smaller businesses with greater bandwidth needs can select a service which provides 512 kbps access for about $65 a month plus installation.

Heavier-use business customers needing more bandwidth and video capability can get 768 kbps access at about $80 a month plus installation.

Atlanta gets dial tone

Cable telephony has come to Atlanta. MediaOne has formally kicked off its local facilities-based telephone-over-cable service in metro Atlanta. The service is being offered commercially to about 1,000 Atlanta-area homes, initially.

The move in Atlanta by MediaOne is the company's first commercial deployment of HFC telephone service in its cable TV markets. The company plans to introduce telephone service in several of its other service areas later this year.

Being in BellSouth's backyard, MediaOne expects fierce competition. In order to attract customers, MediaOne will offer: free installation; number portability; and one telephone line that includes caller ID, call waiting, call forwarding, and speed dialing for $24.75 a month. Other packages of service are also being offered, typically at prices 25 percent less than BellSouth.

MediaOne executives said the company is currently more than half way through a major network upgrade that will continue in its service areas over the next three years.

Meanwhile, Ameritech is partnering with Compaq Computer Corp. to install the equipment needed for ADSL-enabled Internet access into future Compaq Presario personal computers. This means that later this year, customers will be able to purchase select Compaq Presario computers and have them configured by some retailers in parts of Michigan to run Ameritech.net High Speed Internet Service.

Zenith bows out of analog set-top business

After 15 years of production, Zenith Electronics Corp. will stop making analog set-tops, opting instead to focus its efforts on digital products.

Cable customers of Zenith's Z-TAC, MM2500 and PM, PA and PZ set-tops got the news in a letter from Bill Luehrs, president of Zenith's Network Systems Division, in late January. In the letter, Luehrs said Zenith will stop making the analog line in the second quarter of this year.

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Reader Service 9

Consumer groups dub '96 Telecom Act 'an abysmal failure'

Telecom deregulation has resulted in increased rates and greater monopolization than ever, and legislation should be introduced to reverse that trend, according to the Consumer Federation of America, which has analyzed the situation.

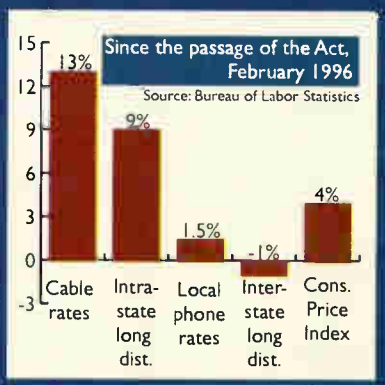
"So far, the Telecommunications Act of 1996 has been an abysmal failure for consumers," said Gene Kimmelman, Consumers Union's Washington Office co-director. "Cable rates have skyrocketed, payphone charges are up, in-state long distance

is up, and AT&T recently hiked basic long distance rates for about 40 percent of weekday calling hours."

According to its research, Consumers Union says: American families spend about $1,000 per year on local phone service, long distance and cable TV services; cable rates are up about 13 percent since 1996; and consumers could save nearly $15 billion per year if competition existed.

Therefore, the Consumer Federation of America and CU want to: impose economic penalties for noncompliance with the Act; withhold merger approvals until enforceable commitments to open local markets are made; fight the RBOCs' resistance to open local markets to competition; and implement the consumer protection sections of the Act

Taking specific aim at the cable TV industry, the consumer groups are calling for the Federal Communications Commission to promote competition to cable by limiting market concentration and preventing monopolistic practices. To do this, the groups want to: freeze cable rates and investigate the causes of recent increases; establish new horizontal concentration rules which



eliminate the "stranglehold" that TCI and Time Warner have on the video market; and prevent vertical integration by TCI and Time Warner that blocks competition for cable programming.

Consumers Union, which publishes *Consumer Reports* magazine, is an independent non-profit testing, educational and information organization. The Consumer Federation of America is a non-profit consumer advocacy organization representing more than 250 local, state and national consumer groups.

Kraft to target market using TCI's digital network

For years, cable operators have touted their ability to segment their customer bases into highly striated demographic categories, which would give advertisers the ability to target market certain products.

Kraft Foods and Grey Advertising will work with Tele-Communications Inc. to develop proprietary advertising/marketing programs to be used over TCI's new digital network. The alliance will allow Kraft to reach consumers with targeted messages on a household-by-household basis.

Kraft will advertise this year over TCI systems in Chicago, Dallas, San Francisco, Houston, Miami, Seattle and Denver on CNN, ESPN, Nickelodeon, TBS and TNT.

"With digital technology, we can now use cable more strategically and inventively to develop a closer relationship with our consumers," said Don Miceli, VP Media Services at Kraft. He added that as the technology improves, it will be used to enhance the dialogue between the company and its customers.

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Encryption technology chosen to protect cable e-commerce

Cable operators put one of the final pieces of the Data-Over-Cable Service Interface Specification (DOCSIS) puzzle in place last month by forging an agreement with RSA Data Security Inc. for public key encryption technology.

The agreement covers cable operators' emerging digital cable networks, including entertainment, data and telephony services. Under the agreement, CableLabs can incorporate RSA's security software components for both public key and symmetric encryption at the core of its multi-layered network security architecture.

Developed by TCI, Time Warner Cable, Cox Communications and Comcast under the MCNS organization, the interoperable Removable/Renewable Security System will be used as the basis for protecting Data-Over-Cable Service Interface Specification (DOCSIS), OpenCable and PacketCable from theft-of-service and denial-of-service attacks, and for protecting the privacy of cable customers. The RSA technology helps prevent these attacks by providing secure authentication and communication between the various components of the digital cable network, such as set-top boxes, cable modems and video servers.

"By relying on RSA technology, CableLabs can enable equipment manufacturers to provide the cable industry and its customers with confidence that their services and private information will be protected," said Stephen Dukes, vice president of network technology with TCI Technology Ventures Management Inc. and CEO of MCNS Holdings.

Future plans include the possible use of RSA technology to securely authenticate and communicate transactions between individuals and commercial entities engaging in electronic commerce over digital cable networks.

CableLabs will distribute and sublicense to equipment manufacturers the RSA security component object code required to implement RSA's public key and symmetric cryptography in their network products. RSA will receive per-unit royalties for the use of its technology.

The DOCSIS security system is designed to defend the digital cable network by providing a number of network security services that give cable operators the ability to authorize a subscriber's access to programming and prevent unauthorized access, including: Identification and authentication of network users through identification and verification of devices connected to the network on an ongoing basis; confidentiality of user information; integrity of data and processes; and continuity of external and internal network services to offer high availability, even in times of natural or man-made disasters.

UVSG, Gemstar team up

United Video Satellite Group Inc. and Gemstar International Group have decided to kiss and make up by agreeing to settle a contentious lawsuit and jointly work to market a portfolio of intellectual property, technology and data services for interactive program guides.

The new venture is called Interactive Prevue Guide Inc. (IPG), and will be managed by United.

In addition, United Video and StarSight Telecast Inc., a subsidiary of Gemstar, reached a settlement agreement in their patent litigation that was pending in the courts. The agreement states that IPG will have rights to exclusively represent to video service providers an interactive program guide and related data and advertising, along with a collection of intellectual property and technology to be licensed to service providers.

Additionally, it was announced that IPG entered into a 10-year affiliation agreement with Tele-Communications Inc. and its HITS affiliates for the deployment of interactive program guides in its digital cable customers' homes.

Said Peter C. Boylan III, president and COO of United Video: "This announcement is particularly timely and meaningful in light of the advent and rapid deployment of digital set-top boxes."

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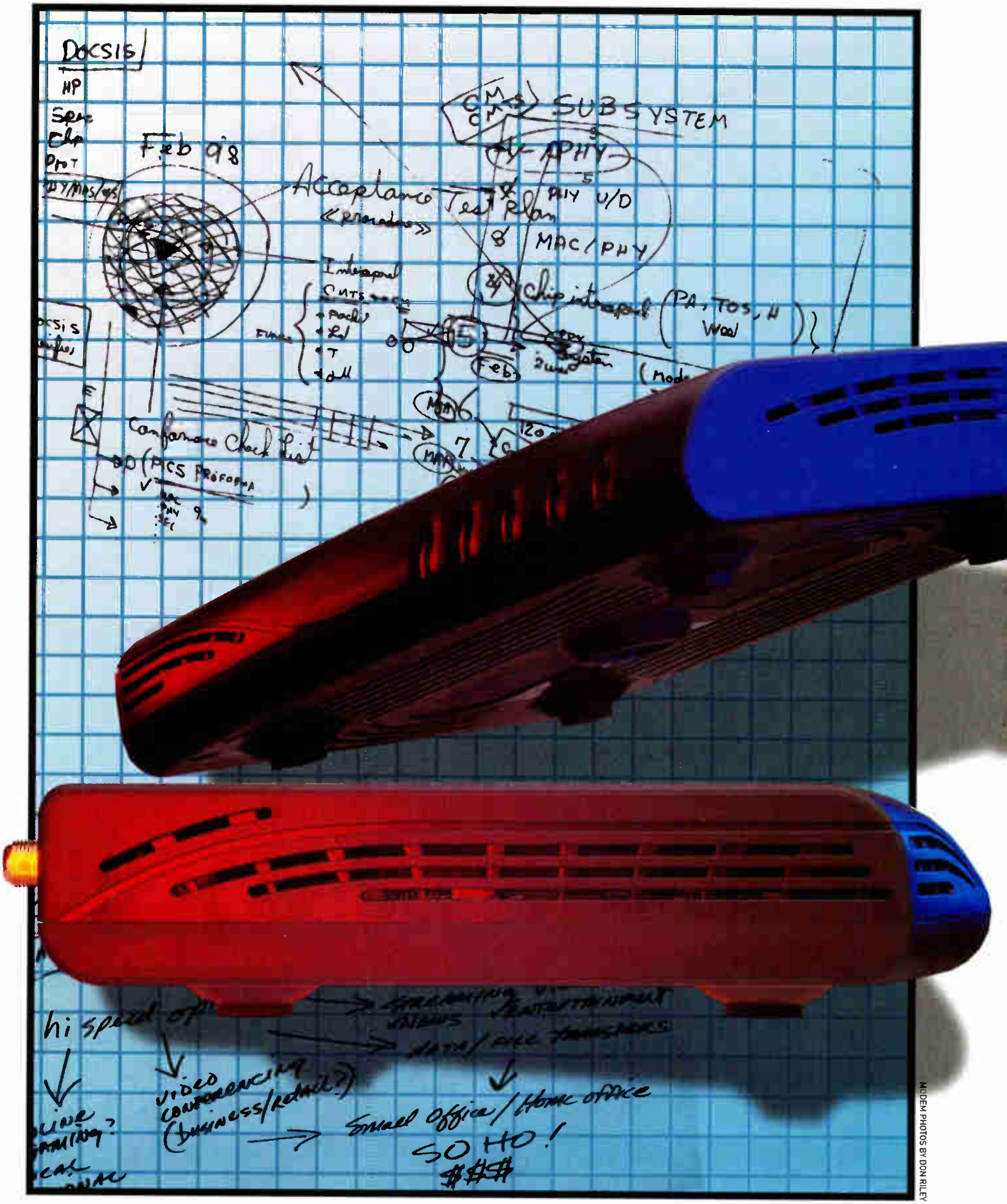

MODEM PHOTOS BY DON RILEY

getting a handle on INTEROPERABILITY

By Michael Lafferty and Dana Cervenka, CED staff

Teamwork. What a concept. Supposedly, that's what Boy Scouts, Girl Scouts, Little League, high school football, the cheer-leading squad, Army (Navy, Air Force, Marine, Coast Guard) boot camp, and even marriage are all about. Yet, practically speaking, the virtues of teamwork have never really been extolled, let alone practiced, in the cable industry to any widespread, sustained degree. That is, until now.

On the rolling hills between Denver and Boulder, Colo. toils a somewhat disparate, but very talented, group of engineering professionals (representing both MSOs and vendors alike) who have suppressed their naturally competitive natures to form a dynamic technology team. This team may be laying the groundwork for a seismic change in the way the industry gets down to business and meets the competition head on.

CableLabs, vendors and MSOs are pooling their people and resources to tackle the complexities of going retail with interoperable cable modems

Standard bearers

Over the last few years, as cable data modem technology has developed from a mere pipe dream to a practical reality, operators have virtually swooned with anticipation over the new revenues that high-speed data services could bring to the industry. Yet their giddy fall to the floor has always been broken by one harsh reality—money. Money to develop, manufacture and deploy these high-speed modems throughout North America.

Standardization became the rallying cry. If the modems had a basic degree of technical conformity, consumers could buy them and take them whenever and wherever they moved. That's why "plug-and-play" soon became the mantra for those who were determined to move massive amounts of money off operators' already overburdened financial books.

Taking the stage at a Western Cable Show just a few years ago, a virtual chorus line of operators and vendors alike vowed to come up with a high-speed spec that would make "plug-and-play" a reality. That brought about the Multimedia Cable

Network System (MCNS) group and its resulting Data-Over-Cable Service Interface Specification (DOCSIS).

According to Bob Cruickshank, director for digital network technologies at CableLabs, initial reaction to DOCSIS was not all that enthusiastic. "When we met with all the vendors for the first time," says Cruickshank, "in what we called our Interoperability Summit right after NCTA last year, the biggest beef from the vendor audience was, 'How the hell are we supposed to test this thing? There's no tester available. There's no test plan. You guys should not have released a spec without a test plan.' And we said, 'Oh, great. You wanted us to wait another couple of years while some competing technology just takes us out?' Obviously, we couldn't do that. We had to follow a new model.

"And what we proposed to them was that each one contribute part of what they had into what we called our incubator. What they had went everywhere from intellectual property to vendor resources such as engineers or manufacturing expertise or whatever."

"So, we opened their eyes to the idea that we could cooperate. That we could

create the business. That we could create the economies of scale and get things down to a commodity level.

"After that, they could shoot back to their Darwinistic survival-of-the-fittest mode. But, we got them to agree to at least cooperate so that they all didn't waste their time while some other competing technology took them out, because they took too long to get it done."

The logistics of cooperation

While everyone involved finally realized there were definite advantages to this teamwork concept, old habits were initially difficult to overcome. To ease the transition from conflict to cooperation, Cruickshank was tapped to represent MSOs' interests in the effort, and modem pioneer Rouzbeh Yassini, CEO of YAS Corporation and better-known as the founder of LANcity Corp., was brought on as an executive consultant to CableLabs to coordinate vendor participation.

"The general idea for us," says Yassini, "is to get the job done. And the job is to make sure we have one retail product out the door. We're not forcing a schedule or product maturity to happen, or forcing arbitrary tests to be passed. And everything is piling into an Acceptance Test Plan (ATP)."

While many feared this cooperative effort might turn into a nightmare of lost R&D and competitive advantages, the intellectual challenges of this daunting effort quickly overcame those concerns. Says Yassini: "The first impression you always get from the vendors is, 'Oh my God, this is our confidential stuff. I'm not going to let my competitors see this.' So, on the first day of work you can see them come in, almost like they've got their machine guns loaded. It seems like they're hovering over their boxes, keeping track of who's getting too close.

"Yet, by the end of the week, the engineers are totally involved in their work. There's all kinds of troubleshooting going on. Every engineer is helping every other engineer to find solutions. There's no other way to do it."

Yassini and Cruickshank have worked hard to keep things simple, open and on track. The rules of engagement, as they call them, are concise (one page), direct and unequivocal, says Cruickshank. While participants aren't required to sign the rules literally, they're bound by them, nonetheless. "We knew," says Cruickshank, "we had to create a protective environment, a technological Switzerland, if you will, so that people would feel comfortable. So, we set up guidelines and rules of engagement. And we just tell them that if they violate them, they're out of the first certification batch.

"The rules say you can't access another vendor's equipment without their permission or without them being here. It says that if you're a vendor and you hook up with another vendor, and you discover issues between your pieces of equipment, you both own those issues and you'll share them with CableLabs. But nobody else will know about them. In other words, any dirty laundry stays between the people involved."

DOCSIS participants are also utilizing the Internet (http://www.cablemodem.-

END-TO-END STRATEGIC ALLIANCES

All for one, and one for all?

Over the past year, as preparations for the DOCSIS certification process began, strategic alliances for end-to-end high-speed data solutions have been forming all around the country. Then suddenly, at the 1997 Western Cable Show, all three camps came together and promised to support one another as the dawn of interoperable modems fast approaches. All for one, and one for all? Only time will tell. Here's a look at the current lineups...

Cisco Systems Inc. allied with...
Com21 Corporation
Hayes Microcomputer Products
Samsung Electronics Corp. Ltd.
Sony Corporation
Terayon Corporation
Thomson Consumer Electronics

Harmonic Lightwaves Inc. allied with...
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com). Cruickshank says they created virtual discussion groups for participants through exclusive e-mail lists. Those interested in physical layer (PHY) issues have their own list, while those interested in MAC and higher level issues have their own list. The e-mail lists go on to cover a wide variety of issues. All correspondence in each list is archived so those coming into any particular discussion later can get up-to-speed with the whole group quickly.

In addition, there are weekly and monthly meetings. And, if a particular issue pops up, a special task force is set up to deal with it. There's also a visiting engineer program that a number of companies (e.g., Toshiba, Thomson Consumer Electronics, Scientific-Atlanta, Motorola, Shaw Communications and MediaOne) have taken advantage of.

This cooperative talent pool has proven to be invaluable in keeping the DOCSIS effort on track. "We're in a situation," says Cruickshank, "where even if we had the money, we couldn't hire the people we need. Because what we really need are the people who are developing these modem products.

"So, these people are on site here. In some cases, it's 50 percent of the time. In most cases, it's 100 percent of the time. They're treated just as if they were regular staff members on the project. They've all got responsibilities. And that's been extremely useful."

Testing, testing...1,2,3

To make a "plug-and-play" certification process a reality, the CableLabs consortium has established an eight-step testing path. It has essentially completed the first four rounds and is currently working on the fifth test area. If things stay on track, the entire suite of eight tests will be completed by autumn of this year.

Steps one through three, says Yassini, covered the "bare minimum requirements" of an open-standards spec. This included tests on the PHY itself and tests for the MAC/PHY interface. Step number four dealt with chip-level operability.

"At this point," says Yassini, "we've proved (been able to test) the subsystem elements of the DOCSIS spec. What this means is that you have the spec; you can develop a chip; you can develop a prototype; you can speak PHY, MAC and a minimum OSS language to build a technology that can act as CMs (cable modems) and CMTSs (cable modem termination systems) by meeting goals one through four."

Test number five, which is currently underway, begins to bring everything together as a system, but still focuses on modem functionality. The goal of step six will revolve around modem configurability or "most of the modem functionality that can be met by hardwiring."


Day


Vecchi


Zeletes

"The goals for these two tests," says Yassini, "are to build a 120-home node network that includes three CMTSs and 120 CMs. How we build this is that we've come up admission and exit criteria." He explains that admission criteria includes such things as symbol rates, operating frequencies, throughput rates, etc. Having these thresholds will save vendors weeks, if not months, in figuring out signal configurations.

Round number seven (currently scheduled to occur in the May time frame) will deal with modem manageability "because SNMP is the last piece of the code that people normally add to their product" says Yassini. Step number eight (slotted for July/August) will put the high-speed data pedal to the metal with formal field tests.

In anticipation of these real-world field tests, Yassini and company expect to put CableLabs' Multiple Services Compatibility Testing (or MUSCAT) Room to good use. Yassini says this 120-home network is "effectively the cable plant you would build for a small town. And, we've got the ability to put digital video, telephony and data on it. It's a controlled environment where you can play with variables, aberrations, lengths and delays, and all kinds of things. It's probably one of the largest indoor instrumented HFC plants in the world."

The first round of certification will likely cover a variety of vendors. After that, individual vendors will go through the process (see Figure on page 28) on their own.

"This first time out of the chute," says Cruickshank, "it's being done in a batch mode. We're bringing all the vendors together and using their peers in trying to identify any problems.

"Through this process, when we take that large network and put 30 of this vendor's modems and 30 of that vendor's modems together, effectively, we'll be using the manufacturers' insights and brain power to find problems with other vendors' stuff.

"Then, what comes out of that batch, is a bunch of product that the engineers collectively feel works well enough to put in the field, as well as documented procedures through the Acceptance Test Plan that details all the things we looked at, how we looked at them, and what we think the right answer is when you run a particular test."

As for the actual seal itself, Yassini says there is no design yet, but "it's going to be something simple and meaningful." He says there are ongoing discussions on branding opportunities that might come out of the certification process as well. This could include raising consumer awareness by using the seal or trademark, not only on the modems themselves, but on packaging and in ads and promotions.

He notes that any revisions of previously certified modems will have to be recertified. And while CableLabs may be greatly involved in the first few rounds of certification, the process may eventually "end up like a UL (Underwriters' Laboratories) affidavit-type situation," possibly supervised by a third party.

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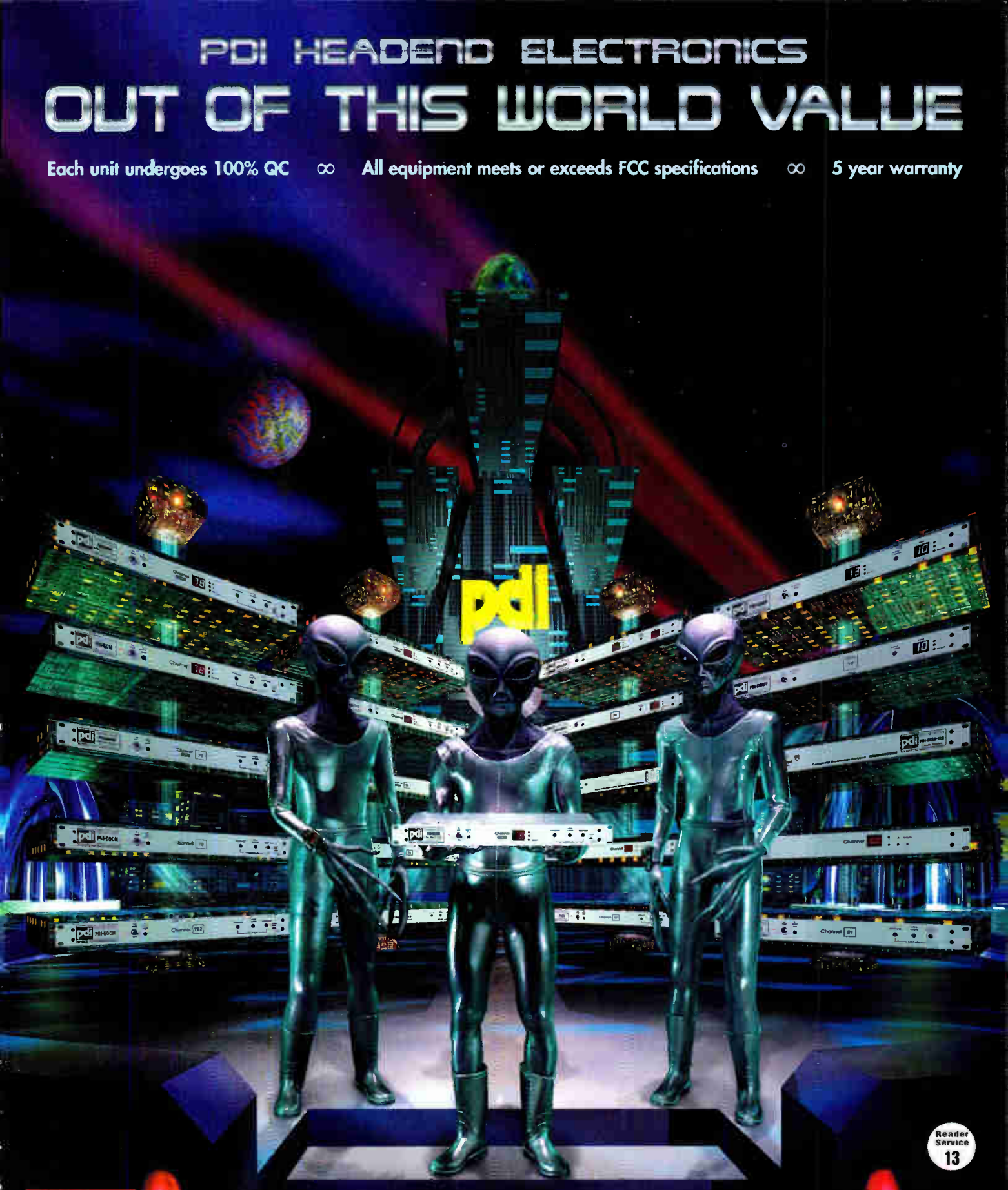

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Lots of progress, a few concerns

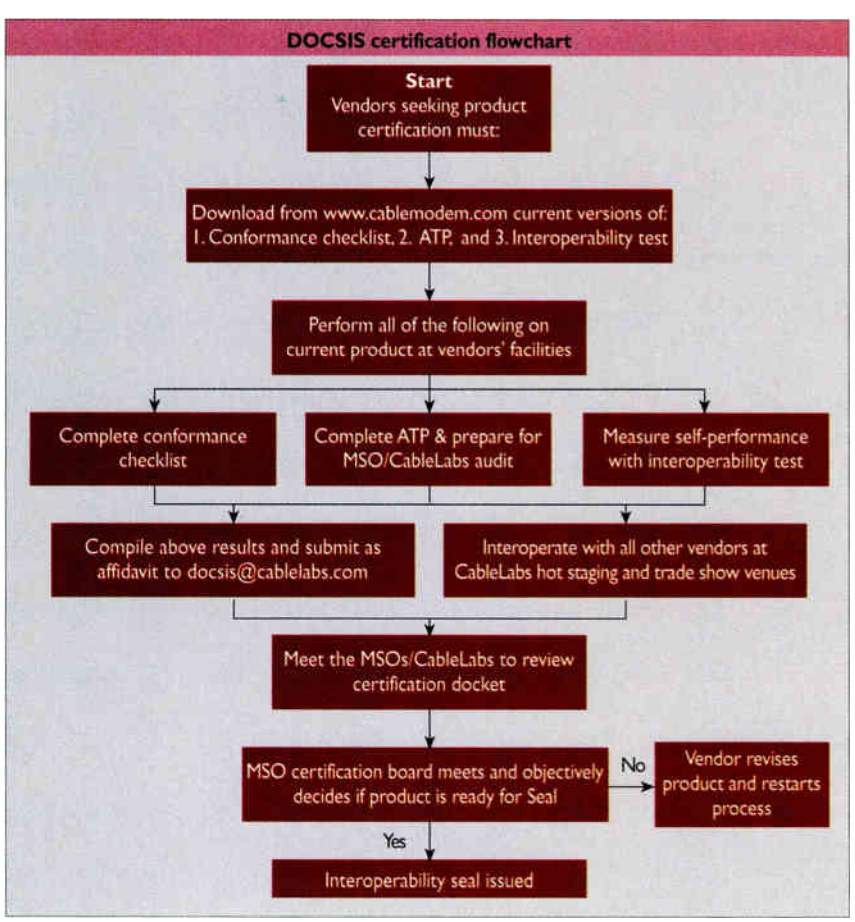
Many of the vendors participating in the MCNS/DOCSIS process say they are pleased with the strides being made toward interoperability. "The good news is, that most of the misinterpretations of the spec are more at the higher layers now, more on the software side of things, so that's easy to change, especially as part of the development process," says Levent Gun, vice president of 3Com's Cable Access Division, a manufacturer participating in the CableLabs' DOCSIS effort.

"I think the major hurdle right now is in resolving, or verifying, the interoperability of the various silicon (chip) platforms that the vendors are working with," says Mario Vecchi, senior vice president and chief technology officer at Time Warner's Road Runner Group."...Once that gets established, I think we will have cleared some major hurdles."

"The DOCSIS specification is complex, but I think so far, things have been going pretty much on track," says Chris Grobicki, product management, Broadband Technology Division, Bay Networks. "Yes, there could always be an issue that comes up, but I think that at this point in time, any issue that would slip the timeframe out from '98 to '99 for MCNS modems has not shown itself."

One member of the DOCSIS certification board, Steve Craddock, vice president at Comcast Corporation, is very pleased with how well things have gone and is already focusing on issues that need to be addressed in the next version of DOCSIS.

"I'm absolutely thrilled about the progress that DOCSIS has made," says Craddock. "I didn't, in my wildest dreams, think we would be where we are right now. And I think a lot of the companies that have been participating in the interoperability labs deserve a round of applause. They've really done a lot of great stuff."



But, he notes, because the DOCSIS effort had to "freeze the requirements" to get this initial certification effort underway, compromises had to be made and decisions had to be deferred. "In doing that," says Craddock, "we landed on variable length packet IP, which is not geared for guaranteed quality of service (QoS). What we're doing now is good for the Web surfers, the @Home and the Road Runner subscribers. But, for that next level of services, for example, streaming media, IP voice and video, QoS is going to be a challenge."

The solution, he says, will involve going back into Version 1.0 DOCSIS and "making some changes that will allow us to continue to let the product go to market," but at the same time, allow the MSOs to get some measure of QoS so they can start to offer some of the new services.

And, from what he's seen at CableLabs, Craddock is confident that a solution will be found. "There are some very clever ways to get QoS over the MCNS variable length packet," says Craddock. "There's some extremely bright plans for this. And I'm telling you I'm absolutely impressed with some of the guys up at CableLabs and in the industry who are working this particular issue at this point in time. I mean, it's really good stuff."

The retail challenge

Once the certification process is formalized, codified and cranking out seals, the biggest challenge may still lie ahead: Going retail.

Time Warner's Vecchi says that the company's Road Runner Group is looking at a number of different options to put the modems directly into the hands of consumers. To get its feet wet in retail distribution, the company will be conducting "retail-like" tests in one of its markets, offering consumers its "Road Runner in a box," which wraps up an existing cable modem; a PC labeled as "Road Runner-ready," with a NIC card and service software already installed; and an installation manual and instructions. Through this test, "we are exercising the whole business-marketing-installation cycle," says Vecchi.

Once the consumer gets the box home, the onus is on him to plug in and activate the modem, then call Road Runner to activate

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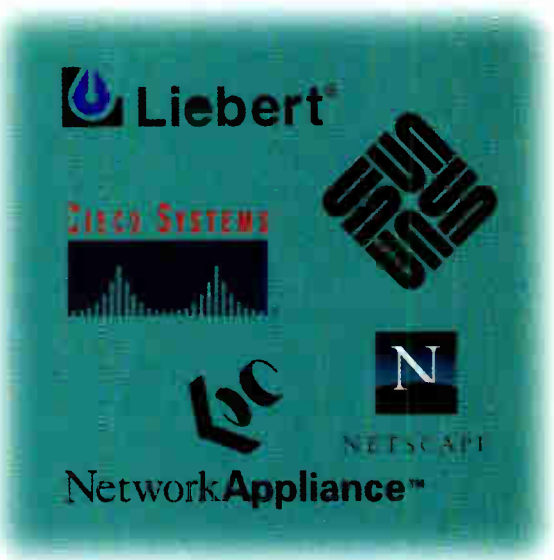

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his account. The expectation, says Vecchi, is that the consumer will do everything.

"If the consumer plugs in the modem and has a problem because the registration process is not working (what our techs refer to as the 'blinking light' problem), then the tech would check to see if the plant is dirty, or if there is some major problem in the home wiring. Our expectation is that the large majority of homes in locations where we have deployed (service) would be able to bring this up on their own."

Dick Day, corporate vice president and general manager for the Motorola Multimedia Group, is another firm believer in the OEM retail model. "One of our end-game visions," says Day, "is that the modem is not going to be an after-market device; it's going to become an OEM device inside the computer. But guess what? It's a personal computer retail model. That's a big difference.

"Technically sophisticated customers will choose to buy it at retail and install it themselves, possibly. And then others, and I'll use as an example my wife, who I always use as my first marketing test, if it's not bundled in and really simple, she's not going to do it. So, it will have to be some type of OEM appliance. Of course, there are some technical issues with that, and that's not on anyone's short-term horizon."

Another DOCSIS proponent, NetGame Cable, is planning to OEM both cable modems and cable modem termination systems. "We don't plan to go to market with our own NetGame CMTS," says Michelle Schulman, NetGame's director of business development. "We have some OEM deals that are in the works with a few different vendors. We're also speaking to computer resellers who are interested in OEMing the (cable modem) product and probably bundling it as part of a package with their computer. That way, they'll be able to offer a network-ready, high-speed PC."

Samsung's David Lin says that, when the time comes, his company will be distributing DOCSIS-certified modems through MSOs, computer retailers and systems integrators as well. "Computer retailers will be the early adopters of these MCNS cable modems," says Lin, who is director, product management and business development, Cable Modem Lab, Multimedia

The impact of the effort goes to the foundation of an industry that's remaking itself

Technology Center, with Samsung. "And as for system integrators, they may be even more qualified than computer retailers, because this is their business."

3Com is pursuing a "micro retailing" approach to modem distribution, says William Markey, director of marketing, Cable Access Division, for 3Com. "We will work with the local cable operator, identify the footprints of available service areas, and then activate our local retail partners to enable distribution," says Markey. In mid-February, 3Com was scheduled to activate its first retail partners by placing US Robotics-branded cable modems on retail shelves in the U.S. and Canada (3Com acquired US Robotics in 1997).

"Generally speaking, there is much hard work ahead to work through all the challenges necessary to make cable modems viable in the retail channel," says Bay's Grobicki. For its part, Bay has already begun working with cable operators on marketing strategies and collateral materials to enable them to start generating demand for the modems, he adds.

By the same token, Grobicki is hopeful that the modem installation complexity will eventually be a thing of the past. "Our experience has been that the complexity is not in the installation of the cable modem. Really, the complexity is in the installation of the Ethernet adapter card, and the software in the PC. That has to get simpler.

"How do you make it simpler? In the way the modem is connected to the PC. Currently, it's Ethernet, but there is already talk of moving to the Intel USB (Universal Serial Bus). That will be a bus that's already installed on the motherboard of the PC. So you would connect directly to that bus, without having to install an adapter card."

Technical standards. Certification. Retail sales and distribution. Anything else standing in the way of cable modem ubiquity? You bet, says Jane Zeletes, vice president of marketing for Hybrid Networks Inc. A 10-year veteran on the consumer electronics retail side of things, she believes there is a whole list of concerns to be dealt with when it comes activating high-speed data service.

"A big issue," says Zeletes, "is the activation process in terms of setting up billing for a service provider once the consumer takes the product home. That whole process has to be in place. And not just activating the product. How does the customer get registered on the network? How does the network acknowledge that and all the billing and all that gets set up? The activation itself is the easy part. It's the support processes behind it that are a concern. This is not a one- or two-month lead item. These processes are extensive."

DOCSIS and beyond

The investment in time, money and talent to bring DOCSIS to certification has been astronomical. Yet, the potential revenues are mind-boggling, no matter whose calculator you use. But the overall impact of the effort, says Yassini, goes far beyond little Johnny surfing the Web at lightning speeds for a homework assignment. It goes to the very foundation of an industry that's in the process of remaking itself and the society it serves.

"You know," says Yassini, "the cable industry has been a proprietary industry for 40 or 50 years. But DOCSIS is not just a cable modem. It's really, for the first time, bringing standardization and the process of building an interoperable digital mentality to this industry.

"We're not just creating a solution for the cable modem problem. We're also establishing a process, a procedure, a mentality and a work ethic necessary to take standards and bring them to the commercial market. It will allow the cable industry to build for the next 40 years based on a digital platform. The DOCSIS effort is going to be the foundation for that technology where multi-billion dollar businesses are going to run." ■

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Future proofing

MCNS DATA-OVER-CABLE PROTOCOL

As new applications like video telephony and multi-user gaming take off, will operators find that the MCNS data specification is too confining?

As industry support has grown for the Multimedia Cable Network System (MCNS) Data-Over-Cable Service Interface Specifications (DOCSIS), the capabilities for cable companies to deliver high-speed access to Internet-based data is quickly transitioning from hype to a robust business reality. However, today's deployment decisions should also take into account the emerging market requirements for tomorrow's even more demanding multimedia applications.

In order to future-proof their investment decisions, cable companies must clearly define their future multimedia service offerings and consider the implications of providing required bit-rate and latency levels over their cable networks. While the MCNS/DOCSIS specification has been inherently designed to allow for future extensibility, planning ahead for key Quality of Service (QoS) extensions can allow for smoother response to future market demands, while minimizing risk of obsolesce and reinvestment costs.

QoS requirements

Essentially, the end-user services that will be delivered over cable can be grouped into two major categories: 1) "Delay tolerant" applications which will immediately benefit from the higher bandwidth of MCNS-based cable systems, and 2) "delay intolerant" applications which will require scheduling mechanisms designed to meet specific maximum-latency levels for acceptable performance.

Delay tolerant applications comprise the majority of today's Internet transactions, which can effectively be delivered with "best effort" bit-rates. They include the most popular Internet-based end-user applications, such as Web browsing, file transfer protocol (FTP), and e-mail transactions. Because these applications tend to be "bursty," they lend themselves well to statistical multiplexing, which allows for efficient use of available bandwidth. Basically, the Internet's IP packet-oriented environment is structured to maximize all users' access to the system's shared bandwidth, while allowing any specific transaction's latency to vary according to changing traffic levels.

As can be seen from the explosive growth of Web browsing and e-mail, this variable latency has not been a major limiting factor to the usability of these non-real-time applications. In essence, users' experience with the slower responsiveness of dial-up connections to the Internet has merely whetted their appetites for the higher-speed access achievable with MCNS-based cable delivery systems.

As Internet usage evolves and MCNS-based cable modems migrate today's end-users to higher speeds and faster expected response times, new classes of delay intolerant applications will emerge, which will inherently require minimized and tightly managed latency levels. These applications will include real-time, two-way communications services, such as telephony and video-telephony, as well as entertainment applications, such as multi-user gaming.

While end-user expectations for Web browsing and e-mail response have been pre-established at low levels, which can easily be exceeded by MCNS-based cable modems, expectations for telephony communications have been set at a much higher lev-

By Thomas Quigley and David Hartman, Broadcom Corporation

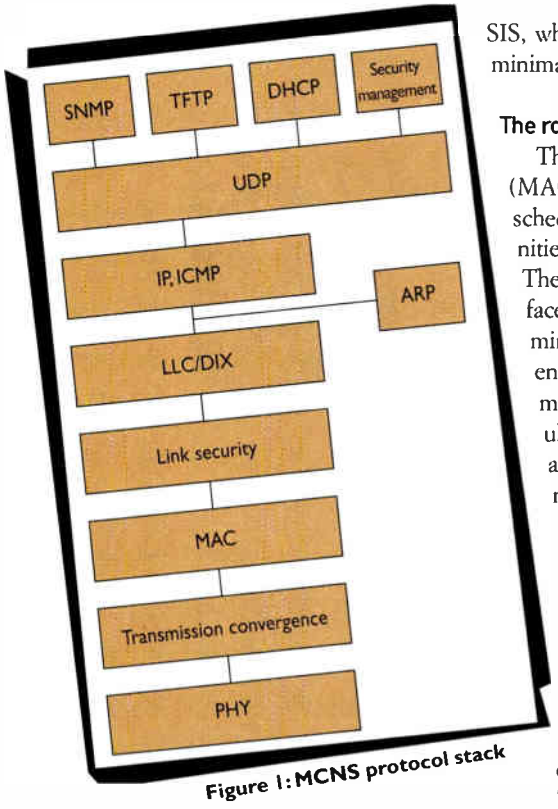

Figure 1: MCNS protocol stack

el by the ubiquitously available on-demand isochronous connectivity of the phone system. Isochronous telephony services guarantee that once a connection is made, the link is dedicated to the connected parties for the duration of the call. As a result of allocating a fixed-bandwidth link, there is a constant two-way flow of data through the connection to and from each and all of the connected parties without interruptions or delays.

In order to offer toll-quality voice service over the network while maintaining reasonable buffering requirements at the receiver, both the average latency and packet-to-packet variations in latency must be controlled. Allocating 20 milliseconds (ms) of delay to the access network out of the 300 ms of total delay acceptable in toll-quality voice has been suggested. To meet this goal and effectively deliver two-way telephony, video-telephony and gaming services, cable companies will need to incorporate extensions to MCNS/DOCSIS, which allow delivery of data with minimal latency and latency variation.

The role of the MAC

The MCNS Media Access Control (MAC) function is responsible for scheduling all transmission opportunities on one or more return paths. The DOCSIS [1] describes the interface between the Cable Modem Termination System (CMTS), or headend, and the subscriber or cable modem (CM). Details of the scheduling algorithm are not described and are instead left up to the implementation.

In order to interoperate with the large base of Ethernet and IP hardware and software, the MCNS MAC was designed to lie directly underneath the 802.2 Logical Link Layer (LLC). The use of standard IP above the LLC layer allows the leveraging of widely used protocols, such as TCP/IP, TFTP for file transfer, SNMP for network management, and DHCP for IP address assignment and management. (See Figure 1.)

Because the cable plant is a shared medium, and unauthorized snooping or modification of user data is possible, provisions were made to provide link layer privacy and security. The Baseline Privacy Specification [2] describes the requirements and mechanisms for basic privacy. Data may be encrypted at the MAC layer in both the upstream and downstream directions using the Data Encryption Standard (DES) encryption algorithm with Cipher Block Chaining (CBC). The DES keys used by the cable modem are transmitted using RSA public key cryptography to preserve their integrity.

MAC flexibility for QoS

Possibly the key aspect of the MCNS MAC is its built-in extensibility and flexibility for framing upstream data. In the MCNS/DOCSIS model, the MAC and PHY layers combine to provide an adaptable system that allows the delivery of constant bit rate, variable and available bit rate service to home and business end users over HFC. This flexibility forms the lynch-pin for system designers when it comes to creating options for various levels of Quality of Service, which can be separately priced to users based upon their specific application requirements.

Some of the features of the MCNS MAC that enable systems to provide highly efficient service to Internet applications, and meet some basic Quality of Service goals, include:

- **"Piggybacking."** This allows a MAC to append a Request-to-Send more data as part of a transmission already being sent, thereby reducing the overhead and contention delays involved with sending a separate request.
- **Concatenation.** This allows the MAC to build up several packets into a "super-packet" by sending a single request to the headend for sufficient bandwidth to send them all at once, with a single concatenated header that allows the headend to parse them appropriately.
- **Headend request polling.** The headend may periodically make available dedicated request regions in the upstream so that services with higher quality of service guarantees can request bandwidth outside the usual contention mechanism.
- **Ability for headend to send unsolicited grants.** In the current system, the CMTS can send unrequested bandwidth grants to cable modems based on a previous agreement. The mechanism for establishing that agreement is as yet undefined.

Packet fragmentation is key

While the previously mentioned features are helpful in supporting basic Quality of Service needs, one key extension necessary to meet long-term goals for supporting a variety of traffic types that is not yet defined in the MCNS/DOCSIS specification is support for upstream fragmentation of large packets. This feature would enable an MCNS MAC scheduler to dynamically manage overall system laten-

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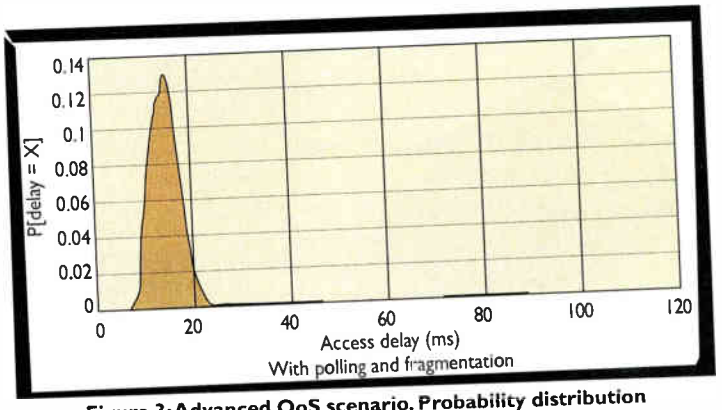

Figure 3: Advanced QoS scenario. Probability distribution function of access delay.

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The HI_PHY

Clearing A Path For New Two-Way Data Services

Cable operators are in the process of upgrading their networks and rolling out two-way data services in a systematic plant-by-plant migration to a completely digital infrastructure. The speed at which cable plants are being upgraded is limited by the amount of investment needed to achieve low upstream noise conditions required by today's cable modems. To improve the speed at which plants are migrating to two-way data, next generation modulation technology is required so cable operators can implement a robust, high capacity cable data network at reasonable cost. High capacity modulation in next-generation cable modems promises to improve the economics of the business model so operators can deploy two-way data services on a more widespread, commercial basis.

The technical community, including the Society of Cable Telecommunications Engineers and IEEE 802.14, is in the process of defining a high capacity modulation standard. This standard is being referred to as "HI_PHY" because the technical goal is to deliver HIgh capacity via a new PHYsical layer specification in the ISO protocol stack. This article describes the benefits of a HI_PHY, and it compares several HI_PHY candidates with the current PHY used in MCNS cable modems, namely, QPSK and 16 QAM. Because there is expected to be a negligible cost difference between current PHY and HI_PHY implementations, it can be argued that cable operators can future proof their networks today with a HI_PHY with no cost penalty.

High capacity modulation addresses two major problems for the operators. First, it reduces the amount of upfront investment required by operators to "clean up" their upstream cable plant to support two-way service, thus accelerating service roll-out to more serving areas. Second, it increases the upstream channel efficiency so the operator's investment in data networking equipment can be leveraged across a larger subscriber base. Higher channel efficiency also means more bandwidth available to operators to support enhanced services such as multimedia traffic (telephony, videoconferencing) and virtual private networking services for the business community.

Noise immunity

The frequency band used by upstream cable channels is plagued by high-energy ingress, burst and impulse noise. The ingress is caused by public HF and amateur HAM radio stations which operate in the same frequency band used by upstream cable channels. Without careful filtering installed at various locations in the upstream path, these radio signals can penetrate the cable and end up in the headend receiver as ingress energy. Single-carrier QPSK channels can be completely lost in the presence of a single strong narrowband ingress signal.

The current solution to ingress noise is to relocate the subscriber's data traffic into a new upstream channel using a technique called frequency hopping–in effect, hopping away from the ingress. This hopping causes an interruption in the subscriber's traffic flow, which could result in packet retransmissions and delay.

The upstream cable plant is also exposed to wideband burst noise created by appliances such as garbage disposals, hair dryers and drills. The burst noise energy can be very high, and it is

By Rod Gross, Ultracom Communications

E-mail: rod@ultracominc.com

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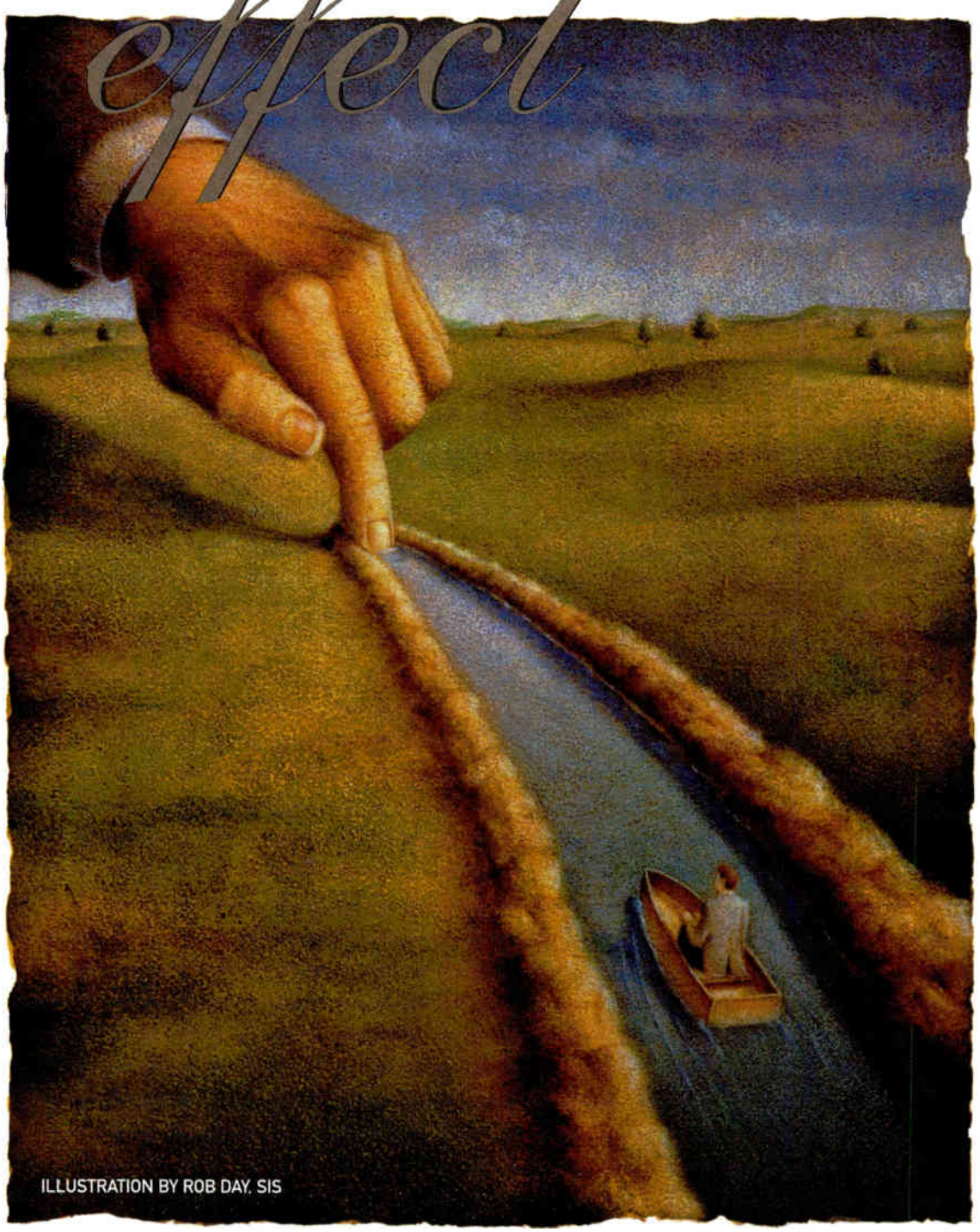

ILLUSTRATION BY ROB DAY, SIS

distributed across a wide frequency range that can impact many upstream channels. Burst noise duration is typically a few microseconds, which can destroy several QPSK symbols and severely impact customer transmission. The traditional solution to burst noise is to apply a forward error correction (FEC) code to the data and to interleave the resulting data in the time domain over a long period. This technique can be effective for long data packets, provided the burst duration is only a few microseconds, but it is ineffective for short voice packets or when the burst duration lasts for several microseconds.

A HI_PHY provides high immunity to ingress and burst noise, so frequency hopping is not necessary. It can also automatically adapt to whatever noise is present in the assigned channel, thus eliminating the operator's need to carefully select upstream channels that are free from high energy ingress or burst noise, and eliminating the need to reserve other channels for frequency hopping. Complex frequency management procedures can be replaced by a robust modulation technique that is capable of maintaining a high quality of service in the presence of high energy ingress.

Bandwidth efficiency

Among the many factors to be considered when evaluating the overall bandwidth efficiency of an upstream modulation technique, the most obvious one is the channel loading, which is usually described in terms of bits per second per Hertz. Channel loading is a function of the number of bits-per-symbol transmitted (also known as the modulation index), as well as the amount of frequency guardband required to keep one channel from interfering with another.

For example, QPSK has a bit loading of 2 bits-per-symbol, and MCNS requires a frequency guardband of 25 percent. As a result, the bandwidth efficiency of an upstream MCNS QPSK channel is 1.6 bits/sec/Hz. A HI_PHY increases channel loading by increasing the number of bits per symbol transmitted.

Other factors besides channel loading also impact the bandwidth efficiency of the upstream spectrum–such as immunity to noise impairments as well as burst guard time requirements. A HI_PHY opens up regions of the frequency spectrum that are unusable by QPSK because of noise impairments. A HI_PHY allows the entire upstream spectrum to be used because it can continue to operate in channels punctured with ingress and burst noise.

As a result, the entire 5 to 42 MHz (or 5 to 65 MHz in some plants) upstream spectrum can be used for revenue generating traffic. Furthermore, the upstream channels reserved for fre-

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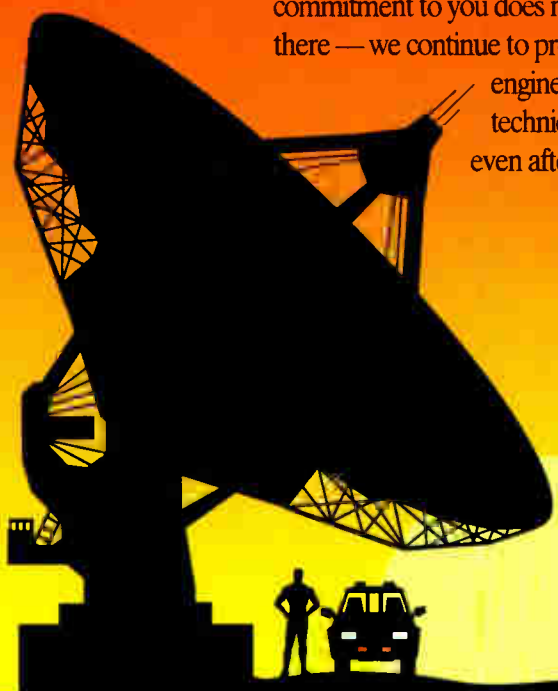

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quency hopping (when an assigned channel becomes unusable due to noise) can be recovered. High-quality service can be maintained in any assigned channel, so reserved channels are no longer required to be sitting idle waiting for traffic from another channel to be switched into it.

To understand how burst guard time requirements affect channel efficiency, access mechanisms used to insert subscriber data in the upstream channel should be examined. Time Division Multiple Access (TDMA) is the upstream channel access method specified by MCNS and IEEE 802.14. It uses burst transmission in which each subscriber modem gets a grant to transmit for a predefined duration, measured in "mini-slots." When an asynchronous modulation technique is used, a guard time is required between bursts for receiver training and transmitter ramp-up, and no useful subscriber data can be sent or received during this guard time. MCNS calls for a minimum guard time of 5 symbols for QPSK and 16 QAM modulation.

The amount of guard time required between transmissions from different modems is a major factor in determining channel efficiency, especially when the symbol rate of the channel increases, causing the average packet size of the data to decrease. While absolute guard time is typically constant, guard time as a percentage of the total channel capacity increases as packet size decreases. For channels with integrated voice and data traffic, the voice packets are typically small compared to data packets in order to decrease end-to-end delay. As a result, short voice packets will have higher overhead and lower channel efficiency than long data packets.

Many HI_PHY candidates synchronize the cable modems to the same timing reference as the headend. As a result, no guard time is required between successive bursts, which means the channel can support continuous transmission of data from multiple modems. Guard time is an important consideration for HI_PHY candidates because the bit loading per symbol typically increases, and upstream bursts naturally become shorter as fewer symbols are needed to carry the same amount of data. As a result, the guard time overhead increases as a percentage of revenue generating traffic. However, a HI_PHY that requires no guard time makes more of the upstream channel available for revenue generating traffic, as compared to one that requires a guard time.

HI_PHY similarities

The HI_PHY modulation techniques that are currently under consideration by the IEEE are listed in Table 1. These candidates can be grouped into two very distinct categories: multi-tone modulation and spread spectrum modulation. Within

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the multi-tone group, however, there are implementation variations that cause differences in end-to-end performance under various noise conditions.

The most important similarity in all HI_PHY candidates is the use of another dimension to carry transmitted data on the RF carrier. For single carrier QPSK or 16 QAM modulation as specified by MCNS, the only dimension available is time, and as described above, each subscriber is allocated a certain number of time slots in which to transmit data upstream to the headend. In the case of all multi-tone HI_PHYs, the added dimension is frequency, whereas for S-CDMA, the added dimension is codespace. Whether it's frequency or codespace, this extra dimension provided by a HI_PHY increases flexibility to combat the hostile noise environment in upstream channels, which results in higher bandwidth efficiency.

To understand how the extra dimension provided by a HI_PHY increases noise immunity, its behavior in the presence of both ingress and burst noise should be examined. For a multi-tone HI_PHY, the upstream channel is divided into many frequency subchannels, each with its own carrier (or tone) that is individually modulated by the subscriber's data. The carrier in each subchannel is modulated with a QAM constellation that varies from BPSK to 256 QAM in response to the ingress measured in the subchannel at the headend. As the ingress level increases, the subchannel(s) in which the ingress appears is deactivated, and the subscriber's data continues to be carried in subchannels that are ingress-free (see Figure 1, page 49).

Multi-tone modulation:
Variable constellation multi-tone (VCMT)
Discrete wavelet multi-tone (DWMT)
Synchronous discrete multi-tone (S-DMT)
Orthogonal frequency division multiplexing (OFDM)
Spread spectrum modulation
Synchronous code division multiple access (S-CDMA)

Table 1: High capacity modulation (HI_PHY) techniques

As a result, the overall channel will deliver a constant bit error rate (BER) while the channel throughput degrades gracefully. Single-carrier QPSK, on the other hand, delivers degraded BER as the ingress increases, until the channel reaches the point where it can no longer deliver acceptable performance. At this point, the traffic is switched to another channel, which interrupts data transmission.

A spread spectrum HI_PHY uses the codespace dimension to spread the subscriber's data across a wide frequency band. The data is carried via assigned spreading codes on a QAM carrier. At the headend receiver, the data is recovered using a de-spreading process. This de-

spreading process causes a narrowband ingress at the receiver input to be spread across a wide frequency band, making the ingress appear as white noise at the output of the de-spreader. As a result, the impact of ingress on data throughput is reduced via the codespace dimension.

While single-carrier QPSK relies exclusively on a time domain solution to burst noise (e.g. FEC and interleaving), a HI_PHY relies on both the time and frequency (or codespace) domains to more effectively combat burst noise. In addition to FEC and data interleaving in the time domain, a HI_PHY can interleave the data across multiple tones (or codes) per frequency channel to increase the immunity to burst noise. A HI_PHY distributes the transmitted data across N frequency subchannels (or N codes), and as a result, the symbol rate per subchannel (or code) is lower and the symbol period is longer than for a single-carrier QPSK channel. This longer symbol period effectively reduces the burst energy in the recovered symbols, thus improving the BER. The amount of improvement in channel performance resulting from the longer symbol periods can be quantified as 10logN, where N is the number of tones (or codes) available in a symbol period.

	VCMT	S-DMT & OFDM	DWMT	S-CDMA	QPSK
Ingress immunity	high	medium	high	Varies with channel loading	very low
Channel bit loading	high	high	high	low	low
Burst guardtime required	none	none (preamble)	4 symbols	none	5 symbols
Ranging accuracy required	medium	medium	high	high	low

Table 2: Comparison of HI_PHY modulation techniques reveals important differences.

Differences

The differences between HI_PHYs can be described in terms of their implementation details or in terms of their expected performance in real plant environments. Although a discussion of implementation details would reveal some important differences, performance-related issues are focused on here. Table 2 summarizes some of these differences for the most popular approaches.

All HI_PHYs provide improved immunity to ingress as compared to single-carrier QPSK and 16 QAM. However, within the multi-tone group, there are performance differences resulting from the spectral shaping of the transmitted tones. The sharper the frequency rolloff of each tone, the more rejection provided to a narrowband ingress. Because VCMT and DWMT provide very sharp spectral shaping of each tone, they can reject the ingress better than OFDM and DMT.

In the case of CDMA, the ingress immunity is dependent on the number of subscribers that are active in the frequency channel. As contrasted to wireless applications, the total power in the upstream cable plant is limited and has to be shared by all subscribers that are transmitting at the same time. As the number of active subscribers in a channel increases, the power level of each subscriber's transmitter decreases while the noise level in the channel increases, thus decreasing the signal-to-noise ratio at the headend receiver. Therefore, the ability of CDMA to withstand ingress decreases as the number of active subscribers in a channel increases.

Another important difference in performance between approaches is in the area of bandwidth efficiency, which consists of two main factors: channel bit loading and burst guard time. The channel bit loading delivered by a

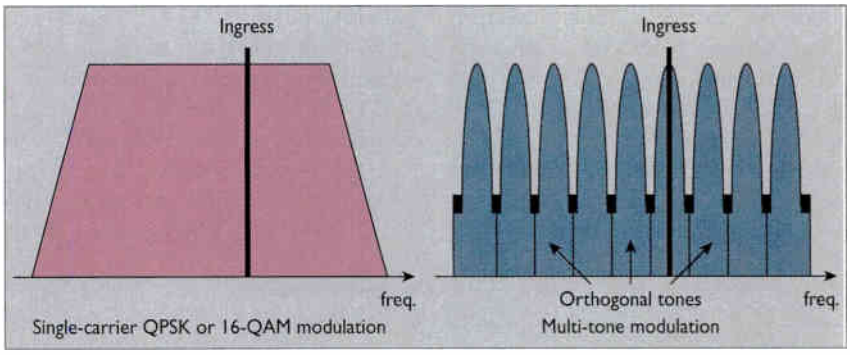

Figure 1: Ingress can destroy a single carrier QPSK signal, but only affects one or two carriers in a multi-tone signal.

HI_PHY is a function of the number of data bits that can be carried per transmitted symbol. For multi-tone modulation, the bit loading per tone changes from 1 bit/sec/Hz (for BPSK) up to 8 bits/sec/Hz (for 256 QAM) in direct response to the amount of noise measured in each subchannel. Subchannels with low noise carry more bits than subchannels with high noise, with the result being the maximum possible bit loading in the overall channel based on the noise characteristics of that channel.

For S-CDMA, the channel bit loading is dependent on the modulation index of the RF carrier used to send the spreading codes. The higher the modulation index, the higher the SNR required at the receiver to recover the spreading codes. To maximize the number of subscribers that can be transmitting at the same time in a channel, a lower modulation index for the RF carrier (and thus a lower SNR required at the receiver) is prudent. As a result, the channel bit loading for S-CDMA is kept low in order to support the maximum number of subscribers in a given channel.

The second determining factor is burst guard time (discussed earlier). Because the channel overhead increases as a percentage of the revenue-generating traffic when channel bit loading increases, a HI_PHY that requires no guard time makes more of the upstream channel available for revenue generating traffic. Both VCMT and S-CDMA require no guard time between successive bursts, while DWMT requires a 4 symbol guard time. Although S-DMT and OFDM don't require a guard time, a preamble (or cyclic prefix) is used to train the receiver and reduce intersymbol interference between bursts. This preamble is a fixed length and causes the overall channel efficiency to decrease as the burst length decreases

(i.e. for higher bit loading or for shorter voice packets).

Finally, differences in sensitivity to ranging offsets between subscribers is important. The collection of cable equipment between the subscriber and the headend typically introduces variations in time delay and phase over the frequency range of a single upstream channel. Delays through block upconvertors and the cable itself vary depending on time of day and outside temperature. These dynamic variations can present particular challenges to some methods that depend on precise phase relationship between adjacent frequency channels and between adjacent symbols. VCMT, S-DMT and OFDM are reasonably tolerant to timing differences between subscribers, while S-CDMA is more sensitive to timing differences between subscribers. DWMT is not only sensitive to timing differences between subscribers, it is also sensitive to RF carrier phase offsets between subscribers.

Conclusions

A HI_PHY can more effectively deal with the highly dynamic noise characteristics of upstream cable networks as compared to single-carrier QPSK or 16 QAM. By continuously monitoring the noise on each tone (or code), a HI_PHY receiver spots any noise and then adjusts the mapping of bits onto tones (codes) to minimize the impact of that noise. A HI_PHY solves two important problems for cable operators. First, it reduces the amount of upfront investment and ongoing maintenance costs required to support two-way data service in existing plants, thus accelerating service uptake in more serving areas. Second, a HI_PHY increases the upstream channel efficiency so the operator's investment in networking equipment can support a larger subscriber base.

In addition to opening up regions of the frequency spectrum that are unusable today because of high noise impairments, a HI_PHY increases the efficiency of all upstream channels. Higher channel efficiency means more bandwidth is available to support more revenue-generating traffic. Cable operators can increase the revenue generated by existing upstream spectrum by fourfold.

HI_PHY frequency channels can coexist with already deployed QPSK channels to minimize upgrade costs and to eliminate disruption of existing services while transitioning from first-generation to second-generation network infrastructures. Finally, a HI_PHY can be integrated using readily available semiconductor technology at a cost and power level that is comparable to that of a QPSK upstream solution. ■

About the author

Rod Gross is VP of marketing with Ultracom Communications.

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Crafting a low-cost two-way upgrade

Future-proofing via aggressive fiber deployment

By Xiaolin Lu, Ted Darcie, Alan Gnauck, Sheryl Woodward, Bhavesh Desai and Xiaoxin Qiu, AT&T Labs–Research

One of the most challenging issues facing the cable industry today is the need to cost-effectively transform a traditional one-way cable system, which was designed for broadcast services with tree-and-branch architecture, into a two-way broadband digital platform. Without clairvoyance to foresee specific future service requirements, the platform should be flexible enough to support different service needs without incurring operation complexities and cost. Operators should carefully balance infrastructure upgrade strategy, service uncertainty, financial constraints and the inevitable evolution of technology.

The industry has been feverishly following the traditional upgrade strategy in which 350 MHz or 550 MHz coaxial amplifiers are upgraded to 750 MHz, and two-way capability is enabled using low-frequency (5 MHz to 40 MHz) upstream technology. A regrettable consequence of this traditional technology is that the upstream channel performance is limited. This may be adequate for existing applications like Web browsing, but is likely to become problematic with emerging service requirements. Also, ingress noise necessitates performing complicated signal processing and spectrum management, which then translates into higher terminal cost.

Further, expanding the system bandwidth to higher frequency requires more amplifiers to overcome the increased coaxial loss. Noise and reliability concerns, on the other hand, demand the use of fewer amplifiers in cascade. Resolution of this conflict requires network re-branching and re-engineering. This leads to not only more amplifiers in the field, but also, a more complicated coax plant. These difficulties then translate into higher cost and operation complexities, and raise serious questions about the adequacy, quality and reliability of the resulting transport capability.

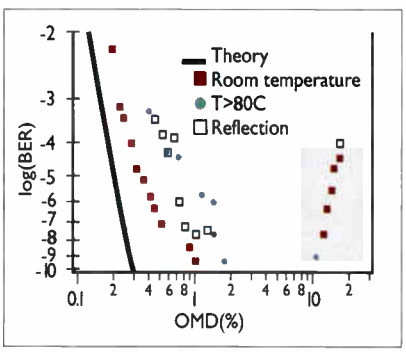

Figure 2: Capacity of an uncooled FP laser. 60 channels QPSK at 2Mbps/ch. were applied to the laser, and the BER was measured in the temperature ranging from 20°C to 80°C.

Operators hope that shrinking the fiber node (FN) serving area would create more bandwidth per user and reduce ingress noise accumulation. However, these fundamental problems remain, and the required costly network re-engineering is a bitter pill that is hard to swallow. It is a gamble, not a given, that a traditional upgrade approach would provide an operationally and economically viable platform for next-generation services.

Without alternatives, operators have little choice but to take this gamble, or watch while new opportunities (high-speed data, digital video, telephony, etc.) pass them by. However, the current upgrade path is based on traditional network technology which has evolved from the notion of providing broadcast analog TV services. Further, instead of resolving the infrastructure limitations,

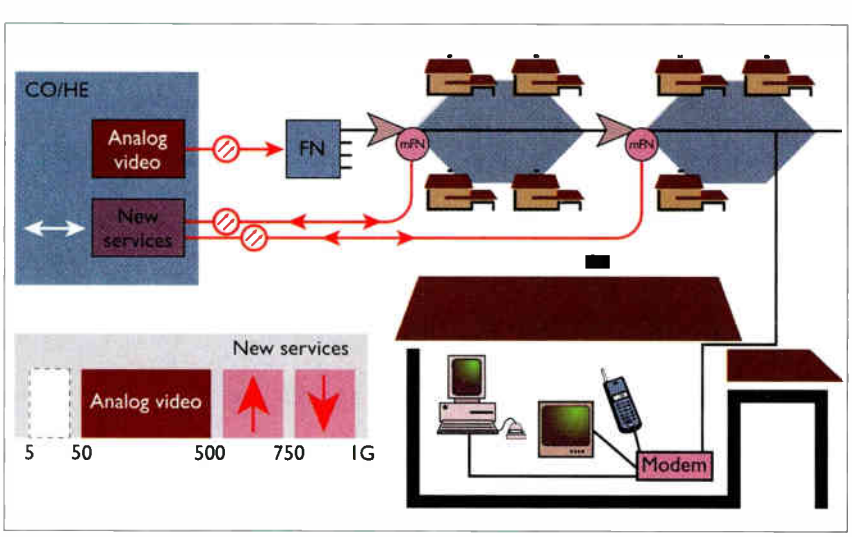

Figure 1: Mini-fiber node (mFN) for cable upgrade

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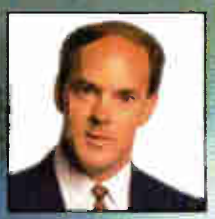

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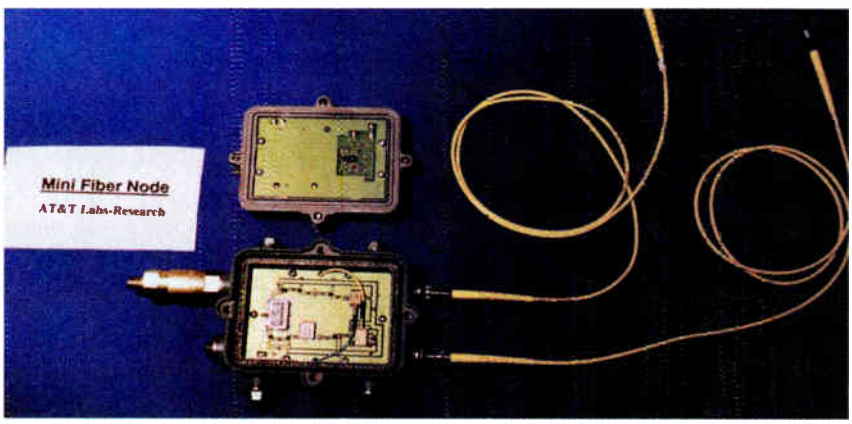

Figure 3: Early mFN prototype. The upper part consists of a power convertor, and the lower part contains all the photonic and RF components. This version uses two fibers, and the latest version uses only a single fiber for bi-directional transmission.

it relies on complex signal processing to attempt to make the resulting poor channels serviceable.

This article describes an alternative approach that aims at fixing the infrastructure first. Using emerging lightwave technology, the existing network is overlayed with an economically viable fiber-to-the-bridger architecture. This provides abundant ingress-free bandwidth and radically simplifies service provisioning. The resulting architecture enables simple and standards-compatible MAC protocols, easy operation schemes, low-cost terminals and a wide spectrum of new service opportunities while minimizing the cost of network redesign and re-engineering. All those technologies have been prototyped, evaluated and demonstrated over an HFC test bed at AT&T Laboratories.

Basic idea: Mini-fiber node

The mFN-based cable upgrade strategy is shown in Figure 1. Independent of existing systems, the mFNs couple directly into the passive coax legs (with drop taps) after each distribution coax amplifier (i.e. line extender). Each mFN contains a low-cost laser diode and a low-cost PIN diode, and is connected to the headend with a separate fiber.

Based on this strategy, the mFNs subdivide the FN serving areas into small cells (typically 50 households) and exploit the clean and large bandwidth at high frequency for both upstream and downstream transmission. The mFN therefore creates a new path for digital services without affecting analog TV services carried by conventional FN/amplified-coax paths. All services are then merged over passive coax distribution legs.

Indeed, this approach brings fiber to each coax distribution amplifier. At this point, readers may recall economic studies that illustrate clearly that shrinking node sizes to 100 or fewer homes passed (HP) is uneconomical. However, these studies do not apply to the mFN architecture, which separates analog video services from those delivered over this new "digital only" path. Hence, the expensive high-quality linear lasers used in traditional systems are replaced by low-cost lasers, and the mFN can be extremely simple, while serving a small group of users. The mFN is purely an O/E convertor without any A/D, modulation/demodulation or mux/demux functions. AT&T's analysis and prototyping experience show that the cost of each mFN is not a concern. The cost of fiber dominates, but is still under control, as discussed later.

By exploiting the clean and large bandwidth, this strategy avoids the complexities of traditional RF techniques (e.g., frequency agility) and related signal processing. This therefore simplifies system operation and reduces terminal cost. It also increases the overall system bandwidth beyond the current coax amplifier limitations, for new digital services, without replacing coax amps and changing amplifier spacing. For example, a system with 750 MHz bandwidth and 1 GHz passives (taps) cannot be operated above 750 MHz with the traditional approach. The mFN can use the 750 MHz to 1 GHz spectrum directly, independently of the coax amplifier capabilities.

Using this approach, the upgrade for two-way digital services is separated from the improvement of analog broadcasting service. A simple broadband digital platform can then be established without affecting existing analog services. No network re-engineering is needed, and the additional fiber can be installed along the

	mFN upgrade strategy	Conventional upgrade strategy
Architecture	Clustered fiber-to-the-amplifier	More tree-and-branch
Bandwidth capacity	250-450 MHz/50 HHP noise-free two-way bandwidth	35 MHz/500-2000 HHP noisy upstream 250-400 MHz/500-2000 HHP downstream, limited by coax amplifier
RF transmission	Allow simple and easy transmission	Bandwidth efficiency and robustness to noise are necessary
Operation	Simple operation (no frequency agility) Standard access protocol Easy network monitoring	Complex operation (spectrum management) Custom access protocol
Reliability	Small failure group (50 HHP) Better reliability	Large failure group (500-2000 HHP) Limited reliability
Upgrade	More fiber usage No network re-engineering One-stop upgrade, no need for further infrastructure investment Upgrade Cost: $100-200/HHP Capacity cost: $12-40/MHz two-way	Less fiber usage Extensive network re-engineering Architecture and cost barriers for future growth Upgrade cost: $200-400/HHP Capacity cost: $1.4K-11.4K/MHz upstream $125-1,600/MHz downstream

Table 1: Cable upgrade comparison

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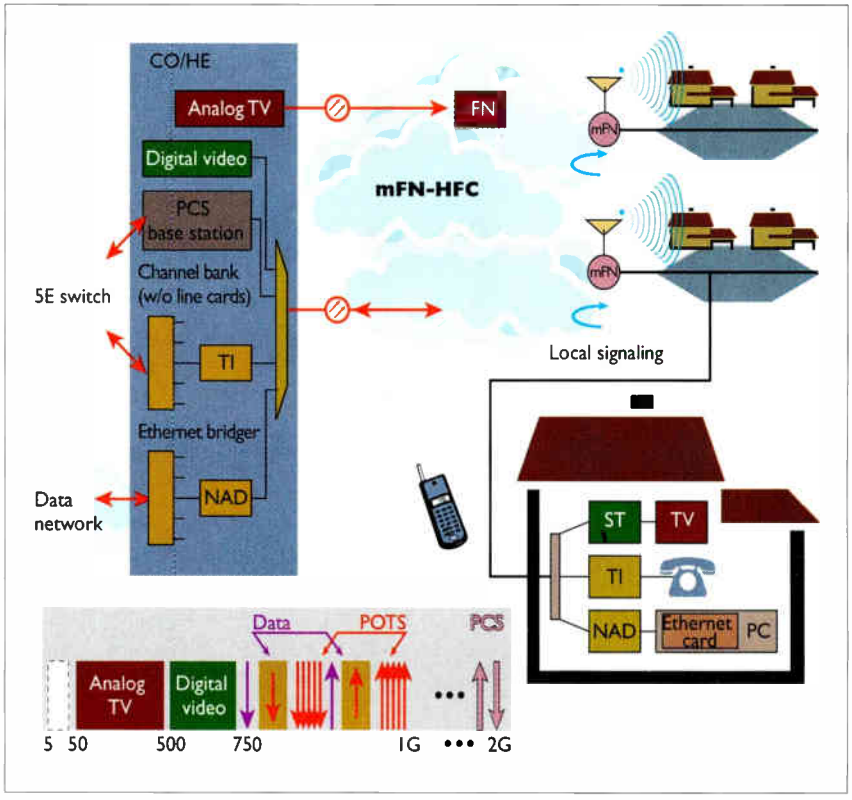

Figure 4: mFN-HFC for multiple services. NAD: Network access device–modified Ethernet transceiver; TI: Telephony interface–modified cordless phone handset or base; ST: set-top box.

existing strands. This strategy can be incorporated into an ongoing "analog-service-enhancement" upgrade, thus minimizing incremental cost. On the other hand, if the analog service works satisfactorily, the mFN technology could be transparently implemented over embedded systems for new services, therefore eliminating the need for system redesign and re-engineering.

Also, by bypassing the coax amplifier cascade, the new mFN/passive-coax architecture has substantially higher reliability and smaller failure group size (50 HP compared with 500-2,000 HP) than conventional cascade-coax architecture. The positioning of mFNs in the network further enables easy network monitoring.

Because the mFN is transparent to two-way traffic, the system capacity can be provisioned to meet both today's service needs and the need for future growth. No further infrastructure investment is needed.

The major challenge is, of course, bringing lightwave components and fiber deeper into the network, at a reasonable cost. Unlike the conventional FN-splitting approach, mFNs only carry digital subcarrier signals over a clean high-frequency band. Therefore, low-cost, low power consumption and space-saving optical and RF components can be used in the mFNs and also at the headend.

Figure 2 illustrates the capability of a $100 uncooled Fabry-Perot laser used in the mFN. This device requires no thermo-electric cooler and no optical isolator to maintain acceptable performance, in strong contrast to the high-performance lasers used to deliver analog video. A prototype mFN, including power convertor, laser, PIN diode and roughly 50 dB of amplifier gain in each direction, fits into a typical tap box (see Figure 3). Given the cost of the laser, minimal power con-

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sumption (<1W/mFN) and functional simplicity, the projected cost of each mFN is small enough not to be relevant.

The dominant cost of this mFN-HFC architecture is that of the fiber deployment. Operators have enough experience deploying fiber to nodes serving 500 to 2,000 homes to be able to predict reasonable costs for an mFN system deployment. Estimates over several cable systems show that, depending on system specifics like demographics and topography, a complete mFN deployment, including fiber deployment, costs $100 to 200 per home passed. A traditional upgrade, based on operators' experience, costs $200 to $400 per home passed. This, of course, depends strongly on the amount of coax re-engineering required to complete the traditional upgrade.

In some cases, a mini-coax node, which is a diplexer-based jumper to shunt high frequency signals around a coax amplifier, could also be used to reduce the amount of mFNs, and therefore, fiber cost. Also, if mFNs are clustered to some local hubs, as favored by many cable operators, the cost of an mFN strategy could be substantially lower.

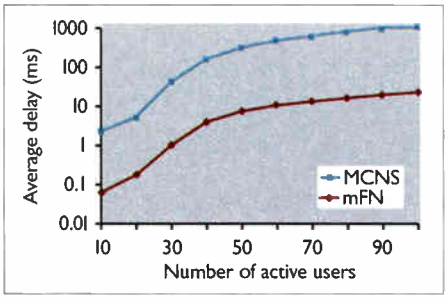


Figure 5: Upstream delay comparison between mFN-based NAD and MCNS standard-based cable modem. It was assumed that the average data rate is 120 kbps/user, with total speed of 10 Mbps. The assumptions for the MCNS modem will change in real implementation.

Yet the performance and capacity of the resultant mFN infrastructure could be far superior to that of the traditional system. Especially when we are moving into the broadband arena, the capacity cost (dollars per MHz) is probably a bigger concern to operators (Table 1). Most important, the mFN technology provides a one-stop upgrade for two-way broadband and creates more value that cannot be provided otherwise.

If one breaks from tradition and fixes the infrastructure to establish a noise-free broadband digital platform, rather than using complex signal processing over a capacity-limited network, then numerous opportunities arise.

Data services. The unique position of each mFN enables a considerable simplification in defining medium access control (MAC) protocols. Each mFN can do local policing, and resolve upstream contention within its serving area without involving other parts of the networks (see Figure 4). This can be accomplished by incorporating a simple out-of-band signaling loopback scheme such that users know the upstream channel status prior to transmission. This enables the use of standard, but full-duplex, Ethernet protocol (CSMA/CD), and therefore the use of standard and low-cost terminals (modified Ethernet transceiver, Ethernet bridger and Ethernet card). No ranging is needed, and the headend becomes virtually operation-free.

The relative small round-trip delay between each user and the mFN (about 2,000 feet) also substantially increases bandwidth efficiency and reduces contention delay (see Figure 5). This is appealing for VBR (variable bit rate) types of services. For CBR (constant bit rate) services, certain scheduling or priority provisioning may be necessary, which can be added easily to the above protocol. The local access control in the clustered small mFN serving area further simplifies system operation, enables QoS and multi-

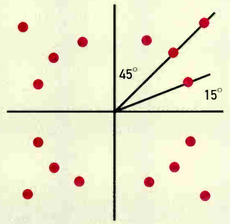
CED CABLE MODEM DEPLOYMENT UPDATE

Quadrature Amplitude Modulation (QAM)

This form of modulation was chosen through the Cable Television Laboratories Data-Over-Cable Service Interface Specification (DOCSIS) process for the downstream communication path (from headend to modem). QAM utilizes amplitude and phase modulation to transmit multiple bits per baud. Several varieties of QAM exist (16-, 64- and 256-QAM being the most popular), providing various levels of bandwidth efficiency. QAM is preferred because it supports high data rates and because it can be inserted into a typical 6 MHz television channel without interfering with the video signal.

In general, QAM data can achieve transfer rates of up to 36 megabits per second over a cable TV network. The downstream data is placed in a TV carrier somewhere between 42 MHz and 750 MHz, preferably in the higher frequency ranges, in order to avoid possible conflicts with Ham operators, citizens band radio transmissions and impulse noise.

How it works: QAM is used to encode a variable number of bits into both a phase and amplitude modulated signal. An unmodulated digital signal exhibits only two possible states, which means it can only be transmitted as either a "zero" or a "one." With QAM, it is possible to send many more bits per state, because there are more states. A signal can be synthesized by summing amplitude-modulated sine and cosine waves. These two components, being 90 degrees out of phase, are called quadrature. These "states" are typically represented in constellation diagrams, as shown at right.



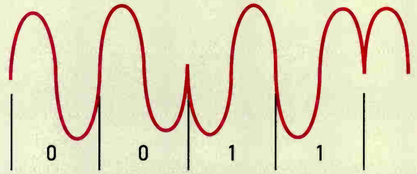
Quadrature Phase Shift Keying (QPSK)

A robust form of modulation, QPSK is preferred for signal transmission in the noise-plagued sub-low return band between 5 MHz and 40 MHz in cable television systems. QPSK is more immune to the Ham radio signals, citizens band transmissions and various sources of impulse noise that are often found in the return path.

Because of this, the modulation method was chosen as the specification for the upstream (from modem to headend) signal flow by Cable Television Laboratories Data-Over-Cable Service Interface Specification (DOCSIS).

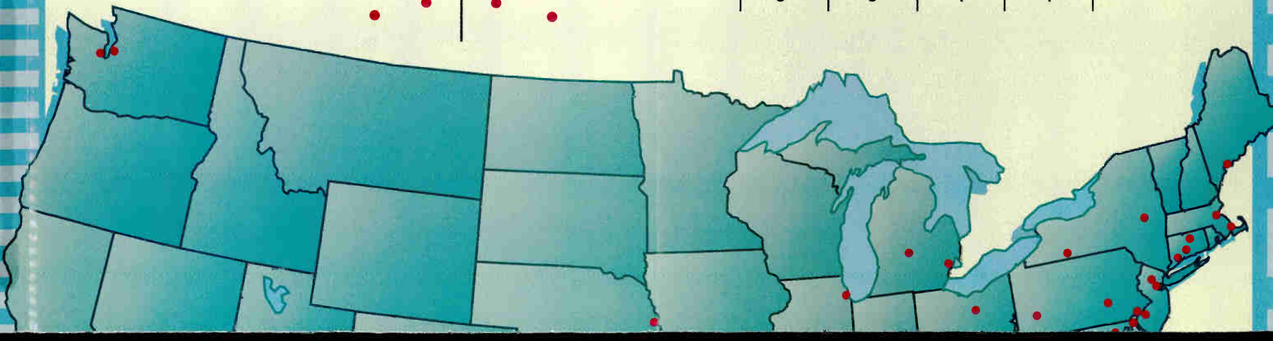
The robustness doesn't come for free, however. QPSK can only achieve data transfer rates of up to 10 megabits per second.

How it works: Phase shift keying is a technique which shifts the period of a wave, so that it is out of phase with the one that came just before it. The waves are shifted by one-quarter of the wave's full period. It can therefore be shifted three times (one-quarter, one-half and three-quarters of its period), resulting in a total of four waves. Then, each wave is assigned a different digital bit value.



Current household base for cable data services

MSO	City served	Homes passed	Modem supplier	Monthly rate*	Install charge
Adelphia	Northern Palm Beach County, Fla.	250,000	G. I.	$34.95	$99.95
	Toms River, N.J.	N/A	LANcity	N/A	N/A
	Coudersport, Pa.	N/A	LANcity	N/A	N/A
	Amherst, N.J.	N/A	LANcity	N/A	N/A
	Plymouth, Mass.	N/A	LANcity	N/A	N/A
Cablevision Systems	Long Island Communities	150,000	Bay Networks	$45	$150
	Westport, Conn.	10,000	Bay Networks	$29.95/$44.95	$150
Charter Comms.	Pasadena, Calif.	N/A	Com21	N/A	N/A
	Riverside, Calif.	N/A	G.I.	N/A	N/A
Comcast Corp.	Baltimore County, Md.	N/A	Motorola	$39.95	$175
	Greater Philadelphia	N/A	Motorola	$39.95	$175
	Greater Detroit	N/A	Motorola	$39.95	$175
	Northern N.J.	N/A	Motorola	$39.95	$175
	Orange County, Calif.	N/A	Motorola	$39.95	$175
	Sarasota, Fla.	N/A	Motorola	$39.95	$175
Cox Comm.	Meriden, Conn.	N/A	Motorola, Bay	$44.95	$175
	Mission Viejo, Calif.	18,000	Motorola	$44.95	$175
	Omaha	15,000	Motorola	$44.95	$175
	Phoenix	50,500	Motorola	$44.95	$175
	San Diego	N/A	Motorola	$44.95	$175
Gans Multimedia	Western Shore, Md.	20,000	Bay Networks	$39.95	N/A
GTE	Clearwater, Fla.	96,000	Zenith	$43.90	$34.95
	Ventura County, Calif.	54,000	Bay Networks	$48.90/$64.90	$93
InterMedia Partners	Nashville	335,000	Motorola	N/A	N/A
	Greenville/Spartanburg, S.C.	120,000	Motorola	N/A	N/A
Jones Intercable	Alexandria, Va.	62,000	Bay Networks	$39.95	$99.95
	Prince Georges County, Md.	N/A	Hybrid Networks	$21.95	N/A
Marcus Cable	Fort Worth	200,000	Bay Networks	N/A	N/A



Cable modem vendors

Company name	Modem model	DOCSIS compliant?	Proprietary 2-way?	Telco return?	Availability	Price	Notes
ADC Telecommunications www.adc.com	ACE	x			7/98		with Phasecom
Bay Networks www.baynetworks.com	LCP LCx	 x	x		immediate TBD		
Com21 www.com21.com	ComPort 1000 ComPort 2000 TBA	 x	x x	x x	immediate immediate TBD		ATM based ATM based
Daewoo Electronics www.daewoo.co.kr	TBA	x			3Q98		
E-Tech www.e-tech.com.tw/engh/	ETC 610	x					
General Instrument www.gi.com	SB2100 SB1000 SB1200	x		 x x	6/98 immediate 4/98	TBD $199 $349	 33.6 modem
Harmonic Lightwaves/ New Media Corp. www.harmonic-lightwaves.com	NMC 010 NMC 020 NMC 030			x x x			ASK card QAM card QPSK card
Hayes www.hayes.com	Ultra TBA	 x		x 	 TBD		
Hybrid Networks www.hybrid.com	TBA Single-user Multi-user Single-user Multi-user	x	 x x	 x x 	4/98 immediate immediate immediate immediate	TBD $295 $540 $370 $615	
Integrity www.integrity-modems.com	PTP-8		x				
[illegible] [illegible]	CablePort			x			

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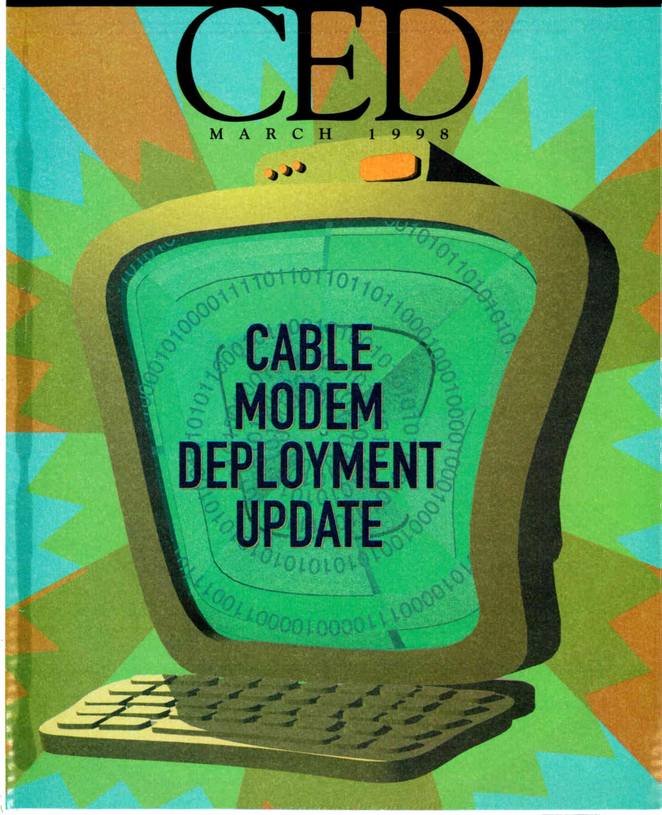

CABLE MODEM DEPLOYMENT UPDATE

Mediacom	Ridgecrest, Calif.	17,500	G. I.	N/A	N/A
MediaOne	Atlanta	N/A	Motorola	$39.95	$150
	Boston area	225,000	Bay Networks	$39.95	$150
	Broward and Dade Counties, Fla.	400,000	G. I.	$34.95**	$150
	Chicago	N/A	Motorola	$39.95	$150
	Detroit area	40,000	Bay	$39.95	$150
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	Los Angeles	N/A	N/A	$39.95	$150
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Palo Alto Co-op	Palo Alto, Calif.	56,000	Com21	$99.00	N/A
Prime Cable	Las Vegas	N/A	Com21	N/A	N/A
Suburban Cable	Harrisburg, Pa.	N/A	N/A	N/A	N/A
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	Hartford, Conn.	N/A	Motorola	$39.95	$150
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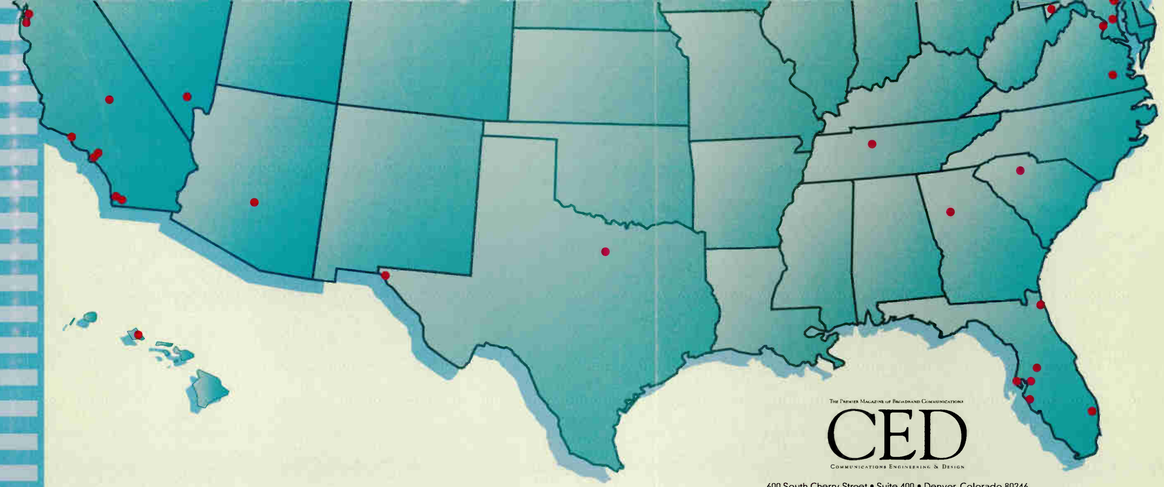
	Binghamton	60,000	Motorola	$39.95	$99
	Corning/Elmira, N.Y.	60,000	Motorola	$24.95	$99
	El Paso, Texas	218,000	Toshiba	$39.95	$99
	Oahu, Hawaii	332,000	Motorola	$39.95	$99
	Portland, Maine	77,000	Toshiba	$39.95	$99
	San Diego	135,000	Motorola	$44.95	$99
	Tampa Bay, Fla.	N/A	Motorola	$39.95	$99
21st Century	Chicago	N/A	Zenith	$50.00	N/A
US West	Omaha	36,000	Bay Networks	N/A	N/A

*Monthly rates are prices charged cable TV subscribers and include cost of modem rental, non-cable subs usually pay a surcharge of $10 or more for data service over the base rate. Some MSOs offer subscribers the option to purchase modems and typically charge $10 to $20 bms per month. A range in rates indicates pricing for different levels of consumer service; rates are not given for business services.
**MediaOne charges the lower rate for users connected via one-way modems supplied by General Instrument.
Source: Broadband Commerce and Technology newsletter



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SOURCE: CED research, industry sources
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TBA= Vendors have announced their intention to comply with DOCSIS, but modem name has not been announced.

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tier services capability, and makes overall cost independent of usage rate.

In contrast, the large round-trip delay of traditional cable systems makes this an unfavorable or unacceptable protocol, forcing the industry to standardize complex headend mediated protocols. Such protocols rely on centrally controlled broadcasting schemes over large serving areas with limited channel capacity. They work well in lightly loaded systems, but fall short and become expensive if capacity demand increases.

The large and clean bandwidth supported by the mFN infrastructure also enables the use of efficient but much simpler modulation schemes such as multi-level FSK or even ASK. This therefore provides a low-cost alternative to the custom RF techniques incorporated into current cable modems.

Telephony services. The mFN local access control protocol with QoS capability can easily support packet voice and other synchronous and mixed synchronous/asynchronous services. Alternatively, the large bandwidth and small serving area provisioned by each mFN allow dedicating one or more RF channels to each user for synchronous telephony services. Whereas the traditional approach uses time-shared channels to increase spectral efficiency, the mFN system can use a less efficient but simpler approach, like FDM/FDMA (see Figure 4).

Freedom from ingress noise eliminates the need to have complex ingress-avoidance features built into the call-control software. One can then consider leveraging cordless phone technology, with modifications suited to the mFN architecture. Normally, cordless phones convert the voice signal into an RF signal (digital or analog) for transmission over the air between the base and the handset. It has been demonstrated that RF channels can instead be transmitted directly over the mFN system between the base, located at the headend, and the handset at home.

By reconfiguring the parts of a cordless phone handset to make it also interface with regular phone sets, off-the-shelf technology can be utilized for telephony services without incurring the cost and complexities of traditional NIUs. The low power consumption of cordless phone technology also simplifies the powering scheme and makes home-powering more attractive. At the central office/headend, instead of using a custom HDT, the standard but simplified telco interface, such as the channel bank (but without line cards and battery), could then be used.

Digital TV. Independent of analog TV services carried by the existing amplified-coax path, multichannel digital video can be directly broadcast over the mFN path. This eliminates the analog-digital interference arising from clipping and nonlinearity of lasers and coax amplifiers, and also substantially increases the cable network channel capacity without network re-engineering. Because digital video signals do not have the stringent requirement that the AM-VSB does, low-cost lasers and electronics can be used (Figure 2). The small serving area provisioned by each mFN also enables easy narrowcasting schemes.

	mFN-HFC	Conventional HFC
Data	Standard protocol (IEEE 802.3/Ethernet) Simple terminals, off-the-shelf components High-efficiency, low-delay and easy to scale	Custom protocol (MCNS, IEEE 802.14) Complex terminals Large overhead and delay, expensive to scale
POTS	Simple FDM/FDMA Standard telco interfaces	Complex TDM/TDMA Custom interfaces
Digital TV	Low-cost laser for broadcasting Automatic capacity enhancement Easy narrowcasting	Need further network upgrade May need to resolve analog-digital interference
PCS	Remote antenna at mFN Advantageous lightwave backhaul	Competing for coax bandwidth

Table 2: Service capability comparison

PCS. By including a remote antenna at each mFN, the mFN-HFC system provides an advantageous backhaul for wireless PCS applications. The unique location of each mFN allows the use of various distributed antenna or simulcasting techniques. The direct lightwave backhaul also allows PCS signals to be directly transmitted between the base station at the headend and the remote antenna at each mFN without competing for coax bandwidth. This effectively extends the overall cable network capacity beyond coax limitations.

The above technology has been prototyped and evaluated over an HFC test bed at AT&T Labs. A demo there shows the simultaneous delivery of 80 channels of MPEG-2 digital video, 10 Mbps bi-directional data (full-duplex Ethernet), and telephony service over the mFN system, in addition to the existing analog video carried by the traditional HFC.

Bottom line

HFC is no doubt the first economically viable means for broadband services. However, well-known network problems limit the value it can provide, and traditional solutions create unresolved challenges and complexities. The problems associated with the traditional cable upgrade may render the resulting systems incapable of supporting, or cost-effectively supporting, the services that operators will demand in the near future.

The authors have described an alternative approach, based on new technology, that offers a means to a future-proof HFC architecture. Aggressive fiber deployment is advocated, and it is shown how the resulting abundant ingress-free bandwidth and the advantageous architecture can reduce operation and terminal complexities and create more opportunities that the traditional strategy could not provide (see Table 2). Economic studies project that the cost of this new system is, in many cases, comparable to that of the traditional approach. Yet the mFN infrastructure enables significant cost reduction on system operation and terminal equipment. ■

About the authors

All of the authors are with Communications Infrastructure Research at AT&T Labs. Ted Darcie is AT&T Labs vice president.

This article was originally published in the SCTE's 1998 Emerging Technologies proceedings manual.

Praise shines on Williamson

1998 Polaris Award goes to Time Warner engineer

By Leslie Ellis, CED
Contributing Editor

Louis Williamson, senior project engineer for Time Warner Cable, was presented with the prestigious Polaris Award during the SCTE Conference on Emerging Technologies, illuminating his contributions to optical advancements in the broadband industry.

The award, sponsored by Corning Inc., *CED* magazine and the SCTE, was created to recognize the efforts of a "next-generation" cable engineer who exemplifies an aggressive and innovative approach to fiber optic deployment. Williamson now adds his name to the impressive list, which includes Tom Staniec of RoadRunner; Jim Ludington of INT2; Hugh McCarley of Cox Communications; John Brouse of 21st Century; and Oleh Sniezko of Tele-Communications Inc.

Williamson fit that bill because of his early work on fiber optics in the mid-1980s, when lightwave was considered to be more of a voodoo concept than a commonplace signal transport method. His fiber roots go back to a project in which he was charged with finding a laser that would transmit analog signals, which he discovered at Ortel Corp.

"We put 40 channels through the laser, and the pictures weren't all that great, but they were pictures—it proved to us that it would work," he said.

After that, Williamson participated in refining the technology for wide-scale use, then served for a time as Time Warner's fiber expert, training technical staffers on how to install lasers and receivers in the field.

Notably, one of Williamson's students was previous Polaris Award winner Ludington, who is now president of INT2, a system design and integration firm. Back when he worked with Williamson, Ludington was the Time Warner engineer who spearheaded the MSO's 1-GHz project in Brooklyn/Queens, N.Y. and the Full Service Network in Orlando, Fla.

"He was a star student," Williamson laughed.

Williamson, who often toils behind the high-profile scenes, is no stranger to awards, however. He accepted a Technical Emmy Award with colleague Jim Chiddix, chief technical officer for Time Warner, two years ago for their work in Orlando.

Williamson: 1998 Polaris Award winner

Williamson accepted the award by remarking that "it's been an exciting week in Denver," referencing his hometown Broncos' win during Super Bowl XXXII and his own big win.

After thanking his colleagues and peers, Williamson said that "when I look back and see the things that have been enabled by fiber optics, I'm both shocked and amazed" at the momentum the technology is now enjoying.

Williamson was awarded a piece of Steuben crystal. The award sponsors also donated $5,000 to the SCTE in Williamson's name, to further lightwave-related training. ■

PHOTOS BY STEVE YOUNG, JOWDY PHOTOGRAPHY

Williamson poses with the Polaris Award sponsors. (L to R) Bill Riker, SCTE; Rob Stuehrk, *CED* magazine; and Pat Brown of Corning Inc.

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Louis Williamson, Senior Project Engineer, Time Warner Cable, embodies the principles of the Polaris Award. We're proud to recognize his exceptional vision, achievements and contributions to the cable television industry.

The winner of the Polaris Award receives the handsome Steuben "Rising Star" crystal sculpture shown here. Corning also will donate $2,500 to the SCTE in the honoree's name to fund fiber-optic technology training.

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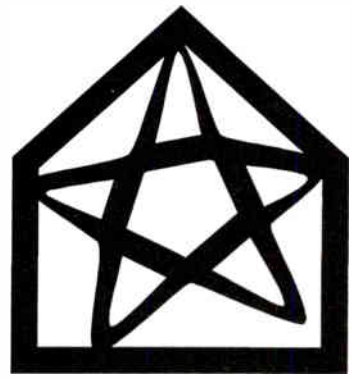

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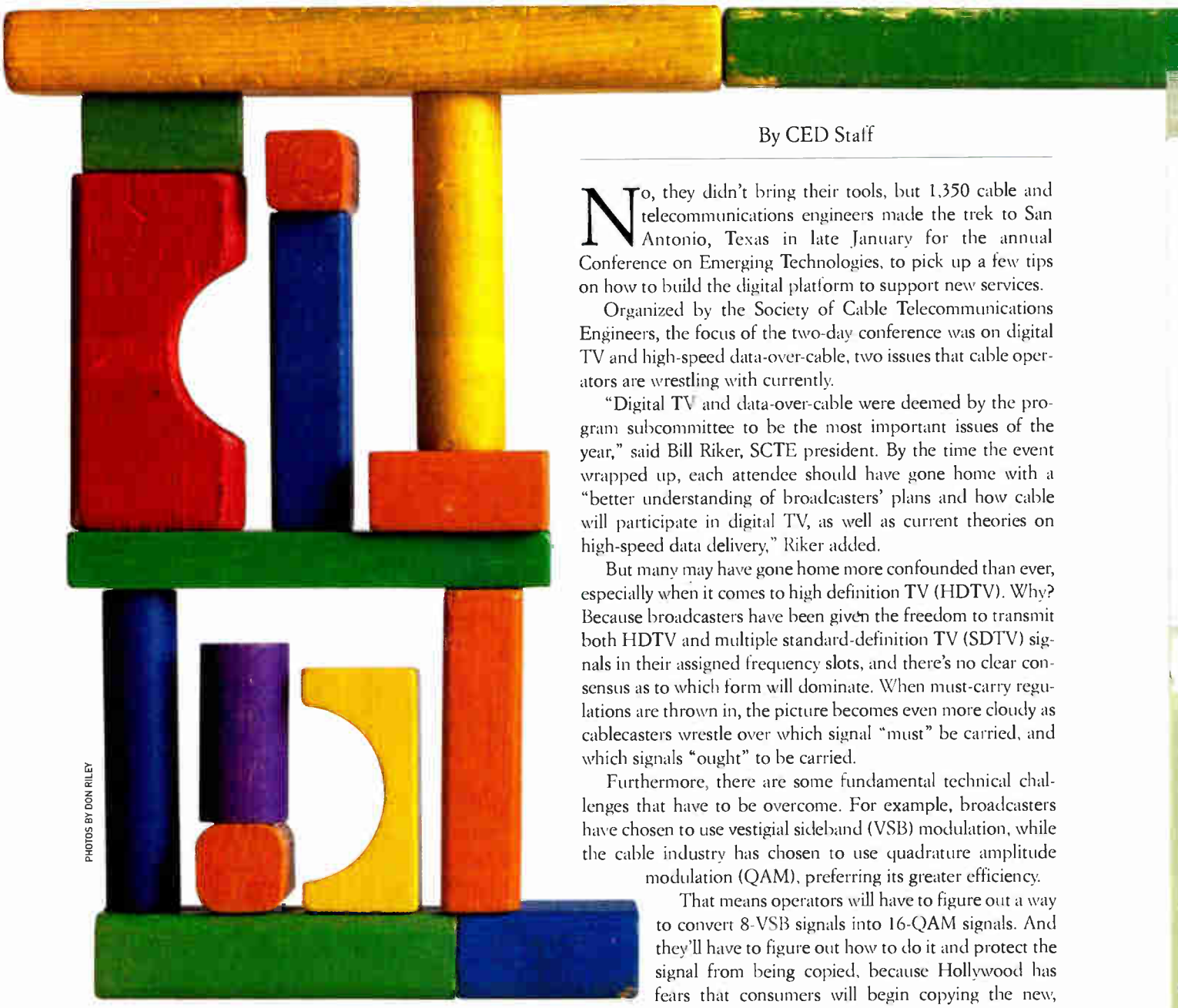

PHOTOS BY DON RILEY

By CED Staff

No, they didn't bring their tools, but 1,350 cable and telecommunications engineers made the trek to San Antonio, Texas in late January for the annual Conference on Emerging Technologies, to pick up a few tips on how to build the digital platform to support new services.

Organized by the Society of Cable Telecommunications Engineers, the focus of the two-day conference was on digital TV and high-speed data-over-cable, two issues that cable operators are wrestling with currently.

"Digital TV and data-over-cable were deemed by the program subcommittee to be the most important issues of the year," said Bill Riker, SCTE president. By the time the event wrapped up, each attendee should have gone home with a "better understanding of broadcasters' plans and how cable will participate in digital TV, as well as current theories on high-speed data delivery," Riker added.

But many may have gone home more confounded than ever, especially when it comes to high definition TV (HDTV). Why? Because broadcasters have been given the freedom to transmit both HDTV and multiple standard-definition TV (SDTV) signals in their assigned frequency slots, and there's no clear consensus as to which form will dominate. When must-carry regulations are thrown in, the picture becomes even more cloudy as cablecasters wrestle over which signal "must" be carried, and which signals "ought" to be carried.

Furthermore, there are some fundamental technical challenges that have to be overcome. For example, broadcasters have chosen to use vestigial sideband (VSB) modulation, while the cable industry has chosen to use quadrature amplitude modulation (QAM), preferring its greater efficiency.

That means operators will have to figure out a way to convert 8-VSB signals into 16-QAM signals. And they'll have to figure out how to do it and protect the signal from being copied, because Hollywood has fears that consumers will begin copying the new,


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DIGITAL

HDTV demos, hands-on testing

What's a discussion about HDTV if there isn't a demonstration involved? This year, for the first time at its annual Conference on Emerging Technologies, the SCTE featured viewing salons for attendees to see the latest equipment for HDTV. Demonstration areas were set up by Zenith and PBS, while Panasonic showed a demo of digital TV.

Also, the SCTE had an analog and digital test procedure demonstration area, hosted by the SCTE Interface Practices Subcommittee. The purpose of this demo was to give cable technical personnel a chance to review newly-adopted test procedures, as adopted by the Subcommittee. Specifically, test procedures for composite triple beat, composite second-order, cross-modulation and digital were shown.

high-quality images without authority.

But after all the regulatory uncertainty was hashed out, the bottom-line question for many engineers became: "How much bandwidth do I really need?," which was asked by Tom Jokerst, VP of engineering at Charter Communications. MSOs that are already wrestling with limited bandwidth could become even more bandwidth impaired if they have to carry broadcasters' HDTV and SDTV channels.

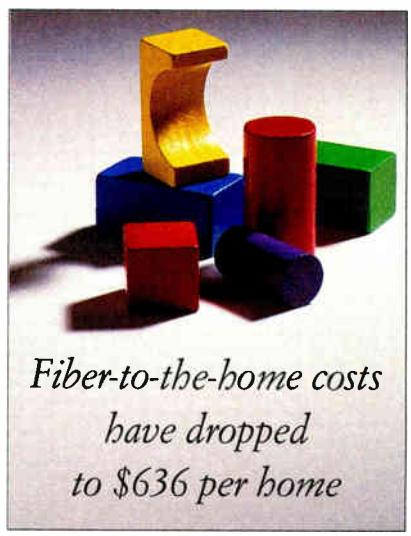
One solution to the problem is to increase the amount of bandwidth capacity, which was also addressed during the conference. For example, a team of AT&T engineers proposed a method to drive fiber deeper into the network, adding a digital overlay for new services (for details, see "Fiberline," page 52).

Or, why not take fiber all the way to the home, as some have suggested for years? While most cable engineers still scoff at the need to do that, the cost of the hardware has come down dramatically, according to analysis by Earl Langenberg, VP of network implementation at Tele-Communications Inc.

Langenberg outlined how a new fiber-to-the-home network with 2 GHz capacity proposed by Synchronous Communications can be deployed to support both analog and digital signals, while supporting both residential and commercial applications.

All network components are passive beyond node points serving 30,000 or more households, representing a big improvement over FTTC, with its need for bulky, power-consuming and damage-sensitive electronics on every neighborhood pedestal. EDFAs positioned at the 30,000-home hub amplify the split signal from the central transmitter, generating enough power to support distribution in a tree/branch mode to individual homes at a splitting ratio of 64 individual fiber drops per feeder fiber.

This set-up supports delivery of 110 analog broadcast channels plus 200 digital broadcast channels at a carrier-to-noise level of 48 dB at each house-mounted optical network unit (ONU), or, if the analog/digital ratio is 77 analog/400 digital, a CNR of 49 dB at each ONU. The laser capacity at the central transmission point is such as to leave an additional 1 GHz of bandwidth for delivery of high-speed data to households and/or other dedicated signals to commercial users within the 30,000-home serving area.



Fiber-to-the-home costs have dropped to $636 per home

For future expansion to accommodate more interactive services, second, third and additional wavelengths can be added from the central transmission point to each trunk fiber for delivery of dedicated voice and data signals through the EDFAs and splitters to each household, using wavelength division multiplexers to separate the signals at each ONU. Return signals from each resident are delivered via Fabry-Perot lasers operating at the 1310 nm wavelength.

Langenberg estimated the single-wavelength version of the FTTH system would cost $636 per home passed, or $909 per customer, based on 70 percent penetration, vs. average costs of $372 and $531 for HFC. HFC costs can be higher, depending on levels of fiber penetration, amplifi-

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Its technology-independent stance - which now includes licensing General Instrument's DigiCipher II conditional access (CA) system - quickly enabled it to license and incorporate News Corporation's CA system into its receivers. And its regional manufacturing facilities allowed it to respond flexibly to changes in demand.

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CED3

Are ops ignoring the capacity crunch?

Fiber revolution provides new bandwidth options

PHOTO BY UNIPHOTO

By Fred Dawson, Contributing Editor

The search for new fiber-based solutions to bandwidth expansion in local distribution networks has reached a low ebb within the broadband operations community just when there's every reason to believe a more aggressive pursuit of the options could pay off handsomely in the not-too-distant future.

Lost in the debate over how many well-heeled couch potatoes will buy $10,000 HDTV sets is the question of what happens when those set prices get down to within a few hundred dollars of today's large-screen CRT-based sets, or when flat-screen technology begins to offer cost-effective alternatives to high-end home theater projection systems.

What happens, in other words, if it turns out HDTV, as opposed to standard definition digital TV, becomes the norm in consumer hardware purchasing decisions and, by extension, in the formats chosen by broadcast and cable programmers alike?

And what if, as all investors in advanced digital set-tops spec'd to the OpenCable standard must hope, interactive services of every description, from enhanced Internet to video-on-demand to residential videoconferencing, take hold as the premium services of the future?

"The signs are all around us that the demands on network capacity are going to explode," said Vince Borelli, CEO of Synchronous Communications. "But we're just not seeing the push for new solutions that you'd expect now that there are so many things you can do with fiber that weren't possible before."

Synchronous, a leading supplier of dense wavelength division multiplexing and optical amplification systems designed especially for cable networks, has seen rapid growth in the use of such equipment in regional backbone networks, Borelli notes. "Now that the benefits of 1550 (nanometer wavelength) technology are being routinely applied in linking headends and primary hubs, maybe there'll be less resistance on the distribution side than we've seen in the past," he added. "But first, people have to see the need for the type of expansion path this technology offers."

Indeed, it's ironic that just as a revolution in optical technology is finally opening new vistas for use of fiber in distribution plant, it's hard to find anyone within the operations community who's spending much time exploring the possibilities. That irony was brought into focus at the recent Emerging Technologies Conference sponsored by the Society of Cable Telecommunications Engineers in San Antonio, where presentations suggesting deep use of fiber at heretofore unheard-of low costs were largely met with expressions of mild interest at best, and with no indication that such ideas are fostering heightened pursuit of new fiber solutions

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within engineering circles.

Even one of the speakers was quick to dismiss the possibility that his revealing research into the economics of fiber-to-the-home was part of any new strategic thinking at his company. "There aren't any projects we're involved in where there's a need for what I'm talking about here," said Earl Langenberg, vice president of network implementation at Tele-Communications Inc. That applies to use of advanced optical technology in upgrades as well as new-builds, he noted, adding that TCI's upgrade effort remains focused on maximizing the usefulness of existing plant with application of 450 MHz technology.

Whether it's 450, 550 or 750 MHz, MSOs have placed their bets on whatever versions of traditional HFC architecture they believe will get them where they want to go through the lifespan of recently or soon-to-be upgraded plant, which is to say, over the next 10 years or more. And the telcos, having largely abandoned pursuit of video over fiber-rich architectures, have swung their attention to making DSL (digital subscriber line) technology work as the vehicle for delivering a new generation of data services to the mass market.

HLI believes the passive DWDM approach is cheaper than other broadband options for a new-build situation

Because any use of this technology for video delivery in the foreseeable future requires products designed for AM transmission, it is the manufacturers of optical systems for the cable industry who seem to be opening the door to new thinking about fiber architectures among the telcos. Both Synchronous and Harmonic Lightwaves Inc. (HLI) are working on development of systems that will use multiple wavelengths to support delivery of broadband services to the home over telco networks.

"BellSouth and Sprint are now conducting tests using our equipment in fiber-to-the-curb applications," said John Trail, product manager for transmission systems at HLI. Borelli said telcos, which he declined to name, are testing Synchronous gear as well.

HLI's passive DWDM distribution system, which the company hopes to bring to market in the second quarter, delivers eight wavelengths of narrowcast signals to a distribution hub over one fiber, and up to 110 broadcast analog signals over a second fiber. Wavelengths are passively demultiplexed at the hub and then recombined so that each narrowcast wavelength is transported with the analog wavelength channel to anywhere from one to four nodes, depending on the size of the serving areas.

HLI believes the passive DWDM approach is not only cheaper than other broadband network options for a new-build situation, but also has cost-saving advantages for upgrade situations as well. "If you look at a traditional narrowcast design for an HFC (hybrid fiber/coax) network, you need a lot of modems and other sophisticated electronics in the hub," Trail said. "This design avoids the costs and operational problems associated with putting all that gear in the field."

Nothing better illustrates what's in store for the use of DWDM in the local transport market than the plans of Alcatel Telecom, which has created a new optical business unit based in Richardson, Texas to serve short- and long-haul sectors, marking the first time it has located a world-wide business unit in the U.S. "We believe the U.S. is two to three years ahead of the rest of the world in demand for capacity expansion that will require DWDM," said Tim Krause, director of product marketing and business development for the lightwave products unit.

Over the past year, along with the implementation of DWDM over long-haul routes, one of the most significant developments in this technology was the introduction of add/drop multiplexers, sometimes referred to, erroneously, as cross-connects, by a number of manufacturers, including Alcatel. Add/drop muxes, which support routing of wavelengths without electronic conversion of signals as in traditional

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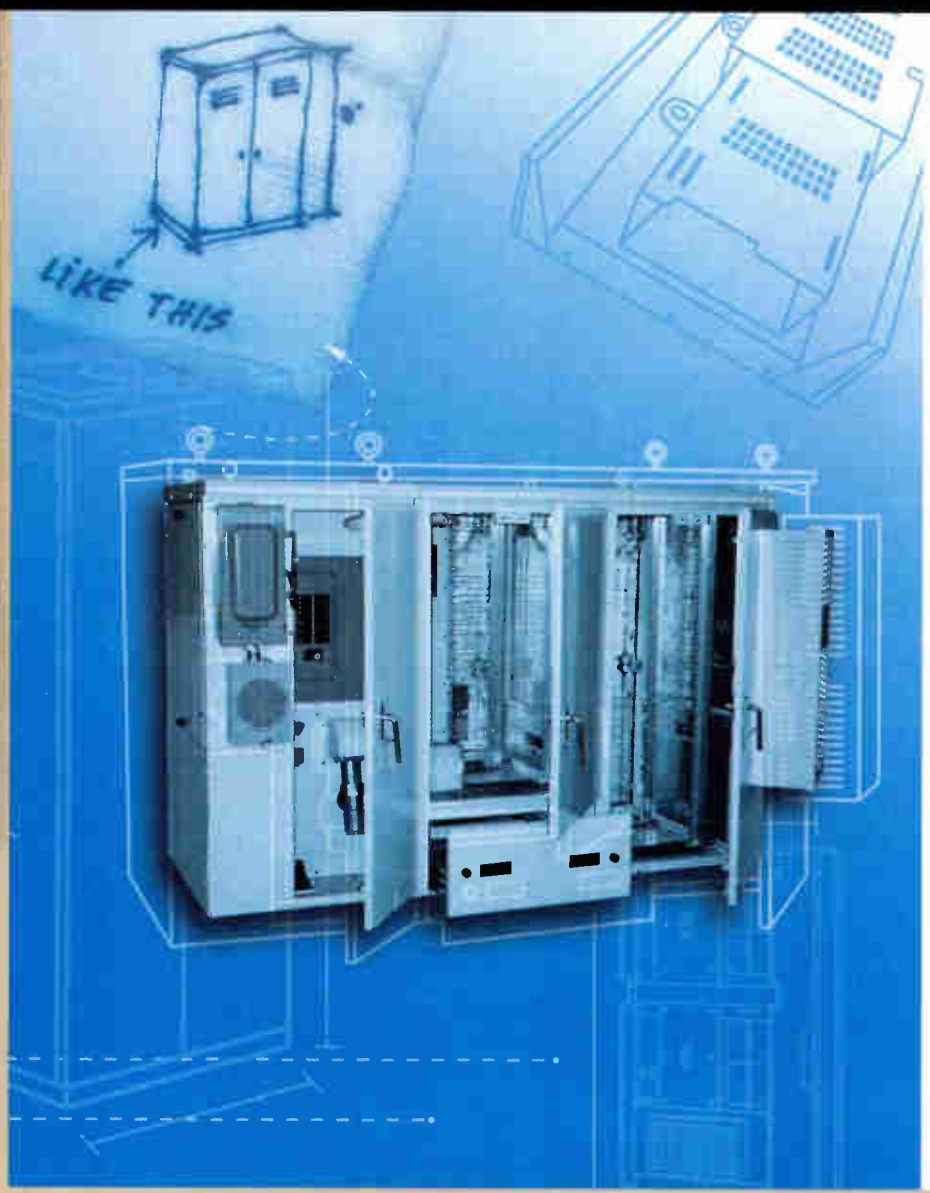

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switching, "change the whole equation for optical networking" in the local transport market, Krause said.

For example, he noted, owners of fiber links will be able to sell "fractional dark fiber," using some wavelengths for themselves and wholesaling others. Moreover, the marketing of transport on a wavelength basis will allow end users and operators to implement services as needed without investing in equipment that will aggregate the signals carrying those services into higher-speed backbone tiers, such as high-speed Sonet layers. But while such multiplexers will help DWDM take off in the local transport business, the big breakthrough will come with manufacture of true optical cross-connects, which is "an extremely complicated beast," Krause noted. "To be a real cross-connect, it must be non-blocking, which none of the so-called optical cross-connects being introduced now can do," he said.

The big breakthrough will come with the manufacture of true optical cross-connects . . .

With the non-blocking capability, not only are the wavelengths routed or switched on the fly, but they are translated into other wavelengths to take advantage of available wavelength slots in a given fiber link as those slots open up in the ongoing routing process. Without this capability, which must be accomplished without converting the signal to electronic frequencies and then regenerating it, a switched wavelength will be blocked until its slot opens over a desired link, which is something carriers can't live with in the high-volume trafficking environment of local telecommunications.

Alcatel is exploring a variety of approaches to this and other tasks that must be performed by cross-connects, Krause said. One of the most promising involves use of a semiconductor optical amplifier, which is an integrated optoelectronic device with a substrate that electronically changes the wavelength characteristics and adds gain to the light pulses passing through. "I believe we'll be in a position to make the fundamental technology choices for moving into production (of cross-connects) within another 12 months," he said.

Another firm well positioned to make DWDM a reality in the short-haul market is Tellium Inc., formed last year by Bell Communications Research with various investment partners, including its new parent, Science Applications International Corp., and cable lightwave systems supplier Ortel Corp. Tellium will build on the technology underlying the MONET (Multiwavelength Optical Networking) program which Bellcore is operating in conjunction with long-distance and local carriers in different parts of the country, according to Israel Ury, CTO at Ortel, which has a 20 percent stake in the venture.

With competitive and incumbent LECs "suffering cable exhaust," DWDM is an ideal solution, but it must bring with it the functionality and interconnection features carriers require in operations over high-speed Sonet and other backbone architectures, Ury said. The MONET networks, along with compacting multiple wavelengths into single fibers, support the type of true cross-connect functionality described by Krause, where a wavelength can be assigned to a different destination point or node on the network at any instant a user desires.

Where cable's needs for efficient backbone networking are concerned, two other vendors entering the DWDM arena are Scientific-Atlanta, which is preparing to make an eight-wavelength Sonet ring system a centerpiece of its portfolio in

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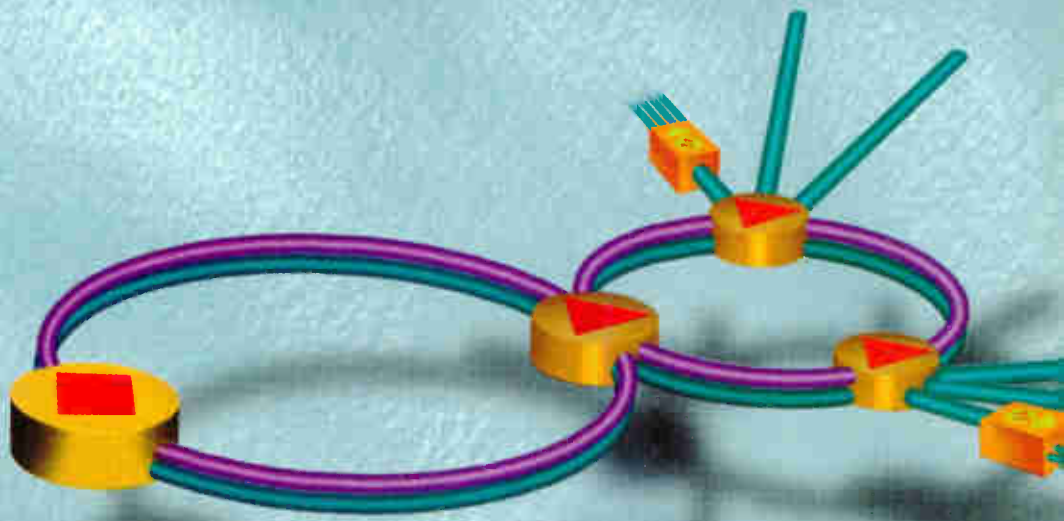

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regional networking options, and ADC Telecommunications, which has developed a ring network that transports signals in Ethernet format at Gigabit-per-second speeds over long distances.

"We've found DWDM offers significant cost savings over other designs, even when there is plenty of fiber available to support more traditional approaches," said Tim Wilk, director of new business development for digital transmissions at S-A.

S-A came to this realization as a result of efforts to solve a problem of fiber scarcity encountered by one of its MSO customers in the design of a ring network linking regional hubs to a central headend. "When we started looking into where the costs for DWDM have gone in just the past few months, we realized this technology had become much more cost-effective than previously assumed," Wilk said.

S-A estimates operators' savings in use of DWDM over multiple fibers for ring networks will be on the order of 50 percent, in instances where the fibers are in place that could support the multiple fiber approach, and on the order of 60 to 70 percent in instances where new fibers would be required to facilitate use of multiple fibers, Wilk said.

In a typical regional networking arrangement, where a single headend is linked to three or four hubs, signals must either be regenerated or optically amplified at some point along the ring. In a system requiring five fibers, which is the number needed to deliver 80 channels of uncompressed digital video over S-A's OC-48 system, the cheapest means of boosting signals is through optical repeaters, which, in the aggregate run about $50,000. This compares to about $20,000 for an erbium-doped fiber amplifier (EDFA) that can boost all the wavelengths traveling through a single fiber, Wilk noted.

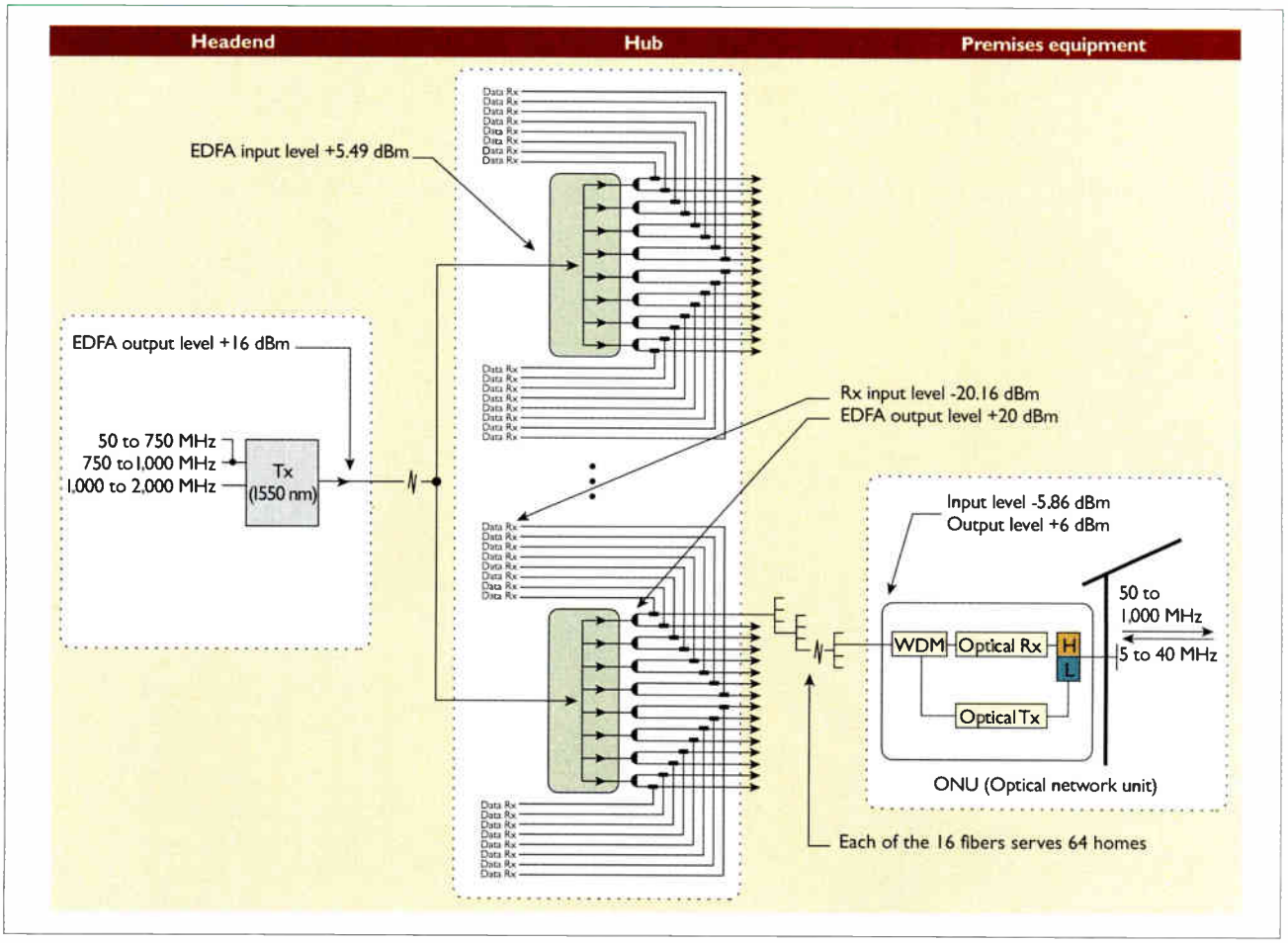
Similar economic calculations are driving Synchronous's offering of DWDM systems that can go all the way to 32 wavelengths, although Synchronous, rather than using Sonet, is using a proprietary 10-bit digital video transport technique to deliver 16 uncompressed video channels per wavelength. "We're offering a 32-wavelength option so that operators can know that they'll have plenty of capacity for future needs after they've put the system into operation for current applications," Borelli said.

Borelli added that the move to this volume of wavelengths is made possible, in part, by the flatness characteristics of the company's EDFAs, which maintain equal carrier-to-noise parameters across the whole field of amplified wavelengths. Another major factor is a supply agreement with Lucent Technologies, which is manufacturing new types of laser chips that are tightly spec'd to the narrow wavelengths of the International Telecommunications Union's DWDM protocols.

These lasers are externally-modulated diodes which, rather than using a separate, lithium niobate component to modulate the signal, employ electro-absorption modulators that are built into the laser chip itself. This design improves signal distortion performance, which will also be enhanced with introduction by Synchronous of a new dispersion-compensated EDFA in the first quarter, Borelli said. Alternatively, Synchronous is preparing to introduce more modular types of externally modulated transmitters capable of delivering output at 10 Gbps per laser (OC-192), thereby increasing potential throughput of multiple wavelengths on a single fiber into the hundreds of Gbps.

In another regional networking concept billed as a breakthrough in Ethernet technology, ADC said its EtherRing system supports delivery of up to 80 separate, full-duplex, 100 megabit-per-second Fast Ethernet channels over distances of 150 kilometers between switches at an aggregate throughput of 16 Gbps per fiber. "Our calculations show this system used in ring architectures for data transport represents savings of between 50 and 80 percent over other means in use today," said William Cadogan, CEO of ADC.

He backed up the claim by citing the first user of the system, the Rainbow Advertising unit of Cablevision Systems Corp., which is using the technology to transmit advertising from agencies to its satellite programming uplink over the New



Fiber-to-the-home key network components. Source: Earl Langenberg and Mani Ramachandran.

York regional advertising interconnect. Where multiplexing and protocol conversion electronics previously put the cost of connecting each agency site to the network at about $45,000, now, the cost is $8,000, Cadogan said.

All of these developments in backbone networking point to an opportunity for use of optical amplification and DWDM on the distribution side of the network as well. Already, using off-the-shelf equipment from Synchronous and other suppliers, Langenberg's calculations show FTTH may be cheaper than fiber-to-the-curb and is approaching cost parity with HFC in newbuilds, while offering far more dedicated bandwidth per user.

"I think fiber-to-the-home will prove itself over the next year for any newbuild or rebuild involving delivery of video services, whether it's a cable or telephone company project," Langenberg said. "The real key to why FTTH is more attractive now than it once was is that you're not factoring in the costs of digital conversion at every TV set, the way people once were with all-optical systems. With the ability to deliver TV services in analog, you have the same cost/benefit tradeoffs to deal with in digital that you do over HFC."

Moreover, he added, optical component costs have fallen drastically. "Five years ago, an EDFA operating at 40 milliwatts (of output power) cost $40,000; today, it costs $20,000," he said. "Fiber was 30 cents a foot; now it's 3 cents."

While the cable industry may have little need for FTTH, given the high capacity of its coax lines, the need for ever greater segmentation of that coax to provide higher dedicated bandwidth capacity per household, especially in the upstream, suggests some of the same optical amplification, passive splitting and multiple wavelength options used in the FTTH concept could be applied in fiber-deep HFC evolution, Borelli noted. "The equipment has evolved to the point that the options are available," he said. "The question is whether the industry wants manufacturers to begin implementing these designs in new product. It would be better if we were thinking this through now, rather than waiting until the capacity explosion hits." ■

About the author

Fred Dawson is a regular contributor to CED and publishes the newsletter "Broadband Commerce and Technology."

'Show me the profits'

Cable's Internet services now getting down to businesses

ILLUSTRATION BY TOM WARD

By Craig Kuhl,
Contributing Editor

The business side of Internet and high-speed data services is lagging behind the lightning-quick pace of emerging technologies, prompting cable operators to mine deeper and wider for potential new Internet and data customers.

The new business of Internet service, and how it fits into a cable operator's business plan, is a 1,000-piece puzzle, with 900 pieces left to assemble. Yet once the puzzle shows some semblance of clarity, most operators agree it will be well worth the effort, and from a business perspective, the final picture will look very good.

Some operators are expanding their Internet customer search to include small to mid-size businesses in their local markets. And while schools, hospitals and city buildings have been the initial launching pads for many operators' Internet services, retail and other local businesses are now the target.

Higgins

"We started looking at the business of Internet as a residential play. What we discovered was that our fiber went right by lots of businesses, too. The plant was already mixed in with the residential plant," says Lenny Higgins, vice president, telephony, for Bresnan Communications. From that point, Bresnan knew it would be in the Internet business.

The company's first Internet play was through BresnanLink in its upper Michigan systems, in which 40 percent of the households served by Bresnan have PCs. Bresnan-Link has connected 90 educational institutions through its fiber/coax networks. Now, it's adding businesses, in-cluding the Ogden Newspaper Group, City of Superior, Wis. and Superior Behavioral Health Network. "In some of our markets, there are large companies, like Schwan's Ice Cream. We want to provide them with telecommuting services for 300-400 employees," Higgins says.

The response thus far, Higgins notes, has been favorable. "We've been pleasantly surprised at revenues in our upper Michigan launch. It's really gone beyond all of our expectations."

Guinn Leverett, president of Internet of Beaufort County, N.C., concurs. "A year ago, if you had told a businessman to commit $1,000 a month to market his company on a Web site, he wouldn't have done it. Today, the ones who did are glad they did it. Now, the interest is there. For example, a local hospital is doing a $250,000 Web site. That's a big business."

Yet, the business of Internet is not without its inherent difficulties. Adds Leverett: "For a cable guy, it's hard to understand (the business of the

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Internet). It's a real 'gulp,' and serious money for hardware. And it runs so fast, you can make mistakes."

Running too fast can lead to complications, says Higgins. "When you put the first business customers up on your network, there will be lots of profits from the business, and it's easy to have a secure, reliable network. However, when you get 15 or more businesses, you scratch your head on how to secure it with firewalls and other security. Your internal and monitoring capabilities are very important."

BresnanLink's home page

The path to Internet and high-speed data prosperity is not a smooth one, insists Jim Balderston, industry analyst for Zona Research Inc., and is bound to include some scary moments. "It's not a walk in the park. It's more like a walk through a dark alley in a bad neighborhood, with people trying to thump you," he warns.

The real challenge to cable operators, Balderston says, is convincing businesses that they can provide these services. "It's a sizeable investment. Is it worth it to cable operators? And even though operators have wired to most of the last mile with newer, bigger wire, it's only one step, and entering the Internet business is easier said than done. Margins are razor-thin, and selling the service to businesses includes a more complex set of challenges."

Steve Adams, Chairman and CEO of Online System Services (OSS) agrees, to a point. "Data services is a complicated business. There's been lots of fear and

In the loop

Have a comment? Contact Tom by e-mail at: ctrobinson@worldnet.att.net

The Power of One in Local Production

By Thomas G. Robinson, Director of Regulatory Affairs and Technology Development, River Oaks Communications Corp.

It has often been said that it only takes one person to make a difference in many situations in life. Even though I'm a big fan of the team concept, group-think, "two heads are better than one," and other cooperative notions, I believe there are many instances where one can succeed when two (or more) can be one (or more) too many.

Which brings me to a discussion of how advances in the "do-it-yourself" arena are leading to powerful new concepts in local cable television program production. Specifically, local public access organizations are finding that the "less is more" concept can be applied very well to certain types of television production. While still finding the need (as discussed later) for at least one large-scale studio operation, public access organizations all across the country are putting together "Studio B" concepts that harken back to the days of the original "video soapbox" idea, but with a lot more sophistication, versatility and high-quality production values.

Rather than yesterday's television verite style where a wide shot of a panel or a closer shot of a speaker would not vary as the discussion or the speech progressed (heavily emphasizing content over form), today's one-person operations offer robotic cameras, graphic inputs, stylized sets, interactive audio (and sometimes video)–enabling accentuation of both form and substance.

Such studios can often be operated by the person serving as host and talent (much like a disc jockey running the board while doing his show). Where the program may involve a discussion with a guest, and thus the interviewer must concentrate on the interview, then a technical director can be added to control all the video, audio and graphic functions. In either case, high-quality productions can result with a minimum of manpower.

The advantages of such a set-up are myriad. Because the system is typically less complex to operate, one-person studio operators can be trained quickly and effectively. This can help eliminate some of the drawbacks that have kept interested people and community groups from initially participating, or continuing to participate, in public access activities.

First, some would-be producers indicate that they would become more involved in developing community programming, but don't have the time. This concern especially has been raised by organizational users. In part, this is why they are many times found as a smaller portion of the mix of public access participants. This is unfortunate, because they can often bring a significant knowledge base and resources to public access program development and facilitate a wealth of high-interest, community issue-oriented shows.

Second, the use of complex video

continued on page 104

hype for cable operators to get into computer-based businesses. Right now, it's up to cable to take advantage of its window of opportunity."

The "fear and hype" of climbing aboard the Internet train is not reserved for cable operators. Says Leverett: "There's a certain amount of 'gosh, the train's leaving the station, and I'd better get on quick' attitude among small to mid-size businesses. There's a fear of being left out because they've read and heard about selling books, ads, etc. on the 'Net, and that's appealing to them."

And speed counts as well, according to Grant Gabrielson, general manager of US West Telechoice in Omaha, Neb., which offers cable modem service. "Our marketing is based on speed, and since we have exhausted our early adopter market, we've spoken to banks, telemarketing firms and other small to mid-size businesses about telecommuting and other services. Their question to us is: How can we get information faster to our employees?"

Gabrielson has been able to sell Telechoice and its cable modem service by word-of-mouth to about 1,500 customers out of 17,500 video customers. Next up is the business sector. "Over

Profits continued on page 104

BresnanLink has expanded into retail businesses

newproducts

PRODUCT REVIEWS

Model 381 WDM

Multiplexer

GREENLAWN, N.Y.–Telebyte's new WDM (wavelength division multiplexer), Model 381, provides the ability to mix any two full duplex signals on a single fiber optic cable. As an example, digital traffic can be mixed with analog traffic–such as cable TV video can be mixed with Ethernet–or, data streams of different speeds can be mixed, such as T-1/E-1 and Ethernet. For applications requiring extremely high reliability, one of the signal paths through the WDM can be used to perform out-of-band signalling as a form of network management.

The Model 381 is a passive, single-mode, wavelength division multiplexer that allows the doubling of the data carrying capacity of a fiber pair. The WDM allows the combining and separation of individual wavelengths, which allows the individual channels to be simultaneously transmitted over the same fiber optic cable. The unit can merge data, voice, video or any other electrical signals together on a single fiber.

The standalone unit contains two WDM modules to achieve full duplex for two separate data sources. The WDM utilizes the fused biconic taper concept, which features high isolation, low insertion loss and back reflectance over a wide range of temperature and mechanical stresses.

Circle Reader Service number 60

Fiber optic assemblies

PLYMOUTH, Minn.–Computer System Products Inc. has announced a complete line of angled polished fiber optic assemblies. Designed for demanding applications like cable TV and video, the assemblies provide a return loss of 65 dB minimum. The cable assembly connectors use 8-degree Siecor connectors and are available in SC and FC connector styles.

Polished fiber optic assemblies

The assemblies are available, preconnectorized from stock, in standard 1-, 2-, 3-, 5- and 10-meter lengths. They are also available with quick turnaround in custom lengths. CSP's angled polished assemblies feature a 0.30 dB typical, 0.50 dB guaranteed, insertion loss, a 65 dB minimum return loss, and a guaranteed operating temperature range of -40

FIBER OPTICS

Headend manager

WOONSOCKET, R.I.–AWC/US Fiber Optics Division has introduced the Headend Manager, a compact fiber optic distribution shelf designed for cable TV headend installations. It was specifically designed to distribute signals from a headend or feeder to the outside plant, node or other locations. The manager is an integrated termination, splice and coupler housing with customer-designed configurations for various signal splitting of (6) 1x4, (8) 1x3, (12) 1x2 and others, as required.

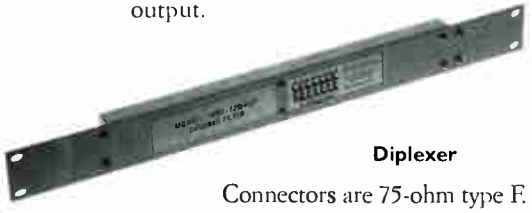
It features a swing-out termination drawer with the capacity for up to 24 bulkhead interconnections, and a platform shelf that has the capacity for two splice trays for 24 fusion splices. The unit also has a pull-out coupler/splitter module drawer and has accessible, hinged front and rear covers for access to all connection and splice points within the cabinet. Circle Reader Service number 61

degrees C to +85 degrees C.
Circle Reader Service number 62

Diplexer

EAST SYRACUSE, N.Y.– Communications & Energy Corporation Inc. has announced a new diplexer which combines two inputs into a single output. The diplexer is used with cable TV systems or MATV for combining bands.

The low input port has a passband of 0 to 108 MHz, with a typical passband insertion loss of less than 1 dB. The maximum passband insertion loss for the low port is 3 dB at 108 MHz. Minimum stopband rejection for the low port is 40 dB between 170 MHz and 450 MHz. The high input port has a passband of 170 MHz to 450 MHz, with a typical passband insertion loss of less than 1 dB. The maximum passband insertion loss on the high port is 3 dB at 170 MHz. Minimum stopband rejection for the high port is 40 dB between 0 and 108 MHz. A special 11 dB injection port is used for incoming video signals. The diplexer output is power blocked. A special 10 dB test port is provided for sampling the diplexer output.

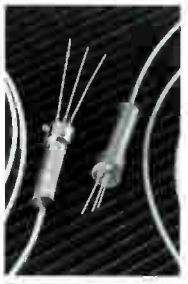


Diplexer

Connectors are 75-ohm type F. Each unit comes on 19-inch rack-mounted panels which measure 1.75 x 2.0 x 19 inches and weigh 1.5 pounds.
Circle Reader Service number 63

AM detector modules

WEST TRENTON, N.J.–EPITAXX has introduced two new Broadband Detector Modules that provide low distortion at high optical power for 860 MHz cable TV receivers used in either forward or return path applications. The EPM743FJ-S is designed for 1550 nm applications, and the EPM744FJ-S is appropriate for 1310 nm usage. To improve distortion performance, both models have a low second-order distortion, less than -75 dBc at 860 MHz, and are linear to optical powers as high as +3 dBm. Also, a low capacitance of 0.4 pF eliminates individual receiver tuning, reducing costs in receiver manufacture, says EPITAXX. This performance is achieved by incorporating EPITAXX's most linear photodiode chip inside a pigtailed coaxial module that is more commonly used for high-volume, digital, fiber-in-the-loop applications.



Detector Modules

Circle Reader Service number 64

Multi-mount UPS

BELLINGHAM, Wash.–Alpha Technologies has announced its new Nexsys Multi-Mount UPS, a multi-application AC uninterruptible power supply suited for a range of telecom applications. The

Nexsys Multi-Mount UPS

Nexsys Multi-Mount Series is available in 600VA, 900VA and 1250VA ratings. All models are designed to be installed in any one of three configurations: rack-mount, wall-mount or tower. The installation configuration of the Multi-Mount may be changed by changing the position of the mounting brackets. The brackets, included with all Multi-Mount models, enable the unit to be rack-mounted at front or mid-chassis, mounted to a wall, or to stand on the floor next to sensitive equipment.

The power supply incorporates high efficiency power conditioning with the longest internal run time available, up to 30 minutes. Additional run time may be added via external battery packs. All batteries are hot-swappable and regulated by the Alpha "Smart Charger."
Circle Reader Service number 65

Text messaging

HAUPPAUGE, N.Y.–Video Data Systems has announced its new MCM-96, a modular, text-based messaging system capable of providing keyed text or billboard displays on up to 96 channels simultaneously.

Designed for multichannel environments, the MCM-96 fits a range of applications, including Emergency Alert Systems, pay-per-view interstitial overlay, cross-channel promotion, and logo insertion. Displayed text can be unique to each channel, simultaneously displayed on all channels, or displayed on selected groups of channels. Display cards offer monochrome or full color displays from a single line message, logo or crawl, to a full-page, two region display with a crawl line. Control from remote PCs and touch-tone phones is available.

The MCM features four font styles, full border, 16 character colors and 16 background colors. Crawling text messages can be placed anywhere on the screen and can be of virtually any length.
Circle Reader Service number 66

Cable connectors

SAN DIEGO, Calif.—RF Connectors, a division of RF Industries (RFI), has released connectors designed to interconnect RG-316/U type low-loss coaxial


LMR-100 series connectors

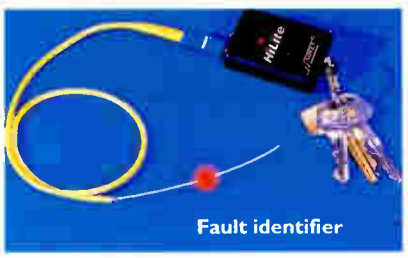
cable. The LMR-100 series of cable connectors includes all popular interfaces: BNC, TNC, N, SMA, SMB, MCX, mini bayonet, and mini-UHF.

Made of machined brass with gold-plated contacts and Teflon insulation, the connectors are also available in both nickel-plated, gold-plated and silver-plated versions. Cable assemblies using the LMR-100 cable and RFI connectors are available from stock or in custom lengths.

Circle Reader Service number 67

Visible fault identifier

LACONIA, N.H.—Noyes Fiber Systems has introduced its new HiLite, a compact red laser source designed to troubleshoot faults on fiber optic cables in distribution frames, patch panels, splice trays and OTDR dead-zones.



Fault identifier

Other HiLite applications include end-to-end continuity checks, identifying connectors in patch panels, and identifying fibers during splicing operations. A universal connector interface provides fast operation with many connector styles without changing an adapter.

Circle Reader Service number 68

Multi-channel DWDMs

LISLE, Ill.—Amphenol Fiber Optic Products has added a line of multi-channel dense wavelength division multiplexers (DWDMs) to its optical product line. Based on the company's fused biconic


DWDMs

taper (FBT) and fiber Bragg grating filter technologies, these DWDMs feature a flexible design architecture that allows modular expansion from 4 up to 16 channels. Standard DWDM network configurations of 4, 8 or 16 channels are also available.

High isolation and low insertion loss are achieved in either unidirectional or bidirectional operating modes. They are offered in flat-pack modules or 948 Series fiber management system cartridges.

Termination options include FC, SC and ST connectors with standard polish choices. The International Telecommunication Union grid is followed for channel spacing in the standard product offerings.

Circle Reader Service number 69

EAS test program

SANTA CLARA, Calif.—TFT Inc. has announced implementation of an automatic Required Weekly Test (RWT) feature for its EAS 911 Encoder/Decoder. The RWT feature automatically verifies that the installed EAS system is fully operational at the cable headend on a weekly basis, in compliance with FCC rules.

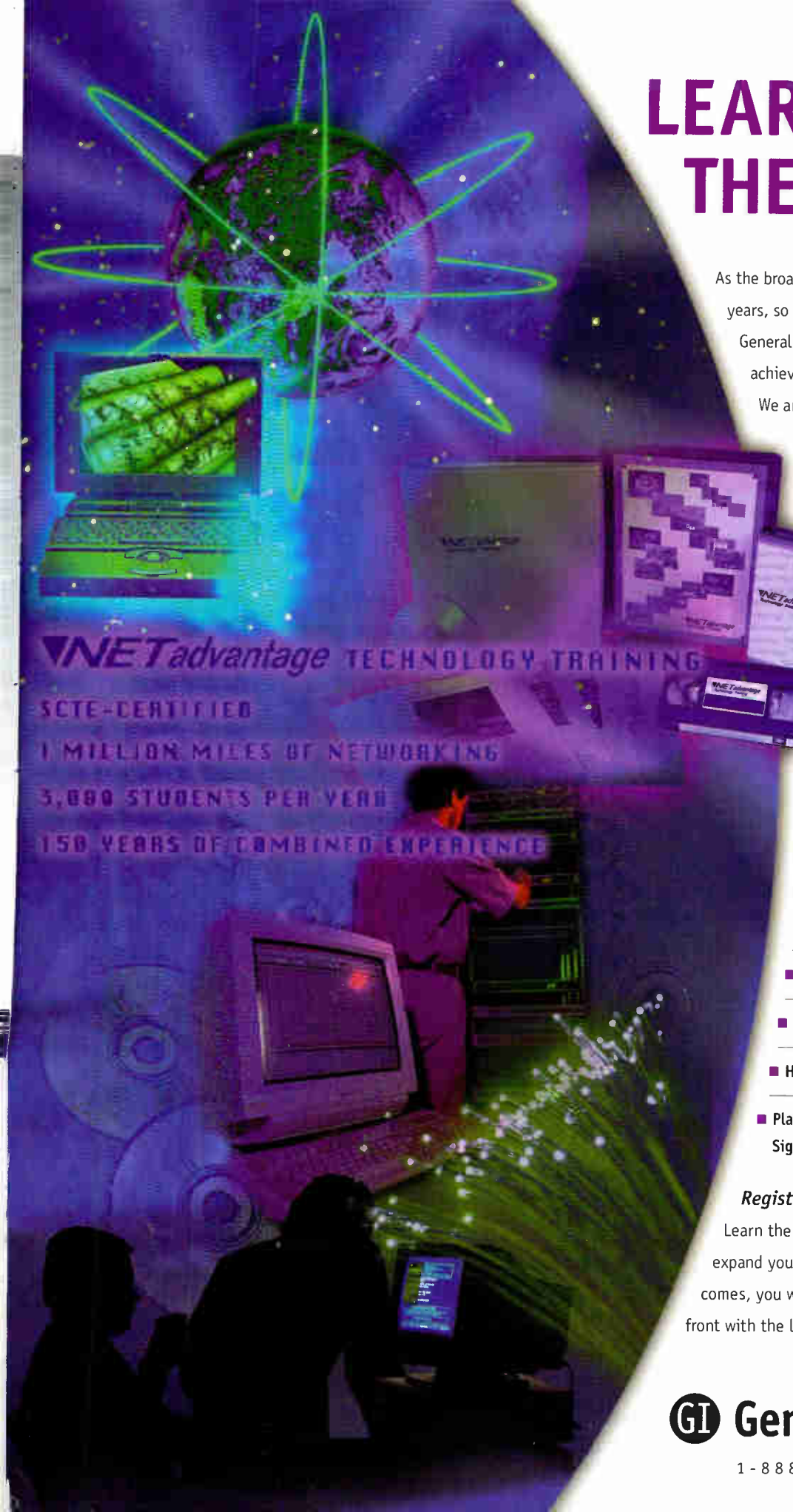
To program the feature, the operator determines a time window for conducting the weekly test (e.g., between 3 a.m. and 4 a.m.). That time is then entered in the EAS 911 set-up menu. The unit will then automatically initiate the RWT on a random day and at a random time during the predetermined time window each week. The cable operator can also auto forward RWTs conducted by monitored sources.

This new test feature will be released in V.82 software, along with other enhancements such as expanded event codes and text transmission, pending FCC approval. A number of other changes have been suggested by such user groups as the Society of Broadcast Engineers, and they will be incorporated into new EPROMs for new shipments and for exchange in units already installed.

Circle Reader Service number 70

WDM tester

MORGAN HILL, Calif.—Anritsu Wiltron Company has introduced its new MS9715A WDM tester, featuring a wide dynamic range over the 1527 nm to 1567 nm wavelength range. The unit is equipped with the ability to perform multifunction measurements, and can measure signal-to-noise ratio, gain and tilt, total power, chan-



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nel spacing, gain slope, and spectrum. The multifunction test capability also allows it to be used to measure the long-term stability of main line signals during manufacturing and installation.

The tester features ±20 pm linearity and accuracy of ±50 pm with a dynamic range of 53 dB at 0.5 nm and 58 dB at 1 nm. The unit has a wide measurement range of -65 dBm to +20 dBm with 0.02 dB stability. Resolution is 0.1 nm and PDL is ±0.25 dB.

The MS9715A also has a unique long-time measurement function that makes it well suited for maintenance and monitoring. With this function, wavelength calibration is automatically conducted by a built-in wavelength standard light source to maintain highly accurate wavelength measurement—even when environmental conditions change.

Circle Reader Service number 71

Variable attenuator

EAST SYRACUSE, N.Y.—Communications & Energy Corp. has introduced its new CEC-1450, an impedance matched continuously adjustable RF attenuator, and the Type 2700 TVRO notch filter.

RF attenuator

The attenuator has been designed for use where precision RF level adjustments are required. The device features a passband of 0 to 1 GHz, with adjustable attenuation ranging between 0 and 20 dB. The unit's line-tilt is -0.09 dB at 300 kHz; -0.43 dB at 500 MHz; -0.98 dB at 524 MHz; and -1.9 dB at 1 GHz.

The attenuator is housed in a metal enclosure which measures 1.4 x 2.3 x 3 inches and weighs 3.8 ounces. It also features a 75-ohm Type F connector.

The 2700 TVRO notch filter installs between the low noise amplifier (LNA) and the feedhorn to suppress terrestrial interference on any C-band frequency. The filter may be factory-tuned to any frequency between 3.7 GHz and 4.2 GHz. Notch suppression is 25 dB (typical); notch width is 4 MHz (typical).

The filter may be ordered with up to six different notch-

Notch filter

es to suppress six different interference frequencies. Operating temperature is -10 degrees Celsius to +65 degrees Celsius.

Circle Reader Service number 72

VRLA battery

ATLANTA, Ga.—GNB Technolo-gies has introduced the Absolyte XL, the latest version in Valve Regulated Lead Acid (VRLA) batteries. Based on the company's Absolyte HP technology, they feature higher cell capacity—2,000 Ah and 3,000 Ah—making them the largest VRLA absorbed glass mat (AGM) cells in the world, according to GNB.

The Absolyte XL features a redesigned post seal that uses a non-corrosive seal design that will maintain its integrity against leaks throughout the life of the battery. It's also constructed to eliminate stresses placed on the cover and post seals by plate growth. A square plate design, which allows more efficient use of the plate by decreasing internal resistance, achieves a 6.5 percent increase in power at the one-hour rate.

Circle Reader Service number 73

Datacom interconnects

NORTHBORO, Mass.—FONS (Fiber Optic Network Solutions) Corporation has announced the introduction of its new line of black datacom wall and rack-mount interconnect products, Light Express 2. Constructed of rugged steel with a black baked epoxy powder finish, each interconnect product comes equipped with cable management reels for enhanced fiber management.

In addition, each interconnect product is available preloaded with standard fiber optic adapters. The company also offers ST and SC cable assemblies manufactured with industry-standard ST and SC connectors. To boost system performance, each connector is fitted with a zirconia ceramic ferrule.

Circle Reader Service number 74

Web software suite

LOS ANGELES, Calif.—Solbright Inc. has launched AdSuite, a software product suite designed to automate advertising sales, trafficking and billing for Internet media. The software suite provides Web-based management of processes including the electronic exchange of proposals and contracts through ad submissions, trafficking and invoicing.

Circle Reader Service number 75

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Reader Service 52

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Advanced Networking

C-COR Electronics, Inc. RS# 29

C-COR's RF amplifiers, AM fiber optics, and customized service and maintenance provide global solutions for your network. p. 53, 70

General Instrument Corporation RS# 51

The world leader in analog and digital systems that provide video, audio and high-speed Internet/data services over cable and satellite television networks. p. 69, 95

Toshiba Multimedia RS# 14

MCNS modems and gateway solutions, plant and market analysis, system design, installation and maintenance. Toshiba's systems operate in six major markets, servicing over 12,000 cable subscribers. p. 29

Construction Equipment

Arrow Fastener Company RS# 27

Arrow Fastener Co. Inc. is a 68-year-old American manufacturer of quality-built hand tools. The company makes the world's only UL and C-UL listed staples shot from staple guns. p. 50

Belden Wire & Cable RS# 22

Belden® broadband cable products are ideal for all your video, voice, data, and even voltage applications. p. 44

CommScope, Inc. RS# 32

CommScope: ISO 9001 registered manufacturer of a comprehensive line of coaxial and fiber optic cables for all telecommunications applications. p. 57, 67

Telecrafter Products RS# 5, 28

Supplies drop installation products for CATV, DBS, and wireless operators, single and dual cable fastening products, identification tags, residential enclosures. p. 10, 51

Datacom Equipment

3Com Corporation RS# 15 p. 31

ISC Datacom RS# 25

Manufactures frequency-agile RF modems and translators. Modem speeds to 64 kbps. Builds electronics to specifications. p. 48

Terayon Communication Systems RS# 8

Terayon Communication Systems delivers high-speed, two-way cable modem systems — based on S-CDMA technology — that operate over any cable plant and support both business and residential services. p. 15

Distribution Equipment

Alpha Technologies, Inc. RS# 3

World leading manufacturer of power conversion products, widely used in cable television, telecommunications, and data networks worldwide. p. 7

Lindsay Electronics RS# 20

Our revolutionary new technology creates 1 GHz communication amplifiers, passives, taps, and subscriber materials to solve system problems before they become subscriber problems. p. 42

Philips Broadband Networks RS# 38

Global supplier of broadband RF and fiber optic transport equipment and advanced systems used to access broadband telephony and data services. p. 73

RELTEC RS# 35

CATV and broadband products including metallic and non-metallic 360 degree access pedestals, amplifier housings and MDUs upright and low profile node housings. p. 60

Times Fiber Communications, Inc. RS# 19

TFC is an ISO 9001 registered manufacturer of coaxial cable for the telecommunications industry. Committed to quality, service and technology. p. 39

Distributors

ITOCHU Cable Services RS# 16

iCS, Inc. is a leading full service stocking distributor, operating ten sales offices and nine warehouses conveniently located in North and South America. p. 35

Jerry Conn Associates RS# 31

JCA is a specialty distributor for Tektronix, Alcatel, Thomas & Betts LRC, PLP, AMP, Signal Vision, Alcoa Fujikura LTD, GI, Trilogy and numerous other lines. p. 56

TeleWire Supply Company RS# 9

TeleWire Supply is a leading nationwide distributor of products needed to build and service a broadband communications network. p. 17

Tulsat RS# 34, 39

Tulsat sells, repairs and purchases headend and line equipment. We specialize in traps, taps, connectors, modulators, VCII, IRDs and receivers. p. 59, 75

Fiber Optic Equipment

FONS Corp. RS# 18

Fiber optic communications products, patch panels, cable assemblies, adapters, attenuators, fiber management software, and transmission products for telecommunications, data communications, and cable television markets. p. 38

Keptel, Inc. RS# 33

Complete line of OSP Fiber Optic, Copper and Coax Interconnection Apparatus, including closures, enclosures, fiber management, NIDs, and Remote Test Electronics. p. 58

Silicon Valley Communications RS# 47

Full two-way optical transmission products, including 1550 nm and 1310 nm transmitters, EDFAs, and receivers with Network Management System. p. 85

Headend Equipment

ADC Telecommunications, Inc. RS# 1

Leading global supplier of transmission and networking systems with a pre-eminent market position. Products for fiber optic, twisted pair, coaxial and wireless networks worldwide. p. 2-3

Dawn Satellite RS# 21

Technical information and competitive prices on products such as: satellite "dish" antennas, satellite receivers, digital ready LNBs, modulators, processors and related products. p. 43

FrontLine Communications RS# 17

FrontLine Communications manufactures patented, field proven, Emergency Alert and PC-based Character Generator products to fulfill the needs of cable and other multi-channel system operators. p. 37

Idea/onics RS# 49

EAS Emergency Alert Systems to meet the FCC mandate and local franchise requirements of cable TV. p. 89

Microwave Filter Co., Inc. RS# 53

Passive electronic filters, traps and filter networks for interference elimination and signal processing at the TVRO, headend and distribution equipment. p. 103

Monroe Electronics, Inc. RS# 48

We supply rack mounted or cased cue tone encoders/decoders. Also, timers, A/V and RF/IF switches and other control products. p. 86

Passive Devices Inc. RS# 13 p. 27

PCI Technologies RS# 54

Manufactures splitter/combiner networks, RF filters from DC to 1GHz, i.e.: deletion filters, diplex filters, banpass, etc. p. 103

readerservice

Scientific-Atlanta RS# 58

Scientific-Atlanta's new Continuum™ Headend System for analog and digital applications features a vertical packaging design which allows for up to forty front-loaded modules. p. 116

Spectrum RS# 11, 37, 36

The Sub-Alert utilizes the advanced features of the Sage Endec for total automation and will interface with your headend by IF, baseband video or comb generator. p. 21, 42-43, 61

Standard Communications RS# 4

The industry's leading manufacturer of rebroadcast quality satellite reception and RF broadband products. Delivering programs to thousands of CATV and SMATV systems. p. 9

Services (Billing, Contractors, etc.)

International Engineering Consortium (IEC) RS# 50

A nonprofit organization dedicated to advancing the field of business and engineering in the information industry through noncommercial and university programs. p. 46

IMMCO RS# 56

IMMCO provides competitively priced, quality HFC and fiber design, drafting and file conversions for CATV and telecommunications companies. p. 103

TVN Digital Cable Television RS# 10

TVN Entertainment is a leading television pay-per-view programmer. TVN Digital Cable Television is a new digital NVOD programming service and turn-key delivery system for cable operators. p. 19

Subscriber Equipment

Pace MicroTechnology RS# 41 p. 77

Viewsonics, Inc. RS# 52

For 24 years designing and manufacturing more than 200 products for CATV and MMDS, including amplifiers, passives, Lockinator Security System, return path equipment, etc. p. 97

Telecom Equipment

Chatham Technologies RS# 45

Chatham Technologies is the world's largest integrated supplier of custom electronic enclosures, related products and value-added services. p. 82, 83

Fujitsu Network Communications RS# 7

Manufactures and markets advanced SONET transport and access equipment which maximizes network operational capacity and services. p. 13

Test Equipment

AM Communications, Inc. RS# 57

OmniStat by AM is the worldwide choice for monitoring HFC telecommunications networks. It is the standard for ADC, NextLevel, Philips and Scientific-Atlanta. p. 115

Hewlett-Packard Company RS# 6, 42

Hewlett-Packard offers a comprehensive range of test equipment to keep your entire broadband system at peak performance–from headend to subscriber drop. p. 11, 79

P. K. Technology RS# 30 p. 55

Tempo Research Corp. RS# 46

Manufacturer of test and measurement equipment for installation and repair technicians, including TDRS, Step TDR, and Coax Tracer systems. p. 84

Trilithic, Inc. RS# 12, 23, 24, 26

Manufactures test equipment for the CATV and LAN industries and components for aerospace and satellite communications. SLMs, leakage detectors, and a comprehensive line of return test equipment. p. 25, 45, 47, 49

Wavetek Corporation RS# 2

Manufactures equipment for CATV, telecommunications, wireless, and general purpose test. CATV equipment includes signal level, analysis, and leakage meters, sweep and monitoring equipment. p. 4-5

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eventcalendar

MARCH

10 Cascade Range SCTE Chapter, Technical Seminar. Location: Holiday Inn, Wilsonville, Ore. Call Betty Reed (360) 891-3295.

11 Old Dominion SCTE Chapter, Vendor Show. Location: Richmond, Va. Call Maggie Fitzgerald (540) 248-3400.

11 Sam Houston SCTE Meeting Group, Technical Seminar. Location: Houston. Call William Bartley (713) 329-7814.

11-13 Northern California SCTE Chapters, Vendor Show. Location: Concord Hilton, Concord, Calif. Call Steve Allen (916) 786-4353.

12 Penn-Ohio SCTE Chapter, Technical Seminar & Testing Session. Topic: Safety–CPR Certification and Pole-top Rescue. BCT/E certification exams to be administered. Location: Sheraton Inn North, Pittsburgh, Pa. Call Marianne McClain (412) 531-5710.

17 North Country SCTE Chapter, Vendor Show. Annual Vendor Day and Cable-Tec Games. Location: Hyatt Hotel, Minneapolis, Minn. Meeting to be held in conjunction with the North-Central Cable Show. Call Dan Shea (612) 572-9290.

18 Big Sky SCTE Chapter, Technical Seminar. Location: Locomotive Inn, Laurel, Mont. Call John Anderson (406) 755-7200.

19 San Diego SCTE Chapter, Technical Seminar. Call Kevin Coldani (714) 458-2288.

25 Great Plains SCTE Chapter, Vendor Show. Location: Omaha, Neb. Call Daniel Karnish (402) 597-5665.

APRIL

8 Bluegrass SCTE Chapter, Technical Seminar. Call Max Henry (502) 435-4433.

8 Delaware Valley SCTE Chapter, Vendor Show. Location: Williamson's Restaurant, Horsham, Pa. Call Chuck Tolton (215) 961-3882.

8 South Jersey SCTE Chapter, Technical Session. Topic: Safety. Call Richard Kerr (609) 467-9333.

15 Michiana SCTE Chapter, Testing Session. BCT/E and Installer certification exams to be administered. Location: LaPorte, Ind. Call J.J. Jones (219) 324-6943.

23 New England SCTE Chapter, Technical Seminar & Testing Session. BCT/E and Installer certification exams to be administered. Location: Holiday Inn, Boxborough, Mass. Call Brian Bedard (413) 562-9923, ext. 228, for further details.

23 Northern New England SCTE Chapter, Technical Seminar. Topic: Emergency Alert Systems. Location: Doubletree Inn, Portland, Maine. Call Bruce Bolger (207) 967-5212 for additional information.

For more extensive calendar listings, including training opportunities, see www.cedmagazine.com

TRADE SHOWS

MARCH

25 SCTE Telecommunications Vendors Day. Location: Omaha, Neb. Call Riser Bond Instruments (402) 466-0933 for more information.

APRIL

20-23 COMDEX Spring '98. Location: Chicago. Call Softbank (617) 433-1500 for additional information.

MAY

3-6 National Show '98, produced by the National Cable Television Association. Location: Atlanta. Call the NCTA (202) 775-3669 for further details.

JUNE

7-11 Supercomm '98. Location: Atlanta. Call the U.S. Telephone Association (202) 326-7300.

10-13 SCTE Cable-Tec Expo '98. Location: Denver, Colo. Call (610) 363-6888; Expo hotline (610) 363-3822.

JULY

8-10 Wireless Cable '98. Location: Philadelphia. Call (202) 452-7823.

SEPTEMBER

22-24 Great Lakes Cable Expo. Location: Chicago. Call (317) 845-8100.

OCTOBER

13-15 Atlantic Cable Show. Location: Baltimore, Md. Call (609) 848-1000.

26-28 Eastern Show. Southern Cable Telecom. Assoc. Location: Orlando, Fla. Call (404) 255-1608.

DECEMBER

1-4 The Western Show. Location: Anaheim. Call the California Cable TV Association (510) 428-2225.

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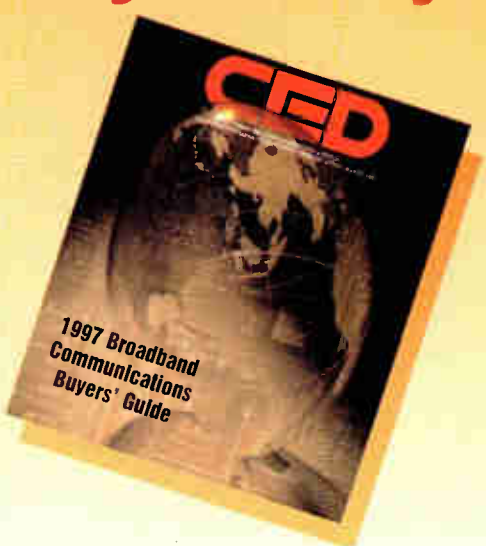

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In the loop

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continued from page 91

production systems do not in and of themselves always translate into sophisticated and high-quality productions. In other words, without significant time spent in training, learning, supporting, maintaining and staffing complex studio

Tele-education offerings could be designed to reach a mass audience

arrangements, their use may not result in the quality of production originally intended. Consequently, those with great ideas but less technical persistence become disenchanted. Today's simplified studio systems can incorporate sophisticated digital camera, graphic, audio and other electronics which produce a high video and audio quality with a minimum of training and production effort. As an example, easy-to-use features of some mini-studio operations include:

- Robotic or "locked-down," chip-based cameras (usually two to three)
- "Arms-length" graphic stands, computer graphics and videotape inputs
- Pre-set lighting (for one-person or interview)
- IR remote, or simplified switcher, video source control
- Audio "follow-on" video, voice-activated or simple mixer-based audio systems.

Consequently, the bulk of training can be spent on style, presentation and other similar production values so that highly entertaining and informative shows can be easily produced. Additionally, the higher volume of people that can be trained quickly and effectively than for traditional studio operations (in some cases, three times as fast) can encourage a higher diversity of public access participants and, consequently, a higher volume and diversity of programming.

One type of program that has significantly benefitted from the mini-studio concept is "talk-back television," which is essentially a talk show that encourages live viewer input (a.k.a., the "Larry King Live" model). Studies indicate that this is one of the forms of public access programming that draws the highest level of interest.

Further, where access operations have traditionally revolved around a larger studio, and the studio starts to see contention for use during the same time period (often during prime production hours in the evening), Studio Bs that have been developed will help to free up that larger studio. This, in turn, will encourage the production of programming that requires more space, such as choral productions, shows with live audiences, dramatic offerings, large panel interviews, etc.

(It is important to note here that studies also indicate that two of the other forms of local programming of highest interest to subscribers are community news programs and high school and other community sporting events. The popularity of these two types continues to indicate the need for larger studio, mobile studio and field operations.)

Part of the Studio B concept grew out of one- and two-person studios that were developed for distance learning operations. The success of one-person studios for educational purposes, applied to the public access model, also indicates that successful tele-education offerings could be designed to reach a mass or adult audience. This could further help public access continue to expand its role into more of a community access model.

"Keep it simple." Watchwords to live by, as we've come to understand in many areas, including television.

Profits continued from page 91

time, we want to sell the service to telecommunications companies, banks, brokerage firms, software developers, personnel placement firms and others.

Though Telechoice's word-of-mouth marketing strategy has been, according to Gabrielson, "extraordinary," he has no illusions about the next step. "We will need significant marketing and promotions plans for the next level of customers. The product *has* to be demonstrated to justify its premium price. We have to take it to the customers," he said. "Now, we have more business than we can handle."

Whether that will continue, however, is debatable. Says Balderston: "The Internet has a different dynamic than cable TV. The Internet services are more capital-, resource- and people-intensive, and cable operators must radically change their business model. At what point do they become non-cable? Plus, there's competition out there. ISPs are adding value services like security and telling customers that they will manage their networks for them. Are cable operators ready to go head-to-head with that? I doubt it."

Despite lingering doubts about the wisdom of entering the Internet business, a growing number of cable operators are bullish on taking their Internet services to businesses–large and small–with the upsides far outweighing the negatives. "We're focusing on Fortune 500 companies," says Matt Fanning, vice president, marketing and sales for Comcast Commercial Online. "The Internet opens up a company's employee pool because employees are not geographically bound. If you are trying to attract people with lots of skill sets, they could effectively work anywhere." ■

About the author

Craig Kuhl is a contributing editor to CED and a Denver-based freelance writer.

GI acquires Fuba Communications

CHICAGO–General Instrument Corp. has acquired Fuba Communications Systems GmbH (FCS), a European manufacturer of cable television equipment, based in Germany. FCS will be integrated with GI's European operations (headquartered in Berkshire, U.K.) as a wholly-owned subsidiary. The acquisition was made in order to further strengthen the company's existing regional organization, bringing a manufacturing base closer to GI's European and Middle Eastern customers and expanding GI's business in Europe, according to GI.

Throughout Europe, FCS has a substantial installed base of digital and analog headends and cable TV transmission networks. Fuba manufactures and sells end-to-end solutions for the reception, processing and transmission of audio and video signals in both analog and digital formats, to cable networks. Its largest market is Germany, but it also serves a customer base in the Netherlands, France, Austria, the U.K., Scandinavia, Switzerland and the Middle East.

Siemens AG, Com21 ink data distribution pact

MILPITAS, Calif.–Siemens AG, Public Telecommunication Networks Group and Com21 have signed an agreement on the integration of Com21's ComUnity Access cable modem system into the Siemens Multilink Access product. Within the scope of the agreement, Siemens receives worldwide, non-exclusive distribution rights to the ComUnity access system.

Siemens' end-to-end solutions, which cover hybrid fiber/coax networks, ATM data networks, solutions for Internet service providers and applications including electronic commerce and voice, combined with the Com21 ComUnity system, will enable cable operators to deliver end-to-end, high-speed data services, according to a statement released by the two companies. Further, the "combined strength" of Siemens' solution range and Com21's technology lies in the ability to provide end-to-end network solutions for both residential and business applications, they add.

Pico, PAS sign contract

LAKEVIEW TERRACE, Calif.– Pico Macom Inc. has signed a three-year contract with Pan Asian Systems Ltd. (PAS) for exclusive distribution in Asia and the Pacific Rim. The expected value of the agreement is in excess of $3 million, according to information supplied by Pico.

PAS was established in 1991 and is headquartered in Hong Kong. From there, it directs an expanding network of offices around Asia and into the Middle East. PAS is a member of the trading group A.S. Watson and is wholly-owned by Hutchison Whampoa Ltd.

Suburban Cable picks Scala ad solution

LOS ANGELES–Suburban Cable has selected Scala Inc.'s InfoChannel IC200 solution to centrally create and distribute local advertising channels. Suburban will use Scala's commercial production and distribution software to deliver its programming to 14 headends in metro Philadelphia, Delaware and southern New Jersey.

The agreement with Suburban calls for Scala to provide the latest software release of InfoChannel for Windows 95 and NT operating systems, and associated computer hardware, as well as custom engineering, which enables the integration of live news, sports, weather and stock information into Suburban photo classified channels.

FONS, Coherent form CFX

NORTHBORO, Mass.–FONS Corp. (Fiber Optic Network Solutions) has entered into a joint venture with Coherent Inc. to form CFX Communication Systems, which will develop and market a high-powered broadband transmission product line capable of providing cost-effective cable TV and high-speed Internet access. The product line will provide both analog and digital transmissions supporting HFC, FTTC (fiber-to-the-curb) and FTTH (fiber-to-the-home) systems.

"In our commercialized product offering supporting broadband transmission, one of the key technological components is a high-powered, solid-state laser. By combining FONS and Coherent's expertise, supported by Coherent's enormous design, development and manufacturing capabilities, we can provide a far superior broadband transmission solution to the CATV industry at an economical price," said FONS President and CEO Michael Noonan in a statement. "Having done this, we will then be able to bring a cost-effective fiber-to-the-home solution to the industry in 1998."

Coherent is a supplier of lasers and laser-based systems for medical, scientific and commercial applications. The company designs and manufactures a diversified selection of laser-based products. ■

ICTV has announced two senior management appointments. **William Zerella** has been named chief financial officer. He will direct the company's financial operations and strategic planning. Zerella comes to ICTV from Pace Inc., where he also served as chief financial officer. Prior to that, he was vice president of finance for AmTote, a subsidiary of Gtech Corporation.


Zerella

The company has also appointed **Christopher Dorst** as vice president of marketing. A 14-year marketing veteran, Dorst's most recent position was at Sun Microsystems, where he directed the outbound marketing and demand creation program for its Netra brand, introducing three major product lines. Before Sun, Dorst held marketing positions in Apple Computer's Newton division, publishing sports and personal information management software for the PDA. His management experience also extends into world-class athletics. For 10 years, Dorst held an elected position on the Board of Directors of the United States Olympic Committee.


Dorst

Sam Dellipoala has been named executive director, client services at CSG Systems Inc. In this position, Dellipoala will work within the company's client services account management group providing support for the company's telephony, cable television, and high-speed data operations. Prior to this new position, Dellipoala was vice president of information technology for MediaOne in Atlanta, where he served as the chief technologist for start-up operations serving 560,000 customers with 1,200 employees. While there, his responsibilities included implementing residential and business telephony customer care and billing systems, leading the product review process, directing the replacement of legacy-based customer care and billing systems, directing OSS server support for a multiple number of network engineering applications, and more.


Dellipoala

SeaChange International Inc. has appointed **Yvette Gordon** as director of interactive technologies. A veteran interactive and systems software developer, Gordon was most recently director of interactive technologies for Time Warner Cable, where she managed a number of technical departments for the world's first digital interactive television project, the Full Service Network. She also assisted in designing and implementing Time Warner's digital cable system for digital broadcast and video-on-demand.

Group W Network Services (GWNS) has created and filled two new positions in its management ranks. **Edward Olson** has been appointed as senior director, technology and project development. As head of a new business unit, Olson is responsible for reviewing and integrating advanced technical solutions into company operations for broadcast, cable and business television clients. This new group is also responsible for developing, engineering and constructing major projects for the company's domestic and international operations. Most recently, Olson held the position of senior director, transmission facilities at GWNS.


Olson

The company also announced that **Donald May** has been named senior project manager, technology and project development. In this newly created position, he will be responsible for designing and managing new projects for the company's domestic and international operations. He returns to the company after working as engineering manager in Singapore for a year-and-a-half at Asia Broadcast Centre, a joint venture of GWNS and The Yellow River Network. While there, May helped design the facility's all-digital system and managed the engineering staff.


May

Vyvx Inc. has announced a number of appointments in its national sales and marketing force. **Regina Rigler** has been named mid-Atlantic regional sales manager in Maryland, where she is responsible for managing the company's account team which serves Maryland, Pennsylvania, Delaware, Virginia, West Virginia and the District of Columbia. **John Lipuma** is eastern regional sales manager for Vyvx Advertising Distribution Services and is responsible for the company's New York City sales team. **Tony Gonzalez** has been named as account manager in Vyvx's western region office in Long Beach, Calif., and **Tom Cormier** has been appointed account manager for Florida. **Christopher Starkey** has been named account manager for New England and New York state in the northeast sales office.

Dwayne Hamilton has been named southeast regional sales manager for Trilogy Communications' CATV products division. In this new position, Hamilton is based in Atlanta and covers the company's territory from Virginia to Florida. With more than 15 years of sales and management experience, Hamilton was most recently regional manager for iCS. Before that, he served as a fiber optics application engineer with Antec.


Hamilton

Philips Broadband Networks appointed **Don Williams** and **Brad Farris** as account executives to serve clients in the southeast and the northwest regions. Williams will work with service operators in northern California, Oregon, Washington, Alaska, Montana, Idaho and Utah. Farris will be responsible for Texas, Oklahoma, New Mexico, Arkansas and Louisiana. ■


Williams

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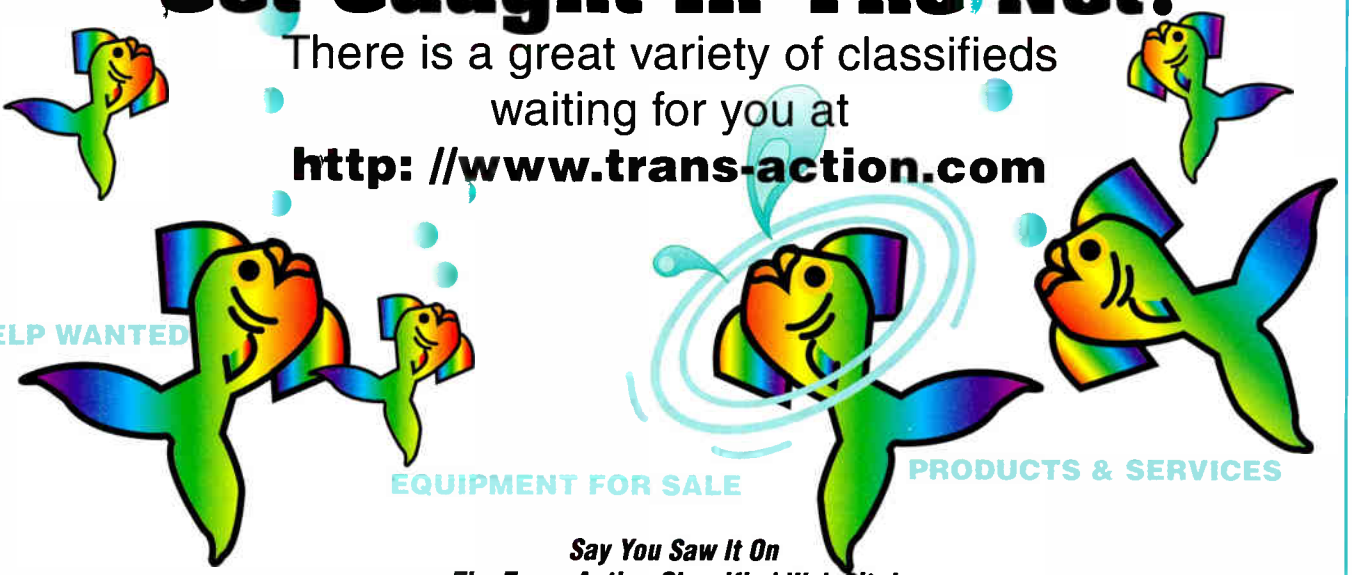

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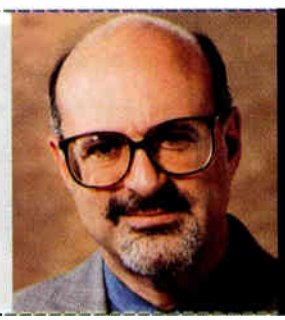
Broadcast conditional access

Remember when there were TV stations that broadcast scrambled programming? Pay TV, it was called. Now they're back again, using the multichannel capability of digital broadcast TV. Envision a world of digital TV, where broadcasters deliver multiple standard-definition TV programs within a 6 MHz channel, some of which are scrambled, and where TV sets have a slot for a security card, just like the DirecTV receiver. That's one possible world of five to 10 years from now.

Consider user-friendliness. When you change channels, do you have to take out one card and plug in a different one? That's a loser. How about a TV set with several slots? But maybe the TV set manufacturers won't put more than one slot in a TV set. Then the broadcasters in town will have to agree on a single scrambling system that uses the same card for all broadcasters in town. There are ways to do this, with each broadcaster transmitting its own entitlement and authorization messages that are addressed to individual subscribers, but all using the same decryption circuitry.



By Jeffrey Krauss, Pay TV oscillator and President of Telecommunications and Technology Policy

Have a comment? Contact Jeff via e-mail at: jkrauss@cpcug.org

So all the broadcasters in town would have to agree on a decryption system. Broadcasters compete vigorously with one another; they'd have to cooperate on this. And they would, so long as each station broadcasts its own entitlement messages.

But suppose you live in Princeton, N.J. and can receive both New York and Philadelphia TV stations. You might still need to swap cards, unless all the New York and all the Philadelphia stations agree on the same system. All up and down the East Coast, there will be daisy chains of TV stations that would all have to agree on a single decryption system. And that is all feasible, because they could each control their own subscribers' access, because they each transmit only their own entitlement messages.

Security risks

How many recall the initial attack on the VideoCipher scrambling system? Pirates exploited a weakness in the system that allowed access to all scrambled programming if the decoder was legally authorized for any scrambled programming. Customers signed up for the cheapest service, then used illegally modified circuitry to watch all programming.

Of course, that was in 1986. Security technology has improved since then. But so have the pirates' capabilities, as evidenced by the successful attacks on the DirecTV security system.

Moreover, because each TV broadcaster could presumably procure its security cards from any manufacturers, there would be multiple card designs, some of which might be more susceptible to hacking than others. Liability is another issue. If I buy a security card to watch channel 7's scrambled programming, but then use it to steal channel 4's programming, does channel 7 have to pay channel 4 for the lost revenue?

With the above scenario, each broadcaster transmits its own entitlement messages on its own channel. That differs from a cable system, where all entitlement messages are transmitted in a separate out-of-band data channel. And it differs from satellite security systems, where all messages are transmitted on all channels. So no matter what channel you are watching, your security card knows what scrambled channels you are entitled to receive.

But broadcasters don't want to carry entitlement messages for other broadcasters, for obvious competitive reasons. Not only that, but entitlement messages eat up channel capacity.

More importantly, when you change channels, your security card may have to wait for the next transmission of entitlement messages in order to determine whether it is authorized to descramble that programming. The channel change problem is serious. It can be ameliorated by lengthening the "epochs;" that is, the period of time over which an entitlement message is valid. If you tuned to a channel anytime during the past month, then you've received the entitlement message that's valid now. Of course, longer epochs mean reduced security.

Even if broadcasters were willing to carry each others' entitlement messages, which ones would they carry? Would Philadelphia stations carry New York messages in order to serve viewers who live in Princeton? With TV broadcasting, the laws of radio propagation determine which stations you can receive, and the TV stations themselves don't know because it depends on your location, intervening terrain, antenna height, etc.

Some broadcasters, Fox in particular, are keen on delivering scrambled programming. Fox's interest comes partly from having a sister corporation under the Murdoch family umbrella which is a leading player in video security, having supplied both the now-hacked DirecTV scrambling system and similarly-hacked systems for Europe. But apart from Fox, broadcasters don't appear to have given a great deal of consideration to the security risks and channel change problems. And TV set manufacturers won't start building TV sets with security card slots until they're convinced there's a business there. It will take some real effort to get this started. Maybe subsidized TV sets, which I wrote about last month, will do the trick. ■

Compatibility

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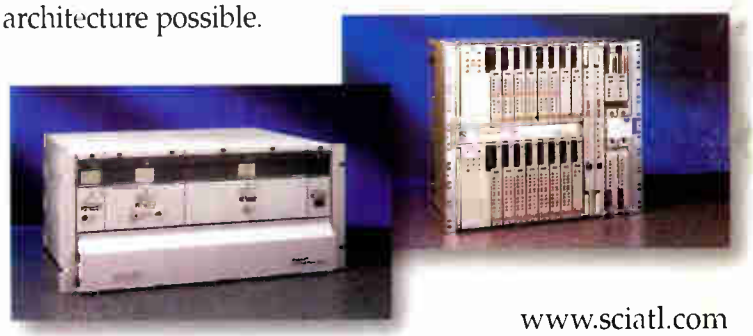

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