Next Month: Western Technology Preview

Communications Technology

Official Trade Journal of the Society of Cable Telecommunications Engineers

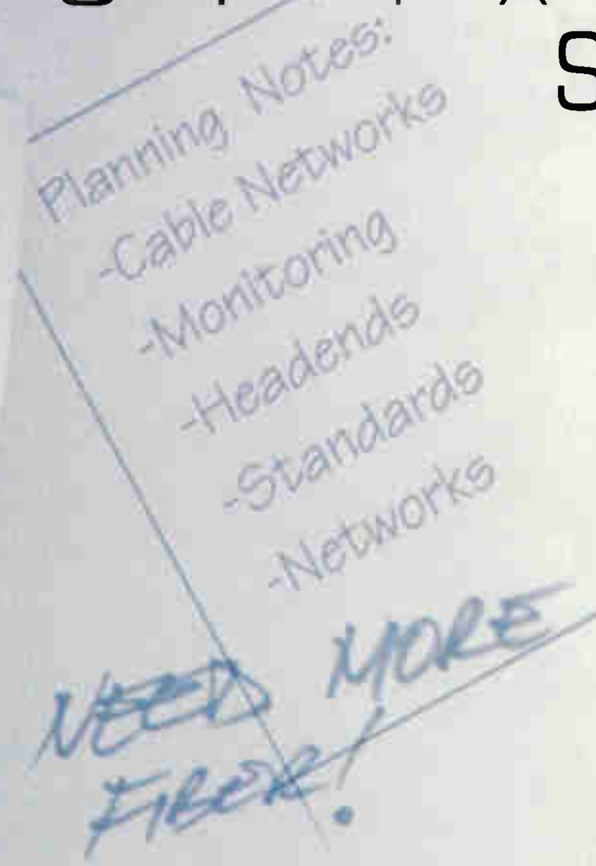
November 2000

PLANNING

2001 • PART TWO

Special Report

PAGES 48-111



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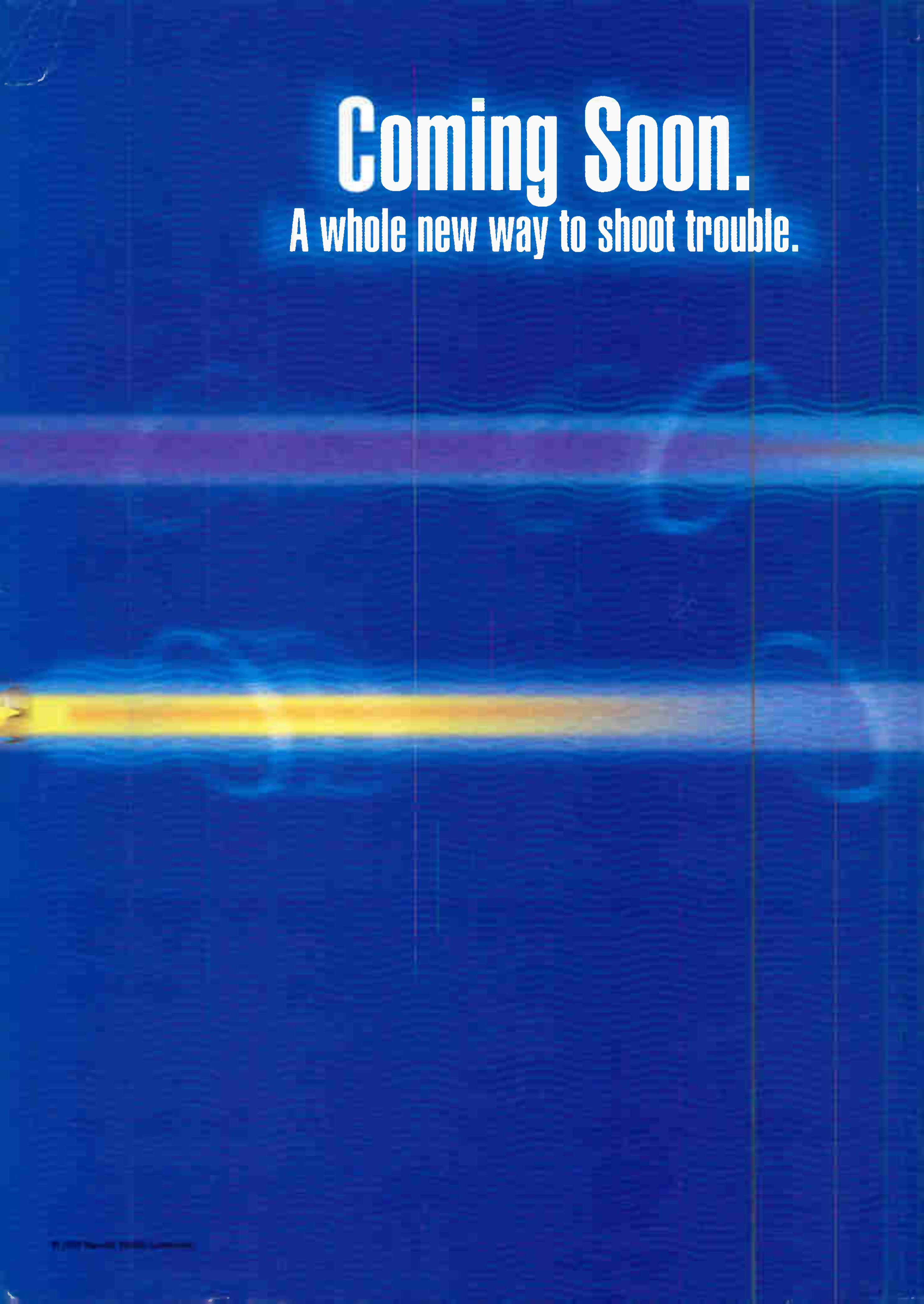
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Cover Design by Tamara A. Morris

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The Value of Certification

I recently received a message from an SCTE member frustrated with the emphasis we give to certification. The topic was important to me since certification is one of three SCTE goals.

He wrote, "The BCT/E program is being especially hurt as other industries develop and promote their own certification programs. I have no objection to other certification programs but, in the short time these new programs have been around, there seems to be a perceived value in having this new certification and a perceived lack of value in BCT/E certification."

I see certification-training ads on TV, especially for computer technology. "Incentive programs seem to have gone away and certification has been removed as a criteria for multiple system operators (MSOs) to promote employees. The most common excuse is that there are not enough certified people to fill the job vacancies, thus they choose to simply eliminate this as a requirement," he said. Shame on broadband communications!

"Other than offering a certificate or ribbon at the Expo, the SCTE does very little to add value to the certification process," the SCTE member wrote. "Many of the certified SCTE members are not listed correctly within our own membership directory." I discussed this particular complaint with SCTE's Melissa Hicks, who is investigating and correcting the problem.

"My employer places tremendous value and pride in its employees and users being certified. This recognition starts at the very top and is constantly endorsed. In our company, every certified engineer at any level of the program is issued a certification number, indicating their placement within the ranks. With the department heads, it is a source of great pride to list the number of certified individuals within each department." I wonder how many certified technicians and engineers there are in each SCTE region? If we don't highlight the numbers per regions, attention will not be drawn to which regional managers are supporting the SCTE and it's certification program and which are not.

"At our company, certified people, working toward re-certification, are granted first priority when signing up for training sessions. Their certification numbers are their ticket to early registration, guaranteed priority in classes, check-in and preferential hotel space. There is a special check-out line in our cafeteria for certified engineers. We receive special discounts on products and so forth," he wrote. While these ideas are from a company that believes in the value of certification, surely we can improve our recognition of those who participate in the program. I purchased one of the first satin SCTE jackets and some nice patches, which I plan to sew onto the front and sleeves. I think I'll attend the next ET and Expo with my jacket. Maybe I can make the first individual step toward change. What do you other members think about certification? Let me know. It's your SCTE! CT

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> Facilitating Communication

Rex:
I read with interest your article—"What Do You Think?"—regarding communicating with the **Society of Cable Telecommunications Engineers** (September 2000, page 12). I had a problem with the SCTE for a while and living in Canada, I have had problems trying to resolve it. Maybe you can help?

I had been an SCTE member for many years, and was elevated to Senior Member in 1979 by the late Larry Dolan, who was the then-president of the Society. I have a plaque and a diploma showing my former status..I believe the reason I lost my senior membership status is because I did not receive any request for membership fees for a few years. I rejoined the SCTE about 10 years ago, and have asked to be reinstated as a senior member without success.

I would appreciate your help in resolving this situation.

J. A. André (Andy) Lamarre
Director Engineering
Trispec Communications Inc.

SCTE's response: On behalf of the Society, I apologize for the challenges you previously faced in assuring your status as a senior member. We have re-instated your status in our database. At the current time, we are updating our Senior Member certificates to reflect our new logo. As soon as they are completed, Barb Kugler will mail yours to you.

We sincerely appreciate your participation in the Society and we look forward to continuing to serve you. If you have any concerns or questions, please don't hesitate to contact me at 610-363-6888.

Melissa A. Hicks
Director, Membership Services & Industry Relations, SCTE

Editor's response: Your problem has been resolved as stated above One of the benefits of *CT's* status as the official trade journal of the SCTE is that we get to work closely with such dedicated staff members as Melissa Hicks. Thanks for your support.

Rex Porter
Editor-in-Chief, CT

Watts Up, Doc?

CT:
I read "Downstream Power Measurements: Watts Up Doc?" (September 2000, page 14)—a great article by Ron Hranac and Mark Millet! We're very interested in your cable-modem industry articles, as we analog RF companies struggle with two-way plant and quadrature amplitude modulation (QAM) transmission installations.

Phil Schelinski
21st Century Telecom Group

CT:
Your article on properly setting digital carrier levels was very helpful (September 2000, page 14). Our systems are running seven pods of digital. We have been debating the different methods of measuring the digital haystacks in relation to the analog carriers. What you see is not always what you get! Is there any specific **Federal Communications Commission** (FCC) testing required on the digital signals? I'm


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proofing my systems for analog testing as usual, but should I be doing specific tests with the digital signals?

Jim Adkins
Regional Tech. Supervisor
Tele-Media Corp.

Editor's response: With regard to setting the level of digitally modulated carriers, your best bet is to use test equipment that has built-in capability for automatic measurement of the average power level of those carriers. This will remove any doubt about measurement accuracy.

As for specific tests for digital signals, this ultimately may be a question for your company's FCC regulatory or legal folks. They're going to be in a much better position to interpret the FCC's rules. Having said that, if you peruse §76.605, you'll notice that most of the technical standards apply to conventional analog TV channels. A few exceptions appear to include such things as channel allocation, terminal isolation and in-channel frequency response. One area where compliance is required for any type of signal carried on the network is signal leakage, as detailed in §76.605(b). Your FCC attorney should be able to provide more definitive information, especially about other portions of Part 76.—*RH*

Audacious Audio

Rex:

I was thrilled with your "Editor's Letter" regarding audio levels (Sept. 2000, page 8). I own three small cable systems in Indiana and would probably have a difficult and cost-prohibitive time employing automatic volume-level equipment for each of our cable channels. My private firm also sells and services satellite systems and rooftop antennas.. Our main goal is to offer our subscribers and customers the best TV programming possible.

It has always irked me to see a musical group performing on TV without quality audio. It isn't unusual to be watching a musical group, even a classical presentation, and see the harp, piano or other instrument, yet hear nothing that resembles the sound that instrument is known to make. It is such a pleasure to take in an *Austin City Limits* or other high-quality program and realize it is possible to reproduce the presentation much more faithfully than what we usually hear.

But worse than the above is the crime you take up in your September editorial. I want to reinforce what you say, except I wonder if you are aware of how much more serious the problem is for the 10 percent of the viewers who are older or have some hearing loss. This is a common joke today, especially among the younger set as they laugh at how loud Grandpaw usually watches TV. But if Gramps normally needs the sound about twice the level of what his wife needs (women have less difficulty than men on average), and the uncaring network doubles that sound, then Grandmother is suffering with four times her preferred volume.

If the screaming commercials affect both the hard of hearing, as well as those around them, then it isn't just 10 percent of the population that is being cheated, but 20 percent. Add in the next door apartment dwellers who hear the double or triple volume through the walls and . . .

The irritation this causes isn't just to the listeners. It causes strained relations within a household. It defeats

LETTERS

the gains many in the consumer electronics business in delivering higher quality TV in other aspects. Those who perpetrate this crime are as guilty as those who steal or mislead you into thinking a telephone sale pitch is really just a 'survey.' Broadcasters, satellite programmers and cable operators who do not protest this crime are as guilty as the advertisers who continue to get away with it. They are industry professionals who don't care enough to stand up to a practice that hurts everyone.

Thanks for your good words.

Dick Glass, CETsr
President
Electronics Technicians Assn., Int'l
Greencastle, IN

Is the Last Mile in Sight?

For years, we have heard the trumpeting of the band in regard to "the last mile." While this analogy still may garner an upshot of emotion, does the terminology still fit?

Delivery of new and existing services into the home certainly is still evolving. Cross-competition among telecom providers offers consumers many choices. All the players—cable companies via broadband, wireless companies with MMDS and LMDS, satellite's direct-to-home, phone companies expanding their ADSL/DSL, electric utilities deploying fiber, and broadcasters with their recently acquired digital spectrum—are promising digitally compressed broadband, which is the utmost criterion.

Who's on first? Not even the players know, as witnessed by the heretofore-unimaginable alliances such as telephone and cable companies, cable companies and Internet service providers (ISPs), municipalities and ISPs, cable and wireless power companies and competitive access providers.

The definition of the last mile needs to be expanded as the data rates of copper, coaxial, satellite and terrestrial services are expanding. In the future, virtue of the supplier, aptness of the delivery mechanism and the variety and desirability of applications will be more important than the physical connection. As old-school narrow pipes and ever-developing new technologies are being distended, the networks they are binded to will follow suit.

For the moment, cable's hybrid fiber/coax (HFC) network design ranks high as a delivery mechanism. But our competitors are not standing still. Every network connected to the Internet expands its functionality. Once a residential gateway is established in the home, applications for its use abound. Being first to the home will hold an advantage only if the product delivered can stand up to scrutiny.

The value of our network lies not so much in the bandwidth available, but more so on the applications delivered. Content is king and the original cable TV application, video, has served us well. In order to lead in this new order, technological advances in delivery must continue. The product also must be enhanced and new alliances and providers sought. Given the ground swell and appreciation for digital video, data, telephony and some of the more creative uses of the networks such as VPNs and point-to-point, deep-pocketed corporations are looking for a piece of the pie.

It seems we are not in the last mile of the race, nor hold the ultimate last mile of delivery. So I ask again, is the last mile in sight?

Michael J. Berrier
Technical Operations Manager
Susquehanna Communications

> Write to Us

What do you think of this month's issue? If you agree, disagree or have comments on what you've read, please let us know. Simply e-mail *Communications Technology's* editors at tvrex@earthlink.net or jwhalen@phillips.com. *CT* may edit letters for clarity and space.

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ADC Enters CMTS Space

By Jonathan Tombes, Deployment Editor

Telecommunications equipment manufacturer **ADC** is jumping into the cable modem termination system (CMTS) ring with its purchase of **Broadband Access Systems**.

In a stock deal valued at $2.25 billion, ADC acquires what Chairman and CEO Bill Cadogan calls a "strategic cornerstone." Specifically, ADC gets BAS's Cuda 12000, an Internet protocol (IP) access platform that contains a CMTS, router and media gateway.

The deal leverages BAS's "already-shipping" status and the **CableLabs** qualification of the Cuda-integrated CMTS, which set BAS apart from rival start-ups.

BAS President Dan Paolino says his company has built more than 200 systems, 60 to 70 of which are in the field.

ADC officials highlight the broader (non-cable) possibilities of the purchase. "BAS technologies also have powerful synergies with the delivery of IP-based services over ADC's DSL (digital subscriber line) and wireless platforms," Cadogan says.

Ron Westfall, a senior analyst at telecom research firm **Current Analysis**, says that the Cuda 12000's flexibility derives from separate application specific integrated circuits (ASICs) for each line card and a non-backplane dependent design.

"The bottom line is the Cuda architecture is really a high-end router that can address different deployment scenarios depending on the line cards you slot into it."

BAS's CMTS technology is one of five that CableLabs has qualified as DOCSIS 1.0-compliant. The others are **Arris Interactive**, **Cisco**, **Motorola** and **3Com**.

> "The Cuda architecture is really a high-end router that can address different deployment scenarios."
> —Ron Westfall, Current Analysis

The competition

ADC faces competition in the CMTS arena from various contenders and may have picked a fight with one of them.

John Mattson, director of marketing for Cisco's cable business unit, says Cadogan's prediction that a competitive platform from Cisco would hit the market mid-2001 is "completely inaccurate." He also objected to any implication that Cisco's current products were "old generation."

Mattson says "next-generation" refers to DOCSIS 1.1, a designation that has yet to be granted. "Everybody is claiming to be 1.1-ready, and we believe we're just as 1.1-ready as they are."

Cisco's current product mix features universal broadband router (uBR) 7246, which combines a Cisco 7200 series router with a CMTS.

As for ADC's challenges on the start-up front, Westfall says differentiation has begun. On scaling capacity, for instance, he says the Cuda 12000 currently supports up to 12 downstream channels and 44 upstream channels per chassis.

Westfall says the comparative channel capacity numbers for **RiverDelta Network's** BSR 64000 are 26 (down) and 104 (up); and for **Cadant's** C4 are 32 (down) and 132 (up). CT

NEWSBYTES

> ***TW Buys Licenses***

Time Warner Cable has agreed to buy one million licenses of **BroadJump's** Virtual Truck installer. Time Warner will immediately begin deploying the licenses recently re-branded as **Road Runner Connect.**

> ***Motorola Sells Modems***

Charter Communications has agreed to purchase at least 300,000 additional SURFboard DOCSIS cable modems from **Motorola** by the end of 2001. Separately, Motorola says it has shipped its millionth DOCSIS cable modem.

> ***AT&T Gets Set-Tops***

Matsushita Electric Corp. of America will provide **AT&T Broadband** with some one million advanced digital **Panasonic** set-top boxes to the company's cable customers during the next three years.

> ***Comcast Deploys Quantum***

Comcast says it will deploy **Quantum Bridge Communications'** Bridge Optical Access System in select markets over the next several years.

> ***DSG-Canusa Expands***

DSG-Cansusa announced an $11 million expansion of its Toronto facilities. The company uses heat-shrink technology to provide insulation solutions for electrical, communications and other markets.

> ***Cisco Ramps Up***

Cisco Systems opened its $100 million New England Manufacturing Center in Salem, N.H., with the goal of generating $50 billion in fiber optic networking equipment sales.

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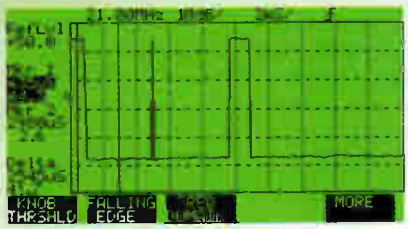

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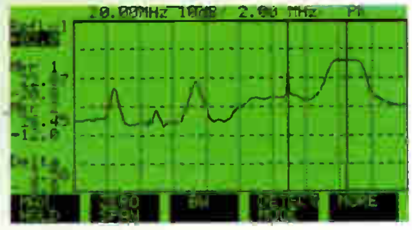

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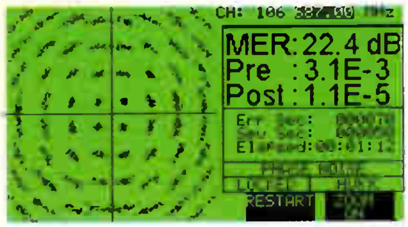

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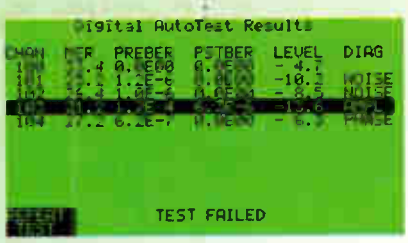

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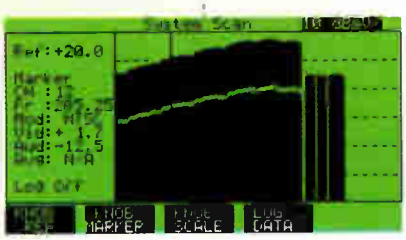

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WorldGate Advances Set-Tops

By Arthur Cole, Contributing Editor

You thought you needed next-generation digital set-tops to launch advanced services? **WorldGate Communications** wants you to think again.

The company has released a new middleware package called CableWare 2000 that is capable of providing advanced interactive services to the nearly 8 million digital set-tops already on the market.

In the headend, the system requires minimal hardware, even as the number of users scales upward. In some cases, the middleware may even reside in a centralized location and operate via satellite links to the headend. CableWare 2000 may be used in one-way or two-way systems. The package also contains a number of application templates that allow operators to brand their news, stock-ticker information and other services with a common design.

> **"There's been a mindset in the industry that advanced applications can only happen on advanced boxes."**
>
> —Joe Augenbraun, WorldGate

Individual set-tops will have to be upgraded for CableWare, but this can be accomplished with a data dump from the headend.

"There's been a mindset in the industry that advanced applications can only happen on advanced boxes," Joe Augenbraun, WorldGate's senior vice president of engineering, says. "But the reason they cannot run on the current generation is not the technical limitations of the box. It's the limitations of the software that runs on it."

WorldGate engineers designed the CableWare product to operate with the limited memory and slow central processing unit (CPU) of today's 2000-class set-tops. The system is compatible with the WorldGate Application Launcher Interface (WALI) that is used by four of the top six multiple system operators (MSOs) in the country.

This compatibility allows applications designers to avoid having to relaunch existing WALI applications for the CableWare environment. New applications, however, will be able to provide a much richer media experience, with features such as interactive graphic overlays synchronized to live video.

For developers, there are two products: the software developer's kit (SDK) and the content developers kit (CDK).

Offering greater security, the software kit offers support for C or C++ developers, as well as those who write interpreted code running in a "sandbox." On the content developer's side, Web authors and designers may use standard industry tools to add animations, fly-ins and synced graphics.

"If you look at cable operators' objectives, it's been more expansion, more consumers," Augenbraun says. "WorldGate took the initial set-top box and expanded it with features that were expected from future technologies."

The company is trialing the product among MSOs and expects to ship the system in the first of next year. CT

DEALS

> ***Redback Acquisition***

Redback Networks completed its $636 million acquisition of **Abatis Systems**, a deal integrating Abatis' service-creation capabilities with Redback's subscriber management and router solutions.

> ***Videotron Recommends Buyout***

The board of **Groupe Videotron** have recommended that shareholders accept **Quebecor's** $5.4 billion offer for its shares.

> ***Cisco to Acquire PixStream***

In a stock deal valued at $369 million, **Cisco Systems** is buying **PixStream Inc.**, a provider of hardware and software digital management solutions across various broadband networks.

> ***Tempo Gets Test Products***

Tempo is acquiring from **Tektronix** the metallic access test products for the telecom and cable TV markets. The acquired line includes the TelScout, CableScout and SignalScout products.

> ***Vivendi-Seagram Deal Progresses***

European authorities say that commitments for **Vivendi** and its **Canal Plus** unit bode well for their pending acquisition of Canadian conglomerate **Seagram**. The merged firm would be called **Vivendi-Universal**.

> ***Gartner Gets Solista***

Market research firm **GartnerGroup** is buying **Solista**, a strategic consulting firm that focuses on digital technology and business.

NBand Raises Funds

nBand Communications, a broadband wireless company, raised $14 million in a second round of financing led by **VantagePoint Venture Partners**.

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Bluetooth: The Future of Home Networking?

By Kimberly Johnson, Associate Editor

Cord tangles and headaches associated with connecting electronic devices could be nearing obsolescence as **Bluetooth** strengthens its foothold in the wireless home networking arena.

Bluetooth is one of the fastest growing industrial standards with more than 2,000 companies involved in its consortium. Some say businesses will buck supporting it until forced to do so, yet proponents maintain that the technology will be built into hundreds of millions of electronic devices by 2002. (See related story, page 130.)

How it works

Tiny microchips featuring built-in radio transceivers in digital devices do the work of cord-free instant connection, allowing for seamless and spontaneous communication without any user input. Devices may be linked up to a range of 10 meters and data may be transmitted at a rate of up to 700 kbps.

Not only will the cords connecting the devices disappear, but so will the conventional rules of connectivity. Broadband-enabled wireless services such as Internet access and voice applications could be carried out through wire-free devices, such as laptops networked to mobile phones.

"Cord replacement is key.... People hate cords," analyst Galen Schreck of **Forrester Research** says. The launch could occur as soon as this upcoming holiday season, when **Ericsson** and **Toshiba** products touting Bluetooth capabilities begin hitting the shelves, Schreck says. "It's definitely coming."

Bill Wall, **Scientific-Atlanta's** technical director of subscriber networks agrees and says wireless home networking is an untapped market. He says S-A is involved in development work and that the new technology holds "great promise."

The competition

Home RF and **IEEE802.11** are Bluetooth's closest competitors, although each is outfitted with various application distinctions.

IEEE802.11 allows for a much larger connection range of up to 100 m and could support hundreds of devices, making it suitable for the corporate world.

Home RF, initially designed for connecting several PCs within the home, is a less expensive version of IEEE802.11. But what Bluetooth lacks in range and data transmission rates, Home RF makes up for in cost and simplicity, putting it in a niche that could catapult it into the mainstream marketplace.

"Bluetooth is simple technology," Schreck says. "It's cheaper, smaller, lower power and easier to use in little devices."

At the same time, Bluetooth wouldn't be advantageous as a sole means of connecting to a network because of its speed. "It's not that fast," Schreck says, adding, "I don't think it will take off with wireless Internet access."

Wireless technology has advantages by being self-organizing, but interaction is tricky, Schreck says. "The language is there but someone is going to have to add an additional layer for applications."

Wireless networking technology brings forth issues of cost, interference and reliability, which won't be resolved until it's deployed on a large scale, S-A's Wall says.

"I think it's really going to be a race to what is more cost-effective," he says, adding that S-A is waiting for the market to decide. "I don't think there will be a single winner right off the bat. Wireless technologies are going to be the ultimate winners." CT

PEOPLE

Best to Retire

Alex Best, **Cox Communications'** executive vice president of engineering, plans to retire at year's end. **Chris Bowick**, who was promoted to senior vice president of technology development in August, will succeed Best.

Werner Resigns

Cable-network expert **Tony Werner** is leaving **AT&T Broadband. Greg Braden** has been promoted from senior vice president of telephony to executive vice president of engineering and telephony operations.

Bukovinsky Promoted

David Bukovinsky has been promoted to the new position of vice president of broadband services at **CableLabs**. He is responsible for blending the Data Over Cable Service Interface Specification (DOCSIS) development project with PacketCable.

Galliard Honored

Margaret A. Gaillard is the recipient of the 2000 Women in Technology Award, an honor bestowed annually to recognize women leaders within the broadband and telecoms communities.

Soderquist to Head Com21

Craig Soderquist was named president of **Com21** and will become CEO January 1 upon current CEO **Peter Fenner's** retirement.

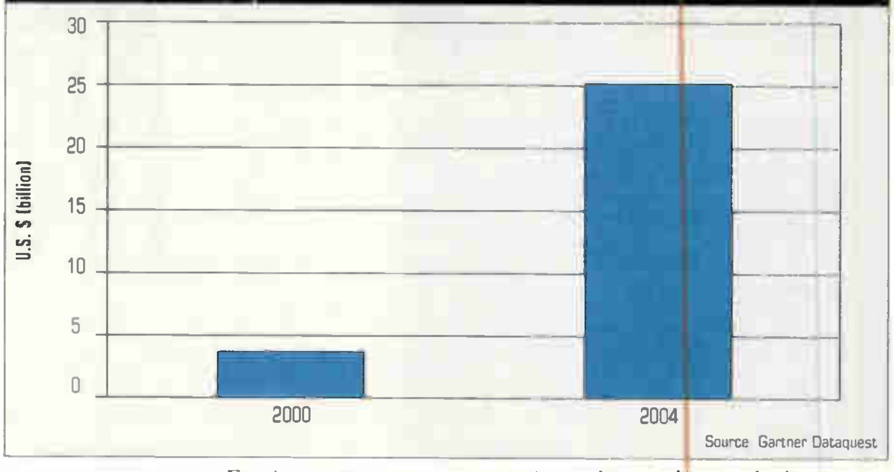
Bryant Named Concurrent Chief

Jack Bryant, Concurrent Computers's video-on-demand (VOD) division president, was named chief executive. Current CEO/COO **Steve Nussrallah** has become chairman of the board.

ASP: From Buzzword to RFP

By Jonathan Tombes, Deployment Editor

FIGURE 1 PROJECTED GLOBAL MARKET FOR APPLICATION SERVICE PROVIDERS (ASPs)



A lot of hype surrounds the application service provider (ASP) industry, and operators such as **Cox Communications** are wading through it to join the fray.

Leveraging the notion of "thin client," the idea of an ASP is to host and deliver mission-critical software over the Internet, thus reducing an enterprise's capital and personnel requirements.

The idea is big. **Gartner Dataquest** says that the global ASP market will grow from $3.6 billion in 2000 to $25.3 billion in 2004 (see Figure 1). **The Phillips Group**, a sister consultancy to this magazine, forecasts that by 2004, U.S. demand for network hosted applications will grow twelvefold, topping $13 billion.

> **"We're looking at working with a partner that essentially won't box us in."**
> **—Christine Faulkner, Cox Business Services**

Back in the present tense, the industry remains young, fluid and ahead of customer. **Cox Business Services** Senior Product Manager Christine Faulkner, who is leading her company's venture in this field, offers a reality check.

"The hype is more driven by the providers of ASP services at this point versus small- to medium-size businesses really understanding what ASPs are," she says. "But I think we're going to turn that corner really quickly."

Cox's first step was to issue a request for proposal (RFP) for a Web hosting and e-commerce partner that would allow Cox to private-label these services and enable further movement up the value chain.

For instance, a business client may begin with Web hosting needs, but over time may migrate to using the Web for sales, or business-to-business (b-to-b) transactions, and then on to advanced hosting options.

"We're looking at working with a partner that essentially won't box us in," Faulkner says.

Which market?

Cox is aiming at the small- to medium-size business (SMB) market, but not exclusively.

"We're also concentrated on a few verticals: government, hospitality, health care, REITs (real estate investment trusts) and education," Faulkner adds.

Terry White, author of the Phillips Group's study, "Network Hosted Applications: U.S. Market Demand and Segmentation Analysis," agrees that the ASP value proposition extends beyond the SMB market.

"Whereas the small companies tend to be the big users of ASP services now, three or four years down the road, big companies will become the largest segment of ASP users," White says. According to his study, larger businesses will account for 70 percent of the ASP market growth by 2004.

From the best prospects not yet understanding ASPs to widespread adoption among the less likely but larger ones is a big jump. **AT&T's** launching of ASP "ecosystems" early this year is an example of the push that will be needed to achieve such results.

Even businesses that have grown accustomed to outsourcing will hesitate when the service involves "mission critical" information technologies. But efficiency demands change.

"I think we'll see something of a culture shift," Faulkner predicts. CT

(For a detailed ASP business case, see related story on page 48).

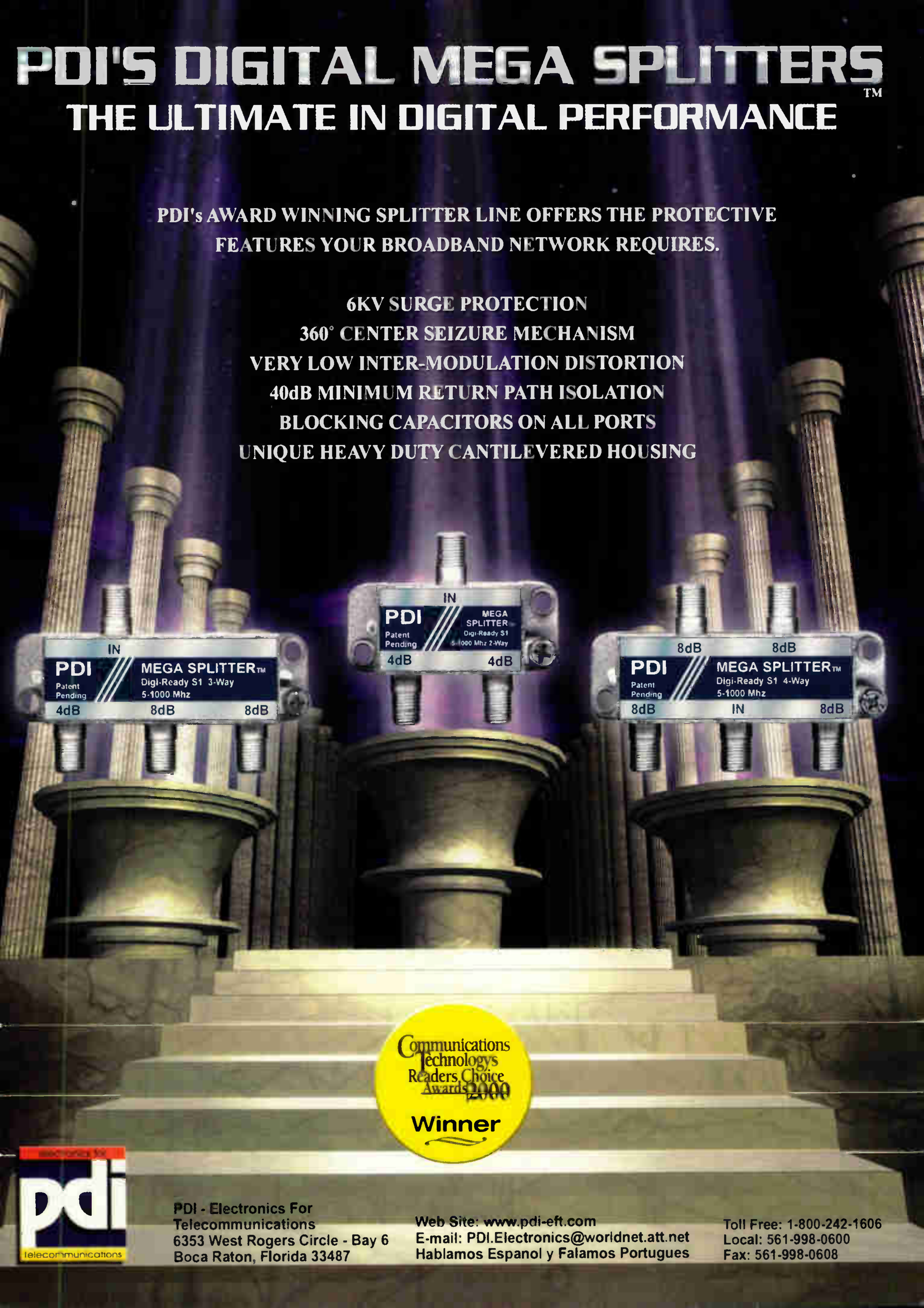
PEOPLE

Farmer Starts Up

CT contributor **Jim Farmer** has left **ANTEC** to become chief technical officer of **Wave7 Optics**, a fiber-to-the-home start-up.

Hercules Leads DemandVideo

Turnkey VOD provider **DemandVideo** named **Richard Hercules** its president and chief executive officer. He had previously served as executive vice president, engineering and operations.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Roving Reporter

Synchronous CEO Talks

Vincent R. Borelli, chairman of **Synchronous Group**, recently talked with *Communication Technology* about his Silicon Valley-based, optical transmission equipment company on the challenges and opportunities facing the cable industry.

CT: What are your company's plans for the future?
Borelli: What we want to be able to do is to take our expertise in the cable industry into the rest of the telecommunications industry. We also want to expand our capability in the cable TV world. Over the next several years, it's going to be more fiber-deep than it has been in the last 10 years. In [1996], we were involved in a fiber-to-the-home project in Switzerland. I'm not so convinced the cable industry is going to embrace cable-to-the-home that quickly, although it has to.

CT: What about competition with the phone companies?
Borelli: We have the bandwidth. There is room for the cable guys to take a look and say, 'Why aren't we the competitive local exchange?' They are saying this, but that's not what they're calling it. The cable operators need to be in a position to be the competitive local exchange. Obviously, if you don't have the local access, you're not a competitive local exchange. How far are we from open access? That is the issue that will drive just how far we get into the competitive local exchange business.

"I'm not so convinced the cable industry is going to embrace (fiber) cable-to-the-home that quickly, although it has to."
—Vincent R. Borelli, Synchronous Group

CT: What are the challenges for video-on-demand?
Borelli: Video today is not interactive. On the other hand, if you take a look at the Internet, that's interactive, the telephone is interactive. Everything is except video. What cable TV offers is interactive, except video. Everything we see today is MPEG-2 (Moving Pictures Expert Group). MPEG-3 is the next generation and the compression is a little better.

How far are we from being able to get on the Internet and watch movies, or download movies? If you have a video source off the Web that's good enough to watch, then what are we doing with cable TV? I'm not saying that's the answer. That's not going to be the solution, or the alternative, but there's going to be a product in the next several years that will be video on the Internet.

CT: What role does fiber play?
Borelli: You can see how the technology of the past does effect the technology of the future. Everything that we did on analog and RF and all that other good stuff electronically is now being done in light, it will be done in light. You (can now) switch in light. It's just amazing what's going to happen.

How long has cable TV really been using fiber—10 or 11 years? Well, look at what we've done. It isn't much different from what we did with coax. It's just a question of who wants to spend the money and what are the benefits. That's where we are with fiber. CT

Deployment Watch Monthly Update

Provider/Operator	Service/Feature	Communities	Vendor/Partner
AlphaStar International	Two-way satellite broadband Internet network	New York City, plus six northeast markets	GE
AT&T Broadband	Video-on-demand services	Los Angeles, the San Francisco Bay area, Pittsburgh	Diva
Cablevision	Software platform to deliver interactivity	Boston-area cable subscribers	Liberate Technologies
Cox Communications	Movies-on-demand	San Diego	Scientific-Atlanta and Concurrent
Cox Communications	Broadband and interactive TV services	Undisclosed	ICTV
Excite@Home	@Home broadband Internet Service on PCs	Nationwide	Sony Electronics Corp.
Charter Communications	Broadband services	Ozark, Ala., Estes Park, Colo., Carrolton, Ga., New Roads, La., Waynesville, N.C., Alamagordo, N.M., Fond Du Lac and Spenser, Wisc.	High Speed Access Corp.
Covad Communications	High-speed broadband Internet access service	39 new markets, including San Antonio, Indianapolis, Columbus, Memphis and Milwaukee	Juno Online Services, Inc.
Cablevision	SourceGuide, an interactive program guide	Boston area	SourceSuite
Hybrid Networks	Fixed broadband wireless system	Detroit and Colorado Springs, Colo.	Sprint


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Broadband Voice Gets Hot

By Natalia A. Feduschak, Senior Editor

Nancy Goguen says the stage is being set for the explosion of broadband voice.

"It's a revolution in the process of happening," says Goguen, vice president of marketing for **Telogy Networks**, a **Texas Instruments** company that produces digital signal processor (DSP) software. "Voice is a killer app.... As voice becomes packetized, then everything is a packet. Data is a packet. Voice is a packet. What that means is that you only need one network over time that can handle voice and data."

Various research firms predict that total world telephony subscribers will number more than 20 million in 2004, while 25 percent of U.S. cable subscribers will have cable phone service by 2005. That means companies such as Telogy will be busy writing applications and selling its services to firms who must incorporate voice services if they want to stay competitive.

New products

The race for deploying voice services is so hot that some companies are stepping outside their traditional sphere of expertise to hone in on the market. Cable modem manufacturer **Terayon** is unveiling a new product that will extend its data cable solutions to include cable telephony with extended opportunities for competitive local exchange carriers (CLECs).

Terayon's BandLeader product is compatible with circuit- and packet-switch, uses Class 5 switch features and enables competitive local exchange carrier (CLEC) partnerships and open access.

"Terayon is well on its way toward becoming a complete solutions provider," Golan Manor, vice president of technical sales, says. "Voice is becoming a key service for cable operators."

Two strategic purchases in the last year, including telephony systems provider **Telegate**, are allowing Terayon to position itself as leader in broadband voice.

"Terayon is in a unique situation because of its strong CDMA (code division multiple access) technology," says Michael Harris, president of the research firm, **Kinetic Strategies**. "They can leverage that technology for a circuit-switched solution because IP telephony isn't ready for prime time."

The future is carrier-class

Officials at **General Bandwidth**, which produces carrier-class voice gateway equipment, say several challenges face manufacturers who want to compete in the voice space. The most pressing is how to re-architecture their products to meet the current and future needs of regional Bell operating companies (RBOCs) and multiple system operators (MSOs), both of which have set high requirements for equipment.

"First-generation equipment isn't able to provide what they want," says Robert Whitcher, director of public marketing for General Bandwidth. Some companies will have to begin at ground-zero to reconfigure products.

Whitcher maintains his company is able to jump headfirst into the broadband voice market because its product was designed with an eye toward the future. Carrier-grade products will be one of the key pieces in the evolution of networks in the next five years, he says.

As manufacturers rethink their product lines, the activity surrounding broadband voice sets the stage for fierce competition between phone companies and MSOs. CT

Middleware Specs Advance

By Jonathan Tombes, Deployment Editor

The selection of middleware specification authors is another milestone in the set-top's ongoing evolution into an interoperable computing device.

CableLabs named three primary authors of its OpenCable Application Platform (OCAP) specs: **Sun Microsystems**, as the lead contributor to the middleware's execution engine (EE); and **Liberate** and **Microsoft**, as collaborators on the presentation engine (PE), the set-top's Web browser equivalent.

Canal Plus, **OpenTV** and **PowerTV** will provide additional support through the review and comment process, and consumer electronics manufacturers also will be invited to participate, CableLabs says.

Execution Engine

Sun earns a place at the table through the widespread adoption of its Java programming language and its spadework in the industry.

"For quite a few years, we've been working with companies around the world like OpenTV, Liberate, **Sony** and **Philips** to help them define an interactive television content platform," Eric Chu, Sun group marketing manager for consumer and embedded software systems, says.

A year ago, the digital video broadcast (DVB) project selected Java technology as the foundation of its multimedia home platform (MHP). DVB is an international consortium of broadcasters, manufacturers, operators and regulatory bodies.

In selecting Java as OCAP's programmable environment, CableLabs is following the lead of its DVB counterpart.

Apart from Java's global footprint, its "write once, run anywhere" programming capability also commends itself. >

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Operators are looking not only to provide Internet-type applications but also to drive TV-centric interactive content whose development is ongoing.

"These set-top boxes are expensive," Chu notes. "Once they get into the field, (operators) want to make sure they're future-proof."

Protection against potentially malicious applications is another concern, since a disabled set-top both increases an operator's technical expenses and reduces anticipated interactive cashflow.

"The Java environment is built from the ground up with security as a core component of its architecture," Chu says.

Unlikely partners

On the PE side of the middleware, hypertext markup language (HTML) and **European Computer Manufacturer's Association** (ECMA) script will dominate. Liberate was a likely candidate for a lead role here.

"I think [CableLabs] liked the contributions we were making, and at the same time, I think they saw that their members were adopting our platform and our technology and standards-based approach," Larry Taymore, Liberate's vice president of strategic partnerships, says.

What's curious is to see Liberate, Sun and Microsoft working together. Liberate, after all, is a brainchild of **Oracle's** Larry Ellison, whose mission is largely defined in opposition to Microsoft founder Bill Gates. Ditto, for Sun's Scott McNealy.

The Liberate-Microsoft PE draft is now under review. CableLabs expects most of the OCAP spec to be delivered for implementation before the year's end.

Just don't expect OpenCable's collaborative effort to soften all competitive instincts.

In a visit to *Communications Technology*, Canal Plus U.S. Technologies' chairman Jean-Marc Racine referred to Liberate as a "browser company" and said Microsoft was "still getting its stuff together."

Racine says that U.S. operators, previously preoccupied with going digital and figuring out Internet-over-the-TV, have only lately focussed on interactive TV.

"And what is interactive TV? It's actually enhancing the content, enhancing the entertainment experience, which truly is what we have been doing for five years," Racine says.

Canal Plus claims to have the lead on executing middleware Java applications in live cable subs. For its part, PowerTV says it inaugurated the PersonalJava engine for interactive digital TV last June. CT

Decision Nears for Northpoint

By Natalia A. Feduschak, Senior Editor

Northpoint Technologies is about to find out if its $10 million fight to get started has paid off.

The **Federal Communications Commission** (FCC) is expected to rule soon on whether to grant Northpoint approval for a technology that the company says will bring high-speed Internet and digital television programming to consumers nationwide at a fraction of the cost charged by most cable and satellite providers.

"This process started in 1994," says Sophia Collier, majority interest holder of **Citizens Advisors**, a venture capital and investment advisor that has stakes in Northpoint. "It takes time for people to accept new technology."

Because all direct broadcast satellites are located over the equator, satellite dishes in North America are pointed in a southerly direction. The northern horizon is unused and available for broadcasting. By transmitting from terrestrial towers located to the north into directional-receive antennas similar to satellite dishes, the 500 MHz currently used by direct broadcasters can be re-harvested for new uses in every city and town in the United States, Northpoint says.

Northpoint plans to implement a system called Broadwave, a wireless technology that uses the 12.2-12.7 GHz radio spectrum to transmit digital, voice and data signals. Although the system is land-based, it uses a consumer-quality receiver dish that is available in most retail outlets and a set-top box.

> **"Our position regarding Northpoint is no secret."**
> **—Robert Mercer, DirecTV**

Northpoint's quest for FCC approval, however, has gained considerable opposition from direct broadcasting satellite (DBS) operators **DirecTV** and **Echostar**, who claim the new technology will cause measurable harmful interference to their service.

"Our position regarding Northpoint is no secret," Robert Mercer, a spokesman for DirecTV, asserts. "This is a threat that Northpoint poses to nearly 13 million existing subscribers. The nature of the interference... would increase the susceptibility of rain fade."

Rain fade is the temporary loss of a satellite signal when it is unable to penetrate unusually heavy rain clouds or rainfall. DirecTV wants an independent study conducted to determine Northpoint's effect on its service.

However, a recent **Lucent Technologies'** study determined that "the impact on DBS services is negligible in all weather conditions."

Start-up costs

Ari Fitzgerald, the FCC's international bureau chief, says complicating matters are applications filed by eight other companies, including **SkyBridge** and **Boeing**, that want to provide a non-geostationary, fixed satellite service on the Ku band. They have requested to use a total of 4 GHz of spectrum, part of which resides in the 12.2-12.7 range.

"We are talking about three different types of services sharing a band," Fitzgerald explains.

But Collier of **Citizens Advisors** says what most worries the DBS companies is that if Northpoint is successful in signing up just 200,000 customers—much less than it feels it can—that would cost the operators some $2 billion in losses.

Broadwave plans to offer high-speed Internet access and high-quality digital programming for less than $20 a month. The company could have initial deployment of local Broadwave networks in six months, with nationwide coverage in two years, Collier says.

Northpoint has spent $10 million since 1994 trying to get FCC approval. That sum would put many start-ups out of business.

"It's difficult when you're in a highly regulated environment," Collier says. She says too many players in the telecom industry block new technologies through their powerful Washington lobby groups.

"Consumers lose when there's no new technology," she says. "We believe strongly in what we're doing."

The FCC, meanwhile, says it will consider all of the information before the body, including its own findings that DirecTV has not provided any evidence to support its claims.

"We're trying to make this as simple as possible," Fitzgerald says. CT


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SeaChange Prevails in Court

By Jonathan Tombes, Deployment Editor

A Delaware jury rejected **nCUBE's** challenge to **SeaChange International's** MediaCluster patent, essentially closing a case that SeaChange had itself launched.

The case stemmed from SeaChange's June 13 filing of a patent infringement complaint against nCUBE. At the time of filing, SeaChange requested a preliminary injunction.

"Because this was a very important time in the deployment of video-on-demand, we thought we needed to have some relief as quickly as possible," Branko Gerovac, SeaChange vice president of research, says.

In lieu of a ruling on a preliminary injunction, the judge offered an expedited trial schedule.

The next step was a Markman hearing, which is required to define the terminology used in a patent. The two terms at stake were "processing system" and "network."

Gerovac says nCUBE defined those words narrowly, while SeaChange used common references. The judge adopted SeaChange's approach, which largely determined the outcome.

"Right after that ruling came out, (nCUBE) admitted infringement under the claims of the patent," Gerovac asserts.

At that point, nCUBE's only defense was to go on the offensive and claim that SeaChange's patent was invalid. Making six challenges to each of SeaChange's nine claims, nCUBE gave the jury 54 opportunities to invalidate. The jury's decision was unanimous.

"We had a very clear and definitive victory on the challenge to our patent," Gerovac says.

In a statement released Sept. 25, nCUBE President Michael Pohl said his system could be adjusted to avoid infringement without impacting design or engineering.

"We can provide the minor modification necessary through a software remedy to the customers that are effected within the next 48 hours," he said.

"There will be no interruption to our business." CT

Telcordia Technologies

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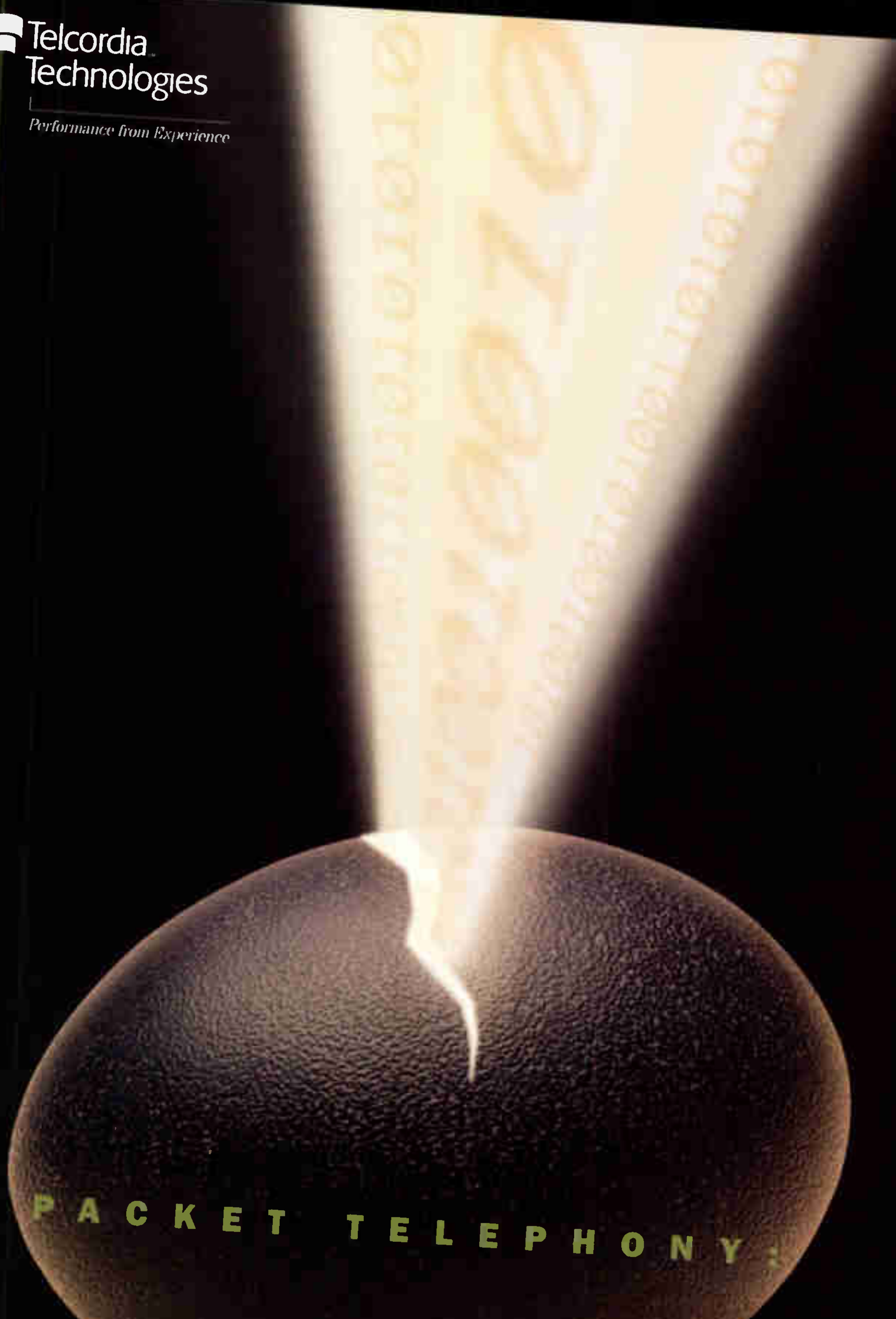

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Videotron's IP Telephony Success

Two years ago, François Laflamme and his colleagues at the Montreal-based communications company Videotron started a small long-distance business, servicing mainly family and friends. Today, Videotron is conducting North America's first Internet protocol (IP) telephony trial using the Telcordia™ Call Agent—providing customers with all the amenities of traditional local phone service, such as call-waiting, voice mail and emergency 911 service.

Laflamme, Videotron's vice president for IP telephony, regularly plays host to visitors from around the globe wanting to learn more about the company's real-world experience with the technology. Videotron believes its success represents the beginning of VoIP's widespread deployment in North America.

"All the multiple system operators (MSOs) are looking at softswitch technology, understanding that this is the direction they want to move in," Laflamme says. "We're way ahead of those folks."

Circuit-Switched vs. IP Telephony

Industry sources indicate that while circuit-switched technology will dominate cable telephony in the next two decades, IP will gain ground and position itself as the primary technology of the future.

The Strategis Group, a Washington, D.C.-based research firm, estimates that by 2005, the United States will have more than 12.5 million cable telephony users. While more than half the subscribers will use circuit-switched technology, the availability of IP telephony next year via a phone-jack installation in cable modems will help fuel IP telephony implementations. Accordingly, the number of IP telephony users will increase from 100,000 in 2001 to more than 2.8 million by the end of 2005.

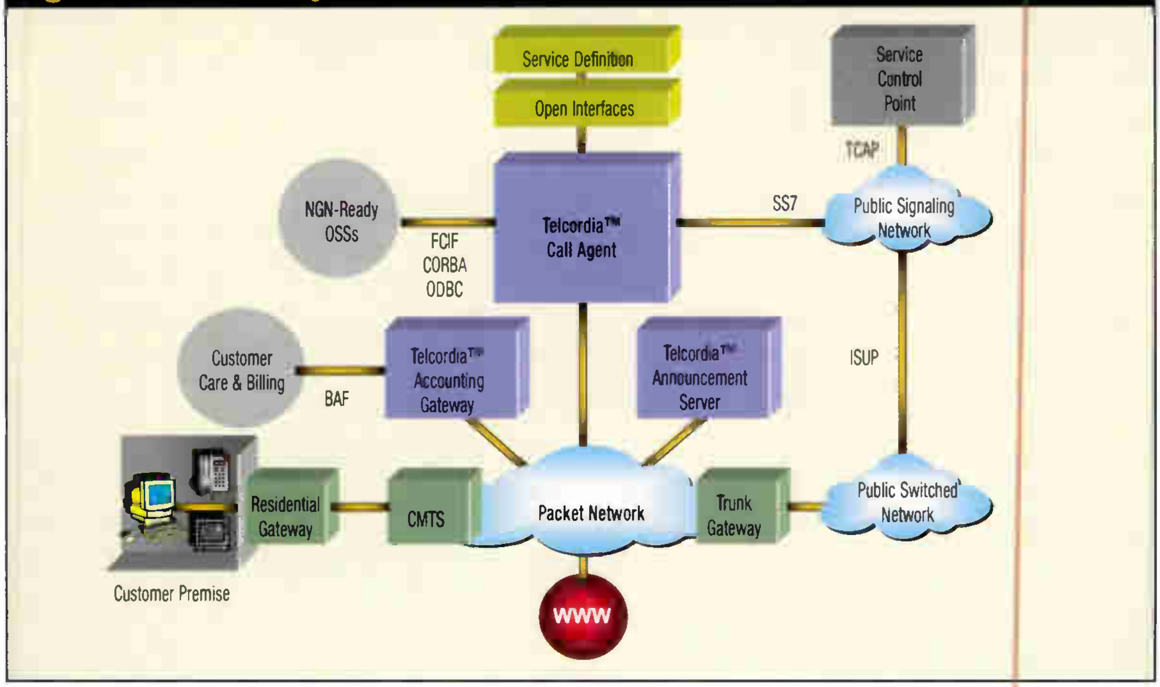
According to the Strategis Group, revenues from IP telephony also are expected to skyrocket over the next five years, increasing from $2 million in 2001 to $717 million in 2005.

The IP Journey

When it embarked on its IP telephony journey, Videotron saw early on the demand for the technology. The question was how to do it.

"Of course, there was the legacy way of doing it—using switches, using proprietary RF technology on a cable plant, commonly known as HFC (hybrid fiber/coax) telephony," Laflamme recalls. "We looked at that and decided we can do better than that on the business-case side of things. We started a discussion with technology partners that could provide us with an IP solution to do primary-line service. From day one, the vision was to replace the incumbent local exchange carrier (ILEC) line—the Bell Canada line—with a comparable feature set, and a superior technology that will allow us to grow beyond the feature capabilities of our competitor's circuit-switched telephony infrastructure."

Figure 1: Telcordia Call Agent's Distributed Architecture



Videotron faced plenty of skepticism from cable operators that saw IP's potential, but couldn't see it realized.

"The MSOs were looking at us and saying, 'Hey guys, we think you're crazy. That technology will never get there,'" Laflamme says. "But the bottom line is, we had to believe that we could."

Cisco Systems, Inc., a major networking solution provider, created the Internet backbone for Videotron's system and minimized packet delays and jitter, two major components in delivering carrier class telephony service. Videotron and Cisco turned to Telcordia to provide that final critical piece of the puzzle—a centralized software platform that controls end points at the customer premise and connects to the Signaling System 7 (SS7) networks, as well as provides billing records and announcements for IP networks.

Between June 1999 and January 2000, Videotron conducted a successful trial with 200 customers using the Telcordia Call Agent. That set the stage for the second wave of the project, started in February 2000.

In that wave, Videotron implemented value-added services like call-waiting, caller identification, voice mail, call-return and other functions associated with switches.

The company also had to ensure that the interconnection with other carriers was in compliance with regulatory requirements. Videotron conducted a series of tests to make sure its system interfaced with Bell Canada, 911 emergency centers and operator services. It also ran a series of tests for local number portability, allowing customers to keep their own phone numbers when they switched from one carrier to another.

Another big challenge for Videotron was to put all the new operations in place, including establishing a network operations center (NOC). Telcordia and their advanced technology also proved beneficial for this exercise.

Scalability and Reliability

"There are three areas that you have to perform on when you build a softswitch," says Laflamme. "The first one is having the necessary feature set that will allow the company to compete in the marketplace." While Telcordia and other companies have a feature set equivalent to a PSTN switch, not everyone has scalability of the system.

"That's where Telcordia makes a difference—scalability and reliability," says Laflamme. "You want a system that is robust, that can have almost have any type of fall and will resist the failure of machines."

Other companies are putting switches in place with IP access to the home. But unlike Telcordia, they haven't implemented the main softswitch, Laflamme says.

"They're doing it in steps," he says. "I don't think that's the right approach because you invest too much in your switch for nothing."

Some companies have traffic coming out of the IP cloud, feed it through a trunking gateway, a device that converts IP traffic into PSTN signals, then through a switch, and finally out of the switch to get into the end-carrier where their traffic will end.

"In my case, I'm coming out of my IP cloud directly into the carrier where I want my traffic to go. I don't have to have a dummy switch in the middle that does not provide much value," Laflamme says.

The Business Case

Videotron's ability to expand its IP services received an additional boost early this year when it received competitive local exchange carrier (CLEC) status. With CLEC status, the company is looking to evolve its other telephony market—business customers served by a Videotron Class 5 circuit-switch—to IP telephony. For residential customers, the Telcordia Call Agent will be used to deliver voice services (over IP). While other companies are still debating whether to implement circuit-switched or IP telephony, Videotron has a business case that drives IP telephony implementation.

"Having one customer premises equipment (CPE) device at the home can get two revenue streams," says Laflamme. "One side is the high-speed data that we have today, but on the other side is the voice revenue stream that we can get from local telephony and all the goodies that come with it—the value-added services and the long-distance revenue as well. That becomes quite an attractive proposition from the business standpoint."

The IP Revolution

Laflamme believes the future is bright for his company, and IP telephony.

"This is really a revolution that we are doing. It's like recreating the telecom way of having a network. It's truly amazing what we have done," he says.

Supplement to
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Voice Services Over Cable

Advanced Packet-Based Solutions Offer Cable Operators a Competitive Entry Strategy into the Market

The benefits of adding voice services to cable's existing product mix of video and data services are obvious. Telephony already represents a significant revenue opportunity. And that kind of immense potential has already inspired the cable industry to start addressing the technical aspects of entering this vast market.

The work already undertaken to provide interactive and data services via cable—such as two-way plant upgrades, adopting Data Over Cable Service Interface Specification (DOCSIS) networking standards, and so on—has helped pave the way for providing voice telephony services via cable. This powerful infrastructure provides cable operators a unique technology choice when delivering voice services to their subscribers. Many of them have already begun rolling out voice services using circuit-switched voice technologies over their hybrid fiber/coax (HFC) plant.

While these circuit-switched voice technologies offer a quick entry into the voice market, such networks provide confined economic efficiencies. They limit an operator's long-term competitive position to differentiate its service offerings in a highly competitive voice market.

Advanced packet-based voice solutions, on the other hand, have evolved to the point where they offer cable operators a much more attractive and competitive entry strategy into this new market. They enable operators to deploy voice services utilizing the same packet networking standards that underlie their high-speed data service offerings. The advancements in these standards have enabled packet-based voice services to rival the quality of service available from traditional circuit-switched voice solutions, while benefiting from the bandwidth efficiency that results from the digital compression and bandwidth-sharing of digital packet networking.

With the rapid market adoption of advanced digital cable set-tops, operators may take this trend a step further. Incorporating telephony functions into the cable modems being built into many of today's advanced set-tops enables operators to employ a true multipurpose device to provide a complete bundle of voice, video and data services—significantly reducing the capital costs associated with an operator's customer premise equipment (CPE) investments.

Designing Your Network for Primary Line Voice Services

One of the foremost goals of the cable-based voice-over-Internet protocol (VoIP) architecture is to provide voice service with quality equal to or better than wireline voice quality. VoIP also enables new capabilities ranging from enhanced voice services through integrated voice-data-video services to high-speed Internet access.

There are several considerations involved in building a carrier-class, 24/7 VoIP solution. Cable operators expect that design goals for a VoIP network are at least as stringent as those followed for circuit-switched voice architectures. Thus, the VoIP solution must:

- Provide the same ***performance*** as provided by incumbent local phone companies;
- Adhere to relevant regulatory requirements for ***availability*** in order to support primary line voice service;
- Provide appropriate levels of system ***security***, recognizing that service is provided on a broadcast/shared infrastructure;
- Embody the functional ***extensibility*** to allow the introduction of new features and services while integrating with existing services;
- Offer a high degree of ***scalability***, from minimum configurations to large-scale configurations that support millions of subscriber lines;
- Support ***flexible*** deployment configurations, from highly centralized to highly distributed; and
- Adhere to relevant ***open standards*** in telephony, data communications and cable.

A primary architectural consideration involves how rapidly operators can implement new capability and services without resorting to expensive, time-consuming hardware/software development efforts. The VoIP architecture should support rapid application development based on the ability of elements to be modified, upgraded or even replaced in the field. That is, it should allow new standards and features mostly through software rather than through hardware redesign.

Because of the inherently distributed software/hardware architecture and support for open standards, it is less expensive to scale up networks based on the VoIP architecture. VoIP architecture provides an open environment that allows easy third-party development of services and applications for both service providers and end-users. This flexibility makes the distributed VoIP architecture the best choice for future integrated networks.

The heart of the VoIP architecture is the softswitch, a much-anticipated technology that has been in the spotlight for the past couple years. The softswitch is essentially the control center that supports IP telephony, maintaining line and trunk information and call states, and implementing user features as appropriate.

Designing the software and hardware architecture of the softswitch is indeed challenging. To date, limited deployments of softswitches have occurred—mostly as Class 4, or tandem, switch replacements. However, Telcordia Technologies has designed and implemented one of the industry's first Class 5 softswitch alternatives, which was deployed at Videotron. Telcordia's softswitch, the Telcordia™ Call Agent, was designed to replace a Class 5 circuit-switch and deliver primary line voice service over an IP network.

In order to understand the Telcordia Call Agent architecture better, it is important to understand the interaction of the Call Agent with the physical network. (See Figure 1, page 2.)

The Telcordia Call Agent in the Physical HFC/IP Network

The existing cable infrastructure may be divided into the following domains:

- Home architecture
- HFC architecture
- Hub architecture
- Headend architecture
- Data center architecture (Call Agent location)

The three key areas to explore in more detail are the home, the headend and the data center because they play a critical role in the Call Agent architecture.

The home is the location of the residential gateway (RGW), which also is known commonly as the network interface unit (NIU), the multimedia terminal adapter (MTA), the integrated telephony cable modem (ITCM), and the set-top box. The RGW is a DOCSIS-compliant hardware device that connects household communications equipment (analog phones, personal computers and other IP communications appliances) to the VoIP network. It supports simulataneous data and voice services. Thus, it is the crucial device needed to design and build a distributed architecture that supports the centralized call-processing and feature-delivery of VoIP services via the Telcordia Call Agent.

From a network transport perspective, the headend and data center use the same architecture, including gigabit switched routers (GSRs) and optical network switches (ONS). The headend houses the trunking gateway (TGW), while the data center houses the Telcordia Call Agent.

The TGW represents the trunk side of the VoIP architecture. It provides bearer channel connection with PSTN via ISUP (ISDN user part) trunks as well as terminates VoIP calls to multifrequency (MF) trunks for "x11" dialed operator services. Essentially,

Figure 2: VoIP Network Solution

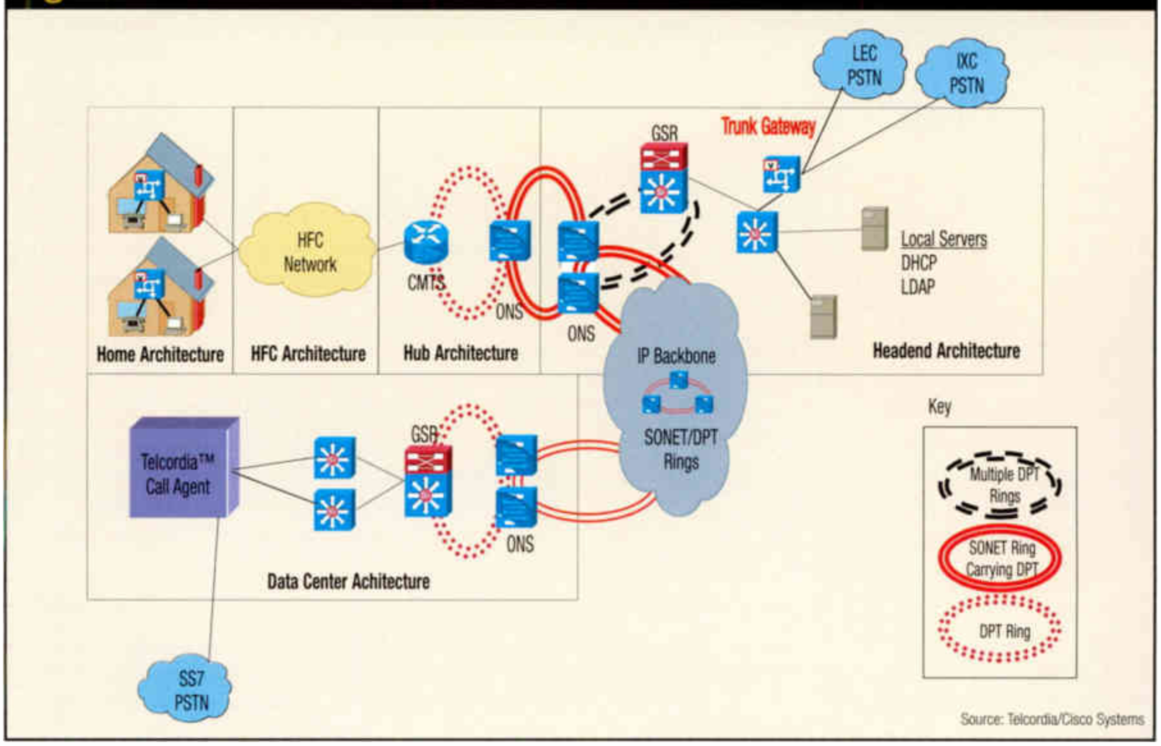

Table 1: Telcordia Call Agent Achieves Design Goals

Guiding Principle	Benefits to Cable Operator	Telcordia Call Agent
Performance	• High degree of customer satisfaction • Efficient operations	• Takes advantage of commercially available computing platforms • Exploits Moore's Law
Availability	• Increased revenue from primary line service	• Supports requirements driven by PacketCable model • Platform is designed to achieve 99.984% availability (not including cable plant or PSTN backbone)
Security	• Minimize service disruptions	• Telcordia works with hardware partners to ensure integrity and security across the network • Call Agent uses standard UNIX-security to ensure that data is not compromised • IP telephony gateways rely on the Call Agent to authenticate services
Extensibility	• Reduce time-to-market for new services • Offer truly bundled, integrated services	• Initially: Uses Java classes/objects to create a set of low level building blocks • Future release: Will use open standards (JTAPI, JAIN), third-party development
Scalability	• Match capital expenditures to service revenues • Avoid "forklift" upgrades	• Currently: A single site scales up to approximately 200,000 lines • Future release: 1,000,000+ lines
Deployment Flexibility	• Match system configuration to existing, planned infrastructure • Centralized configurations allow for minimizing organizational requirements	• Can choose to implement both small and large, single-site configurations as well as configurations that link Call Agent sites to networks of unlimited size
Open Standards Compliance	• Easily support multivendor components • Maximize interoperability	• Telcordia supports multivendor interoperability • Telcordia actively participates in CableLabs efforts • Uses CORBA, Java standards

the TGW converts outgoing VoIP calls to a format that may be sent over the PSTN, and vice versa for incoming calls.

The Telcordia Call Agent components are a collection of software products that an operator can run as one unit on a commercially available hardware configuration, or on separate UNIX-based computing platforms. The Call Agent supports the following group of functions:

- Call processing
- SS7 connectivity
- Operations support (billing, provisioning, configuration)
- Connection to PSTN
- Enhanced services

As the control center for supporting IP telephony, the Call Agent maintains trunk and line information, maintains call state during the duration of a call and implements user features as appropriate. The Call Agent sends and receives:

- ISUP and TCAP messages to/from SS7 network
- SGCP control messages to/from announcement servers
- Call event records to accounting gateways
- Database requests to/from provisioning systems
- SGCP control messages to/from IP telephony gateways

The Telcordia Call Agent controls several types of IP telephony gateways, which are provided by Telcordia's third-party associates:

- A trunk side IP telephony gateway (TGW) that supports SS7 capable trunks;
- A trunk side IP telephony gateway (TGW) that supports MF trunks (for example, "x11" dialed operator services); and
- A residential gateway (RGW) that provides analog (RJ-11) interfaces.

Telcordia has chosen to develop and support simple gateway control protocol (SGCP) to control these hardware components. The SGCP will support media gateway control protocol (MGCP) in future architectures, as well as other protocols as they mature.

SGCP uses text-encoding, a function equivalent to that provided by the H.245 protocol in the H.323 standards, to control the allocation of circuits in IP telephony gateways. The protocol is carried over UDP, and is designed to allow the control of a connection to move from one call agent platform to another. It supports very large configurations. UDP shortens delays, provides scalability and allows for more efficient failover procedures.

The Telcordia™ Accounting Gateway is responsible for receiving messages that represent events from the Telcordia Call Agent and converts the message information into Bellcore Automatic Messaging Accounting BAF records, which are sent to a billing system. The Telcordia™ Announcement Server sends audio announcements to specified destinations. It receives SGCP signaling messages from the Call Agent, and sends announcements (for example, "your call cannot be completed as dialed") via IP telephony gateways.

The Telcordia Call Agent software architecture incorporates CORBA and Java technology. The advantages of CORBA include:

- The platform interfaces follow industry standards;
- Multiple options are available for distribution of equipment and software processes; and
- It is becoming the de facto standard for operations systems software.

The advantages of Java include:

- It provides the level of hardware/operating system independence needed to exploit Moore's Law;
- It provides a friendly, "safe" development environment;
- It provides a complete environment—JAIN, JINI, JTAPI, PersonalJava and more; and
- Interpreted language overhead is addressed through just-in-time compilers, optimized Java Virtual Machines and other standard tools.

Open Architecture: The Foundation for Enhanced Services

A key advantage of the Telcordia Call Agent is its flexible, open architecture, which allows for the separation of network "layers" and enables the interworking of various protocols. A protocol adaptation layer surrounds the network control, management and signaling logic and protects the Call Agent from inevitable changes in protocols and related standards. This architecture gives service providers a foundation that can satisfy the relentless search for differentiated multimedia and management applications.

The Call Agent architecture is designed to take advantage of the three network layers:

- **Application Layer:** Telcordia will provide open interfaces that expedite the introduction of new services into the market for third-party application development.
- **Session Control Layer:** The Call Agent resides here and provides call control, network intelligence, and local office features, and supports numerous protocols.
- **Network Element Layer:** The Call Agent delivers market-proven, carrier-grade telephony regardless of the network access technology in place.

Although the Call Agent is only one component of a cable operator's VoIP solution, it is a critical one. Telcordia understands the need to satisfy VoIP design guiding principles and, as Table 1 on page 6 indicates, the Telcordia Call Agent provides a solution to these needs.

Telcordia Technologies

Telecommunications Pioneer Leads the Way to Next-Generation Networks

Telcordia Technologies (www.telcordia.com), a wholly-owned subsidiary of Science Applications International Corp. (SAIC), provides operations support systems, network software, consulting and engineering services to the telecommunications players around the world.

With more than 1,500 U.S. and foreign issued and pending patents for technical innovation, Telcordia pioneered many of the telecom services—including caller ID, call-waiting, and toll-free services—that are now a part of Americans' everyday lives. Some 80% of the U.S. public telecommunications network depends on software invented, developed, implemented and maintained by Telcordia. Its employees developed such groundbreaking technologies as asymmetric digital subscriber line (ADSL), advanced intelligent network (AIN), asynchronous transfer mode (ATM), integrated services digital network (ISDN), frame relay, personal communications service (PCS), switched multimegabit data service (SMDS) and synchronous optical network (SONET).

The Telcordia™ Call Agent is driving converged network offerings for Sprint and Videotron, a Montreal-based communications company. Telcordia also recently signed a multimillion-dollar deal with CTC Communications, providing the Call Agent and core software necessary to bring local services to CTC's PowerPath℠ Network. Today, CTC provides converged toll data, video and Internet services across their high-speed broadband network to medium- and large-sized enterprises.

"Our focus is on service providers, whether they are incumbents or new entrants, whether they are going with a digital subscriber line (DSL) strategy, a hybrid fiber/coax (HFC) strategy or a fiber-ring strategy," says Mary Turney, Telcordia's vice president of next-generation networks.

Telcordia continues to make significant advances to communications networks worldwide and next-generation networks that are developing as voice and data technologies converge, both domestically and abroad.

Telcordia employs 6,500 people, including about 6,000 researchers and software engineers. Telcordia has revenues of more than $1.5 billion. A leader in the development of next-generation network technologies, the company is head-quartered in Morristown, N.J., and has offices throughout the United States, Europe, Central and South America and Asia Pacific.

Understanding Reverse Path Problems: Part 3

The first two installments of this mini-series covered a variety of problems that may affect reverse path RF performance. The most common ones were discussed in the September issue, and included improper plant alignment, ingress and impulse noise, common path distortion and improper headend combining. Last month, I went through babbling set-tops, transient hum modulation, passive device intermod and group delay. The list doesn't stop there, though. I've got a few more to thrash.

"Having a brand-new or freshly upgraded network does not guarantee successful two-way operation."

As before, I'm going to make the assumption that your system's reverse path is up and running and has been properly aligned, that leakage and ingress are under control, common path distortion isn't a problem, and headend combining is fine. What other trolls are lurking under the reverse path bridge?

I'm glad you asked.

Intermittent connections

This category of headaches comprises a couple areas: Self-induced intermittents and those caused by good ole sloppy workmanship. There is a third category of sorts that I'll get to in a bit.

Self-induced is pretty much self-explanatory. Routine maintenance activities that require temporarily interrupting signal flow are the main culprit here. Think about it for a minute. Let's say you've introduced voice-over-Internet protocol (VoIP) telephony on your network, and subscribers seem to like it. But one day Bob, your line tech, goes out to sweep a particular node. As he evaluates forward and reverse sweep traces at each amplifier, he comes across one amplifier that has the wrong value equalizer at the downstream input.

"No problem," thinks Bob. "I'll just pop this equalizer out and plug the right one in. Shouldn't take more than a second or two."

Not a good idea.

Bob just interrupted forward path signals for the brief amount of time it took to pull out the amp's input equalizer and replace it with another. Subscribers watching TV saw a brief flash on the screen, not really a big deal. But folks downstream from that amp location who were using their VoIP phones may have experienced a loss of a few words, or worse, may have experienced a dropped call. If someone were placing a 911 call, you could have a real problem on your hands.

As we move from an entertainment-oriented business to one that is more telecommunications-oriented, we have to change the way we do a lot of things. This includes routine maintenance. It's no longer acceptable to pop an old part out and plug in a new one any ole time. Those days are long gone. Disruptive maintenance practices must be done during hours least likely to affect subscribers—say, midnight to six—and should be scheduled well in advance. Part of this scheduling includes notifying the subscribers that will be affected so that there are no surprises.

Sloppy workmanship is another source of intermittents. You're no doubt familiar with the flashing picture syndrome. A little detective work usually turns up a loose connection somewhere. Whoops! Someone forgot to tighten the F fitting at the tap. Yes, the loose connector will cause the all-too-familiar flashing in the pictures, but can you imagine what it does to data? It's not a pretty sight.

I alluded to a third category of sorts. Allow me to share a war story.

An industry colleague once told me of a situation he saw in a system where upstream signal levels at the input to the headend's cable modem termination system (CMTS) were fluctuating by as much as 20 dB or more. This was causing incredible problems for the system's cable modems.

To make a long story short, system techs admitted that they had to tape certain amplifiers' reverse attenuators and equalizers into place. It seems when the equipment got hot, the amp chassis attenuator and equalizer pin sockets got slightly bigger, and the attenuators' and equalizers' pins got a bit longer and thinner. The problem? Pins and sockets that were slightly different sizes caused intermittent connections in the reverse signal path. Yee-haw!

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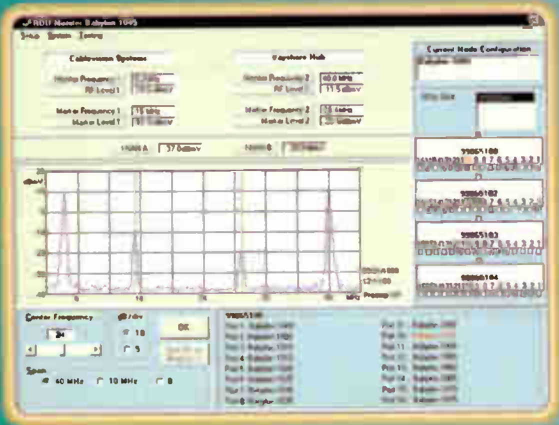

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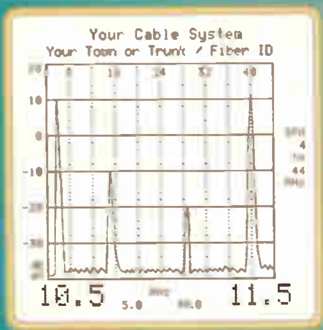
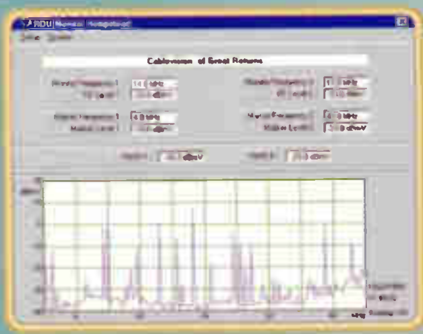
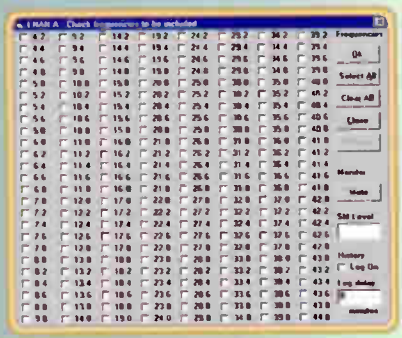


Video Output with Test Carrier Levels



Monitor Screen; Impulse Noise Present



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Noise funneling

Noise funneling is a potentially big problem. What is it? Think about the architecture of a typical cable network. In the downstream direction, we transmit from one point to many points. In the upstream direction, it's the other way around: signals propagate from many points to one point. Many points to one point is a bit like a funnel. Hence the term "noise funneling." When we look at downstream carrier-to-noise (C/N) ratio performance from the headend to any given subscriber, the C/N ratio at that subscriber's premises is a result of the thermal noise building up through a simple cascade of devices between the headend and that particular subscriber. Indeed, any one subscriber sees a thermal noise C/N ratio that involves only the cascade of actives through which the signals pass to get to him or her. For example, a subscriber at the end of a node's four amplifier cascade is affected only by the thermal noise contributed by the headend, the downstream fiber link and the four amplifiers between the optical receiver and the subscriber's house. Going the other direction, the upstream thermal noise from that same node and its service area is a function of every reverse amplifier connected to the node (along with the upstream fiber link), not simply a cascade of actives.

Let's say our hypothetical node has a total of 50 amplifiers. The downstream C/N ratio at our example subscriber's residence is a function of the cascade of four amplifiers plus the fiber link and headend. If the headend and fiber link's combined downstream C/N ratio is 51 dB, and each of four amplifiers in cascade is 67 db [the four in cascade will be 67-10log(4) or 60.98 dB], the C/N at the subscriber's house will be 50.6 dB. However, the upstream C/N ratio will be based on 10log(50)! So, if each reverse amp has a C/N ratio of 64 dB, the combined C/N ratio at the input to the node's upstream laser will be 64-10log(50) or about 47 dB. If the node had, say, 500 amplifiers instead of 50, the combined upstream C/N ratio would be about 37 dB. And you still have to get through the upstream optical link.

See what happens when too many upstream amplifiers are combined? Reverse noise funneling could, under certain circumstances, present a real problem as far as active device thermal noise is concerned. Toss is ingress and other junk, and you quickly see how bad reverse funneling can get.

Gotchas

This is my odds-and-ends category, and includes such gems as sweep transmitter interference to your data. This may apply to forward or reverse sweep, although in my experience downstream interference is much more common. The issue is forgetting to set sweep guard bands around the digitally modulated carrier. Ye olde sweep signal interferes with the carrier, causing all sorts of grief. Reprogram your sweep transmitter, and the problem goes away.

Another gem is the forgotten high pass filter. You install a cable modem in a subscriber's home, and find no matter what you do you can't seem to get the thing to work. Input levels look good, and nearby neighbors have no problems. The gotcha here is the high pass filter that's still installed at the tap. Its 40 dB or more of reverse path attenuation just won't let the modem be heard back at the CMTS. Of course, if the filter had, for some reason, been installed on the side of the house (or utility closet, in the case of a multiple dwelling unit) rather than at the tap, you might not think to look there.

Conducted interference from other devices connected to the network is something that'll cause sleepless nights. It's similar to discrete interfering carriers such as shortwave broadcast, ham radio and citizens band (CB) transmissions, but instead of getting into the network as ingress, the interfering carrier is conducted from another device connected to your system. The interference could be a leaky local oscillator in a cable device in another room in the same house, or maybe in a neighbor's house. Put your detective hat on for this one.

Speaking of gotchas, in last month's discussion about group delay, I began the subject thusly: "I've harped on this particular gremlin before, but it's still a problem unfamiliar to most folks in the industry. When there is no group delay in a system, network or component, all frequencies within a defined given will take..." Huh? Within a defined given? That was my oops, and it should have said "all frequencies within a given bandwidth will take..." Either too much reverse on the brain, or not enough caffeine. I prefer to think my coffee cup was empty.

What's the point?

Now then, what's the point of all of this? Well, a couple things. First, I wanted to share some of the more common reverse path problems you're likely to encounter. Second, I want to make it very clear that having a brand-new or freshly upgraded network does not guarantee successful two-way operation. I've seen state-of-the-art 750 MHz hybrid fiber/coax (HFC) networks that had such a crappy reverse path that it was essentially unusable, and I've seen older systems that were very well maintained, and have an upstream noise floor cleaner than your kitchen table.

So, how do you troubleshoot reverse path problems? You start by understanding what the most common problems are, because you can't troubleshoot what you don't understand.

Ron Hranac is consulting systems engineer for Cisco Systems. He also is senior technical editor for Communications Technology. You may reach him at rhranac@aol.com.

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What's Digital?

Either the new cable industry is ambiguous, or we've really learned how to become marketers. Maybe it's a little of both, but whatever the reason, cable's technical people need to understand the context of technical terms, especially when they are being used by consumers. Perhaps the best reason is that we are often asked by our customers to explain what marketing sold them, and we need to have an answer both they and we understand.

Take the word "digital," for example. Many of us, including me, think we know what digital means. Now, let's look at two examples of how things can get confusing. Both are tied to telephony.

Begin with "digital cable." Among other applications, this term is used by marketers to describe the delivery of video programming via a digital set-top box. As an amateur audiophile who only recently became the owner of a DVD player and digital receiver, I thought it would be great to subscribe to this newly offered service from my cable company. My vision was that I would greatly increase my sources of Dolby surround sound content and have digital end-to-end video over cable, right up to the input on my digital receiver. All this would come to me via my service provider's digital channels.

Therefore, on the day of installation, I was surprised (and disappointed) to notice that the digital set-top (a **Motorola** DCT 2000), was equipped only with baseband audio and video outputs. This means, of course, the input to my receiver is analog. True, I can still enjoy Dolby stereo, but there's one more stage of analog-to-digital conversion. In practicality, most consumers will never notice the difference, but if you're the installer, this is one of those times you need to explain what "digital" means.

In this case, of course, digital refers to the transmission format over my cable provider's network and not to the output on the set-top box. The picture quality is, at least theoretically, improved over analog transmission delivery, because errors caused by transmission impairments can be reduced using forward error correction (FEC) technology. Probably more important to most consumers is the fact that digital delivers more channels, and therefore more variety, because digital signal compression provides more efficient use of bandwidth. The interactive TV guide is also digitally delivered.

Which brings me to the tie-in to telephony.

When I ordered my digital TV service, my provider's service representative told me I would need a telephone line to the set-top box, but couldn't explain the reason. Those of us with some technical experience realize that this telephony return is necessary when a service provider begins offering a two-way service before the two-way upgrades to return plant have been completed. It's a good way to get into a new market, in this case "digital cable," and gain some market share while letting the service contribute revenue to the later plant upgrade. The telephone line is used to return information from the set-top box to the headend, similar to the way a dial-up data connection to a personal computer (PC) works.

Telephony return often requires installation of a new outlet, because few homes have been built with a phone near logical placement of a TV. This means the installer must understand how to identify a particular telephone line in multi-line homes, how to connect a new run of telephone wire to that line and how to install a telephone outlet. Key to these tasks is knowing to disconnect the phone line from the phone network at the subscriber's side of the network interface device while installation is proceeding (90 volts of ringing current can be a shocking experience!). It also helps to be equipped with appropriate tools, such as a butt-set and toner. It just doesn't look professional to ask the subscriber to provide the installer with a "spare" telephone set to check for dialtone.

Now, switch gears and look at a second use of the word "digital." In this case, the term in question is digital telephony. Perhaps there's less chance consumers would become confused with this phrase, but at least a few technicians I've met could use a review. For $1 million—Is digital telephony the same as Internet protocol (IP) telephony?

The answer, of course, is a definite no. Digital telephony could be defined as the transmission of telephony signals and voice frequency information that has been converted from its native analog form to a digital signal. This process occurs at the network interface unit for circuit-switched cable telephony. It has also been used in long distance transmission over T-1 carrier circuits for almost a half-century.

On the other hand, IP telephony is a special type of digital telephony that uses this protocol. It includes the use of discontinuous digital packets, or groups of bits, to move information across a network. Not all these packets take the same path to get from one point to another.

Non-packetized digital telephony is often referred to as constant bit rate. This means that you will find bits representing the information in a telephone conversation at regular intervals in a stream of information moving from one point to another.

Constant bit rate telephony nearly always improves transmission quality over analog telephony, because signals may be regenerated, or recreated. This regeneration is done without any accumulated noise. On the other hand, analog amplification increases the noise level, as well as the signal level.

IP telephony does not necessarily improve transmission quality, because packets may get dropped or delayed. For IP telephony to work as well as analog or constant bit rate, the network needs to be managed to guarantee all packets will reach the destination before any delay is noticed by the human ear.

Digital, as we have shown, may be thus used in several contexts. It's an example of how today's cable technical people need to be aware of the different uses of technical terms. Technical personnel are often a company's front line contact with consumers who are getting ever-more sophisticated. Offering the right answer will often make the difference between a retained subscriber, and one that has gone to the competition. CT

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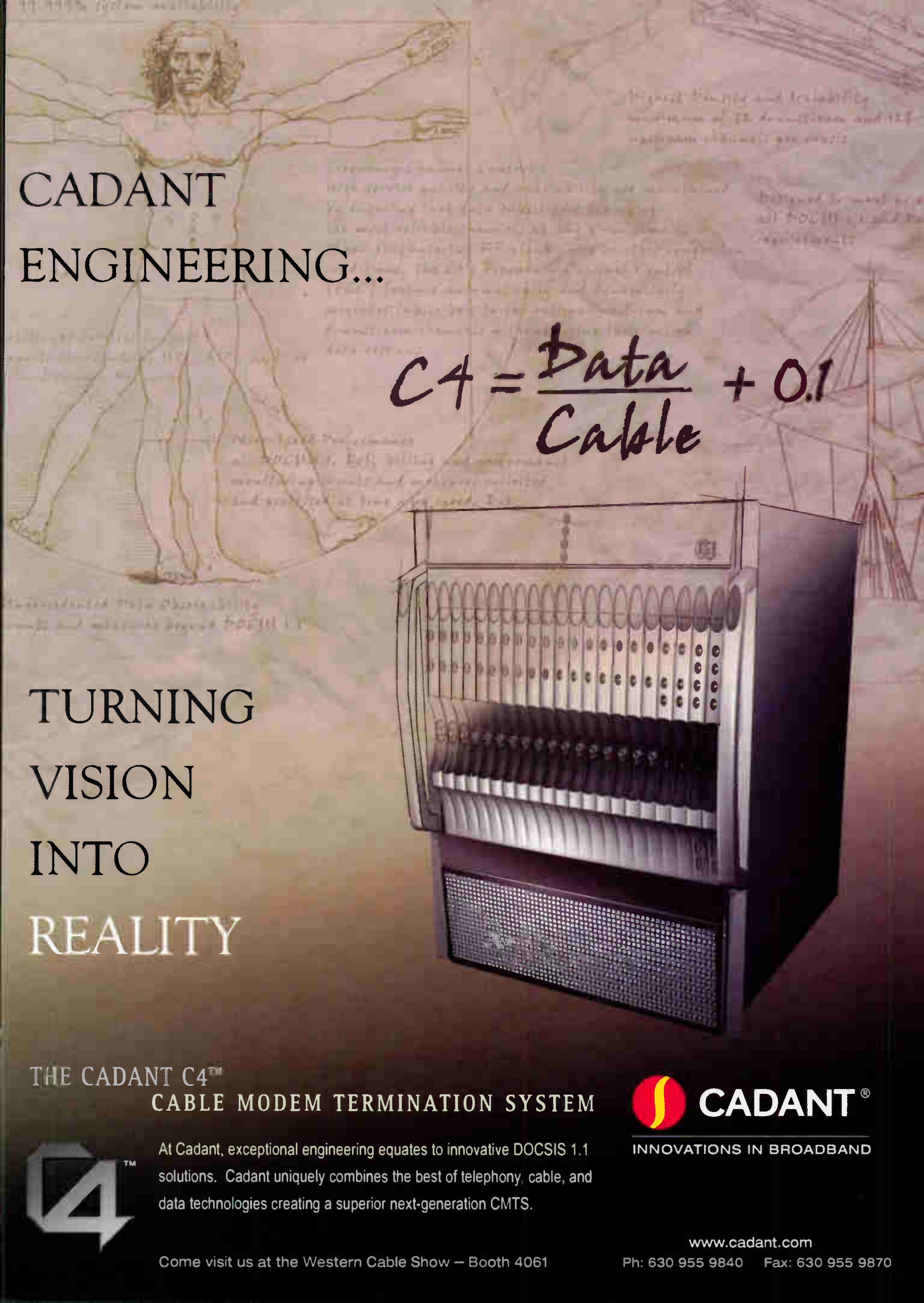
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FOR RENT

Opportunities for Application Service Providers in Cable Networks

Part One

Pablo L. Martinez

Application rental services take advantage of the "always-on" broadband access provided by cable networks. In part one of our series on the applicability of the application service provider (ASP) model to cable networks, we explain basic service models and both network and application architectures.

Internet access for e-mail and Web browsing is currently driving initiatives to upgrade cable plants to Internet protocol (IP)-centric platforms. However, the flexibility and ubiquity of IP technologies give cable operators the opportunity to offer new innovative services not only to residential customers, but also to telecommuters, small office, home office (SOHO) and medium business customers. An example is application rental services, where end-users remotely invoke features from applications running on network-centric server clusters (see Figure 1).

This network-centric service model simplifies end-user system requirements and maintenance. It provides cable operators the opportunity to offer application services that take advantage of the "always-on" broadband access cable networks offer. In this role, cable operators become application service providers (ASPs).

ASP service model

The ASP service model is "one-to-many." Applications run in a network-hosted environment, serving a dispersed customer base. Initially, the ASP service model targets the small- and mid-market business customer segments. However, the large business segment also is showing interest, and in the lower part of the spectrum, home-based businesses may quickly become one of the key segments benefiting from this model. >

FIGURE 1
DELIVERING APPLICATIONS AS A SERVICE

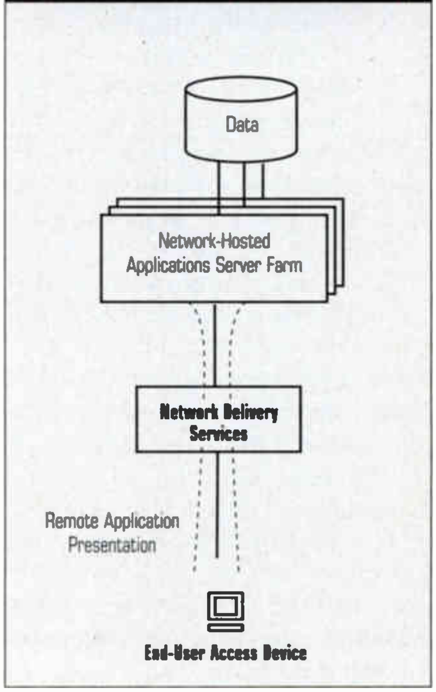
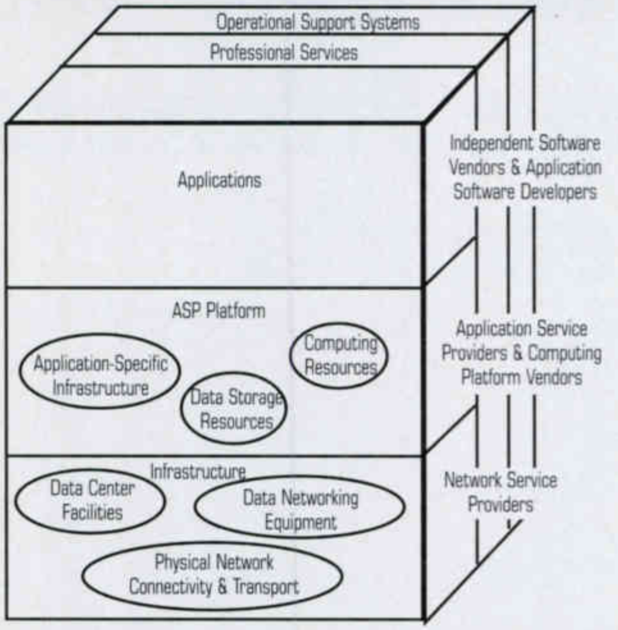


FIGURE 2 ASP COMPONENTS



BOTTOMLINE

> **Benefits of Network-Hosted Service Models and Architectures**
> - Shifts large, unpredictable, up-front capital costs to smaller, predictable, recurring monthly expenses.
> - Includes voice-enabled data applications that take advantage of new programmable communications platforms.
> - Emphasizes application service availability via redundancy and business continuity plans.
> - Improves end-to-end security in cable networks.
> - Enables more controlled application offerings for better quality of service (QoS) support.
> - Provides security and QoS in a coordinated way.
> - Simplifies end-user equipment to "multimedia" user interface devices.

There are many reasons why the ASP service model is quite compelling. A partial list of these benefits include:

- Access to enterprise-grade applications and information technology (IT) resources at a lower price;
- The shifting of large, unpredictable, up-front capital costs to smaller, predictable, recurring monthly expenses;
- Lower operational costs because of smaller IT staff focused on business core competencies, longer equipment life [eight years for thin clients vs. three years for personal computers (PCs)], reduced system downtime costs and better overall utilization of specialized applications;
- Software rental for short-term projects;
- Access to the latest application versions;
- Global access from anywhere, anytime, on any device;
- Multiple "desktops" for both personal and business purposes;
- Reduced risk of virus propagation and other security threats; and
- Ability to quickly add new end-users.

ASP value chain

The ASP value chain goes from co-location services to fully managed services. Co-location services are for customers wanting to have total control of their applications and servers while leveraging the ASP infrastructure. Fully managed services are for customers looking for the ASP to manage their applications and infrastructure. In all these service arrangements, customers may want to monitor security status, as well as application and network performance. Predictable performance translates into the ability to offer quality of service (QoS) guarantees that in turn drive service level agreements (SLAs). It is important that compliance of SLA metrics (for example, network availability and application response times) be proactively reported to end-users as part of service offerings.

Partnering to add value

Given the nature of the ASP concept, the service model is structured into the "layered" framework where applications become services delivered over networks (shown in Figure 2). The lowest layer provides infrastructure such as data center facilities, physical connectivity (network transport and access) and data networking equipment including routers and firewalls. This layer is responsible for maintaining expected levels of network performance, reliability and security. The next layer provides the ASP platform and includes application-specific infrastructure, computing resources such as servers and operating systems, data storage resources and application management. Next is the applications layer where application services reside. A professional services layer provides application planning, consulting and integration services.

The operations support systems (OSS) layer provides fault and configuration management, accounting, application and network performance monitoring and security functions. It also supports subscriber management and customer care functions.

Service providers may partner with others to support all these layers. For instance, a network service provider (NSP) partner provides the networking infrastructure. An independent software vendor (ISV) partner provides applications and tier-two/tier-three application-related customer care. An ASP partner provides tier-1 customer care and overall service management. A professional services partner provides consulting, planning and integration services. In some cases, an ASP may be cross-selling services from other ASP partners. And in other cases, an ASP may have a presence in an Internet service provider (ISP) portal, thus allowing the ISP to offer ASP services.

Target applications

As mentioned earlier, the ASP service model initially targets business segments. In particular, this model is attractive to small- and mid-tier business customers because it provides

FIGURE 3 ASP Service Delivery Architecture

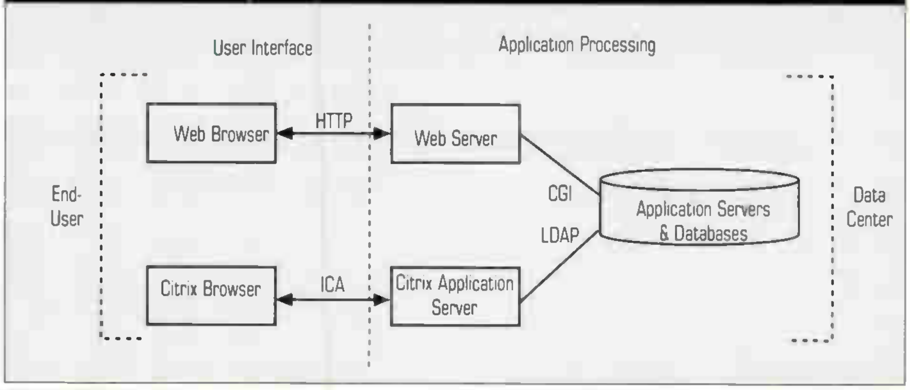


FIGURE 4 High-level, Generic Network Functional Architecture

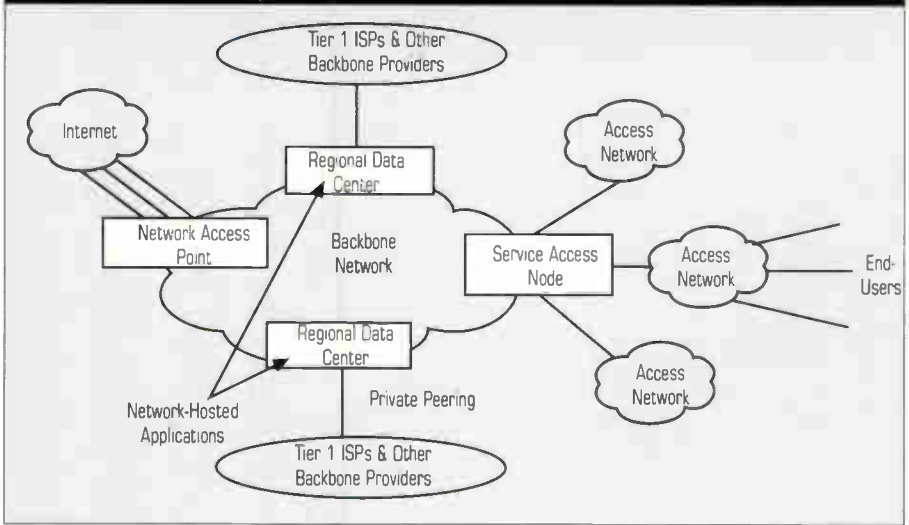
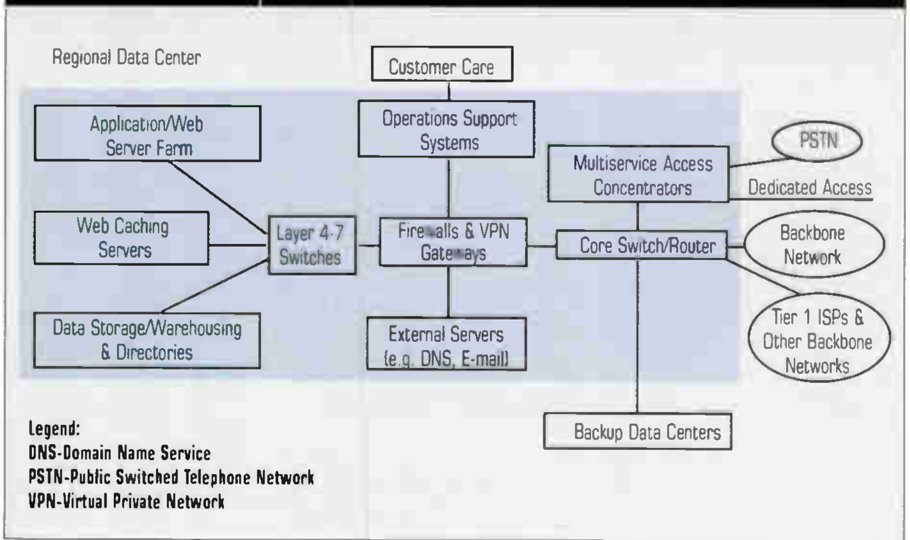


FIGURE 5 Generic Data Center Functional Architecture



access to enterprise-class applications at a lower price.

Right now, business applications not requiring extensive integration or software-code customization are the most suitable to offer with the one-to-many ASP service model. Good examples are desktop productivity suites, e-mail hosting, Web hosting, calendaring, data warehousing, storage, virus control and unified messaging. However, applications requiring a higher level of customization, such as e-commerce hosting, electronic customer care (including customer relationship management), sales force automation and back-office applications (for example, human resources, payroll, supply chain management and electronic payment) are what end-users are demanding the most from ASPs.

Initial service offerings are targeting traditional, data-centric enterprise applications. A next step is offering voice-enabled data applications that take advantage of the convergence capabilities of new programmable communications platforms. There also are opportunities in offering application services to residential end-users. Some example applications include managed home-networking services, media streaming and network-hosted games.

The ASP service model bundles network access, managed network services and network-hosted applications as one service. That gets complemented with ancillary services, such as end-user authentication, application usage reporting and application monitoring. The advantage of providing these value-added service bundles is a significant reduction in end-user churn. This model takes service bundles to the next step in the value chain.

Service delivery architecture

The ASP service model dictates a service delivery architecture. This architecture is client-server in nature, although the functionality is distributed differently when compared to traditional "fat client" architectures. In a "fat client" architecture, the client performs some of the processing and relies on remote servers, if needed, to provide additional data or processing functions. In the ASP service delivery architecture, clients do not perform any processing functions other than presentation to locally display or "publish" remotely executed applications. In other words, clients only perform functions to display the user interface of invoked applications. A specific protocol is used between the client and the server to carry key-

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As shown in Figure 3 (page 52), there are two variants of the ASP service delivery architecture. One is Web-based, where end-users remotely run applications on a Web server and associated backend servers. In this case the hypertext transport protocol (HTTP) is used between the browser client and the Web server. The other architecture is thin client-based. In this case, the end-user relies on a Citrix client to access network-hosted applications running on Citrix-enabled application servers. The server runs a multi-user operating system. The remote presentation services protocol used between the Citrix-based client (browser) and the application server is the Citrix Independent Computing Architecture (ICA).

Network functional architecture

Figure 4 (page 52) shows a high-level, generic network architecture supporting ASP service offerings. Applications are hosted in server farms running in data centers. Multiple instances of these centers are dispersed over a geographic area to increase service availability and improve application response times via load balancing. Backbone network interconnectivity may be leased from a network service provider. As shown in the figure, a network access point (NAP) provides public peering in connecting to the Internet. For improved performance, multiple private peering connections from data centers to major Internet backbone network providers may be coordinated to bypass congested Internet NAPs.

Given that the ASP service model initially offers business applications, security is an important consideration. A layered security scheme covering host, network, application and end-user (authentication) security should be adopted. Another important consideration is application performance, in particular response times and packet loss. Resource management, including traffic management to evenly distribute the traffic load over the network and traffic shaping to enforce SLAs, plays a key role in supporting this. QoS treatments are another part of application performance and are based on application-specific or end-user-specific policies.

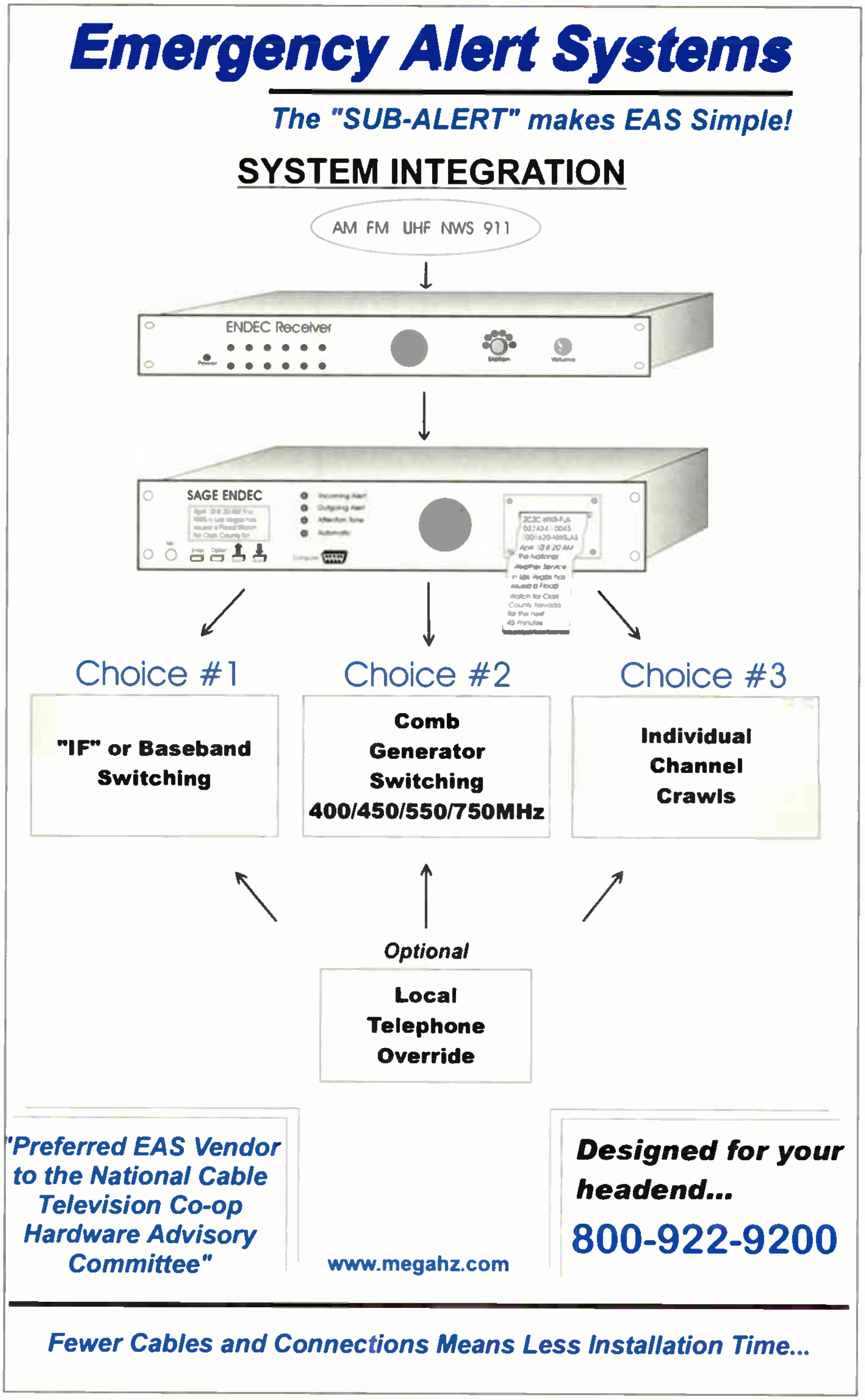
Virtual private networks (VPNs), providing end-user access to network-hosted applications, may offer the necessary security, resource management and QoS treatments in a coordinated way. These are "ASP value-added VPNs" where VPNs complement ASP service delivery offerings. A special case of this is the offering of managed extranet services.

Data centers

The key goal of data center facility design is the optimization of application service availability. That means data center facilities need to be highly secure and disaster-resistant. That includes physical security (escorted access, card-key access, surveillance cameras and intrusion sensors),

equipment redundancy, heat and smoke detectors, fire suppression systems, water sensors, air filtration systems, power/surge protection, dual utility feeders, backup power sources and temperature control systems. However, no physical facility is completely disaster-resistant. Business continuity plans are required to manage multiple redundant or backup data centers. Backbone network connectivity should be redundant and follow diverse paths. These connections should be engineered with spare capacity built-in at 50 percent or more.

Data centers consist of four basic elements: application processing, data networking, transport and operations. Figure 5 (page 52) shows a functional decomposition of these elements.



Application and Web-server farms run on shared or dedicated servers. Redundant servers may be located at separate data centers and accessed via multiple network connections. This may be coupled with Layer 4-7 (Web) switches to provide local and distributed load balancing among servers. These Web switches monitor server and application response times, and network utilization. Web-caching servers complement load-balancing functions to offer Web access acceleration services. Highly redundant database clustering or storage area networks (SANs) provide data storage management services with fail-over capabilities. Firewalls, VPN gateways and intrusion detection systems provide secure access to applications, including those running on external servers. This may include secure ID token-based end-user authentication, host-based security and router access control lists.

A core switch/router interconnects components in data centers and provides connectivity to the backbone network. Multiservice access concentrators may support dial-up and dedicated access.

OSS performs application monitoring, management and billing. A customer care gateway, or customer network management (CNM) system, allows end-users to manage their services on-line. With CNM, an end-user may monitor network and server availability/performance and enter and monitor the status of trouble tickets among other features.

Application architecture

The ASP service model is multi-user and subscription-based. That has an impact on application design, as network-hosted applications need to be scalable and customizable while keeping operational costs down. End-users demand customized applications at a lower cost than owning a fat PC-client. This becomes more critical when ASPs target business customers with premium applications while adopting a commodity service delivery model. One way of dealing with this is to design applications end-users may

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easily configure via templates or wizards. Alternatively, ASPs could build libraries of frequent customized application versions, although that requires keeping larger inventories.

The ASP service model and architecture move application processing, security and QoS to the network and relays presentation functions to end-user terminals. Security and QoS treatments are still needed to guarantee proper delivery and application response times, but these may be provided in a more efficient and simpler way over the cable access network. End-user equipment gets simplified, meaning a reduction in truck rolls and overall maintenance support.

There are some challenges, however, that need to be addressed. Depending on the situation, the ASP service model may require partnering with other service providers to provide certain components. That means proper measures need to be put in place to guarantee the combined security and QoS that satisfy end-to-end SLAs. Another challenge is the definition of best practices. Critical areas include: data center operations, network operations, client-server operations, application management and monitoring, and CPE management.

Other challenges include: designing applications that run on distributed network computing environments under a service subscription model, evolving data center computing platforms to support converged voice/video/data applications and developing schemes that would allow cable operators to guarantee the required application and network performance levels as dictated by SLAs. CT

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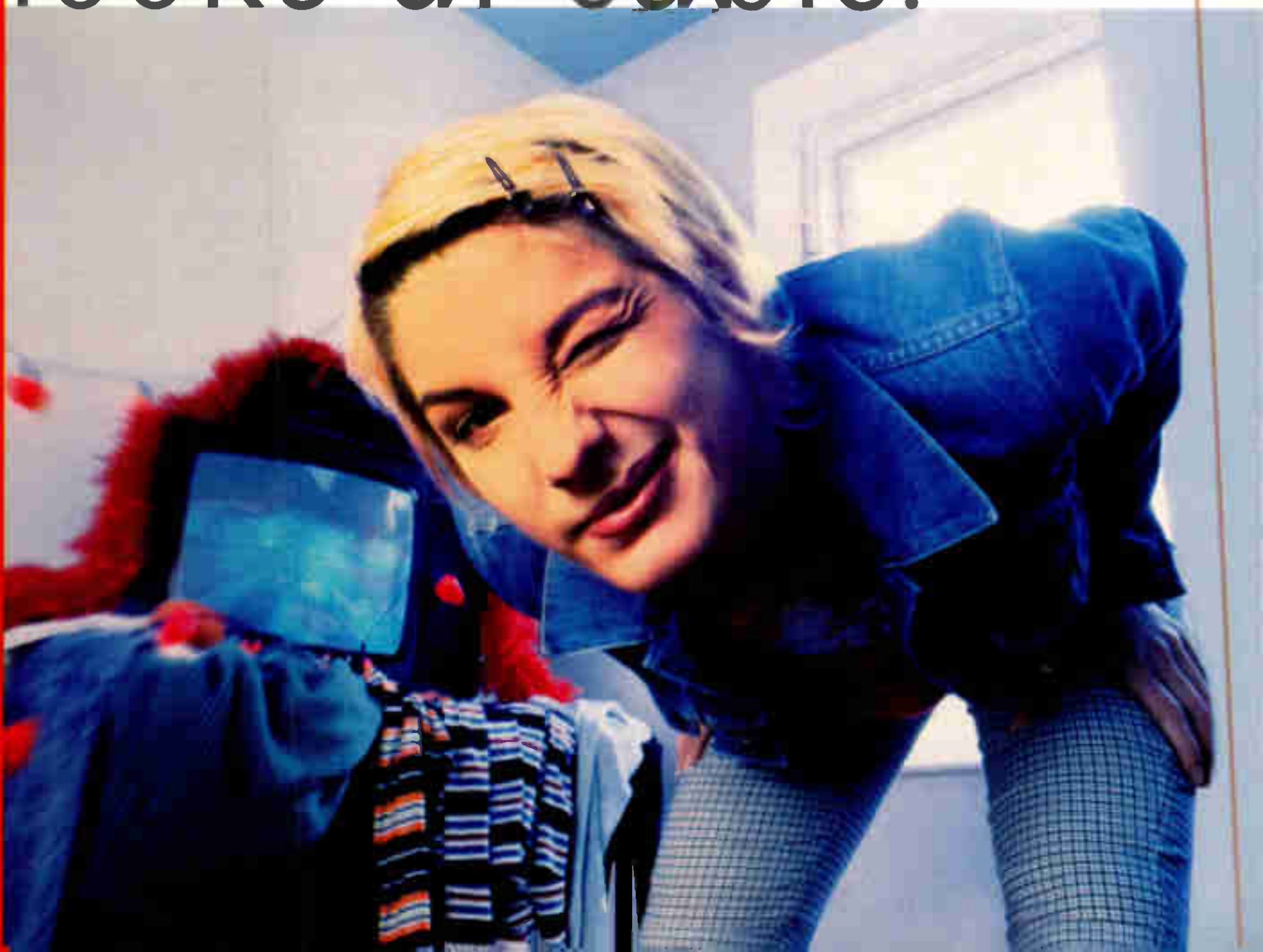
She's looking for faster Internet access. You'll change the way she looks at cable.



Critical Engineering Issues:

Designing, Managing and Scaling Multi-Hub Transport Networks

By Joe Thomas

As more and more businesses look for competitive telecommunications offerings, cable stands to be well-positioned against competitive local exchange carriers (CLECs). So how do you ensure network scaling as capacity needs grow?

While the hybrid fiber/coax (HFC) plant has been the focus for most cable operators, the metropolitan area network—interconnecting headends as well as outside networks—is the critical segment in today's world of expanding cable properties. Cable engineers looking ahead five to 10 years must design and build networks to support such varied applications as:

- Video-on-demand (VOD)
- Rapid, non-linear Data Over Cable Service Interface Specification (DOCSIS) system growth
- Asynchronous transfer mode (ATM) data services
- High-speed Internet protocol (IP) connections
- Distance learning
- Building-ready Internet service
- Enterprise-to-enterprise T-1 and DS-3 time division multiplexing (TDM) leased line circuits
- Virtual local area network (VLAN) service

This wide array of applications, each with its own unique challenges, must be integrated into digital networks not as distinct elements, but as part of an overall network design philosophy that provides for:

- **Unpredictable bandwidth growth:** Bandwidth demand is difficult to predict and may grow unevenly within a network.
- **Multiple protocol support:** Broadband service delivery requires the transport of several types of service protocols (including IP, TDM, ATM and video services) without building separate networks.
- **Fiber capacity:** While the cable industry has made a tremendous investment in fiber-optic plants, it needs to maximize each fiber's capacity using dense wavelength division multiplexing (DWDM) technologies.
- **Network operational efficiency:** Managing and operating a broadband network must cross traditional technology boundaries.
- **Time-to-market:** The speed in which a new service can be deployed will determine market-share leadership in a competitive landscape.

Multiple system operators (MSOs) have created headend clusters by purchasing, or trading for, adjacent cable systems. These geographic clusters have created the need to build a scalable yet flexible transport network to tie together these stand-alone headends.

MSOs are well-positioned to increase revenues by adding additional service offerings in their broadband networks. It is generally accepted that the bandwidth of today's HFC systems can accommodate new services. What is often overlooked is the transport architecture feeding the local cable plant—it must be resilient, provide sufficient bandwidth to meet the current needs of all hub sites on the network and adapt to the dynamic capacity needs of each hub site as new services are added.

In today's environment, operators maintain multiple transport networks (such as video, IP, ATM and TDM), requiring separate fiber counts, training, software, and hardware expense to provision, maintain and upgrade for each transport element. The benefits of an integrated network that can transport multiple protocols will create changes in the way cable operators design, construct and manage metropolitan area transport networks.

As bandwidth requirements increase in metro-area transport, cable companies will have to examine alternatives for enhancing bandwidth on their optical networks. DWDM is currently the most prevalent technology used for such applications.

Finally, as MSOs offer circuit-based (T-1, DS-3, OC-3, OC-12, OC-48) and IP-based traffic alongside their traditional video offerings, transport demands will increase exponentially. These demands will likely grow unevenly as targeted content—VOD, high-speed data and commercial services—become part of cable's standard fare. This explosion in traffic and content will require a transport architecture that is selectively scalable and highly flexible. Engineering networks of this complexity and sophistication will require basic fiber-optic knowledge, DWDM understanding and service-offering protocol facts.

Service applications: VOD

VOD provides connectivity between a primary headend and hub sites for delivery of Moving Pictures Experts Group (MPEG-2) content. In addition to the MPEG-2 signals, you must also plan for the transport of 10Base-T Ethernet management and control signals to and from quadrature phase shift keying (QPSK) modulators and demodulators at the remote hub sites.

There are two schools of thought on how to design a VOD system—the distributed server model and the centralized server model. Each has pros and cons and varies with system demographics and physical plant constraints.

In a centralized server model, a transport network element (NE) is placed at the primary headend where the video servers and control system are located. MPEG-2 signals are transported to the remote hub sites via a digital optical transport system. Modulators are used at the remote hub sites to place 10 or more MPEG-2 streams on a single RF quadrature amplitude modulation (QAM) channel. The distributed server model places smaller video servers at hub sites co-located with the QAM modulators. Content is downloaded to the remote servers via an Ethernet or ATM network.

Interconnected cable headends and distribution hubs for delivery of MPEG-2 digital video over an optical transport network offer a possible solution. An NE is placed at the primary headend and at all hub locations on a protected optical ring. The primary headend network element is connect-

FIGURE 1 CENTRALIZED SERVER VIDEO-ON-DEMAND NETWORK

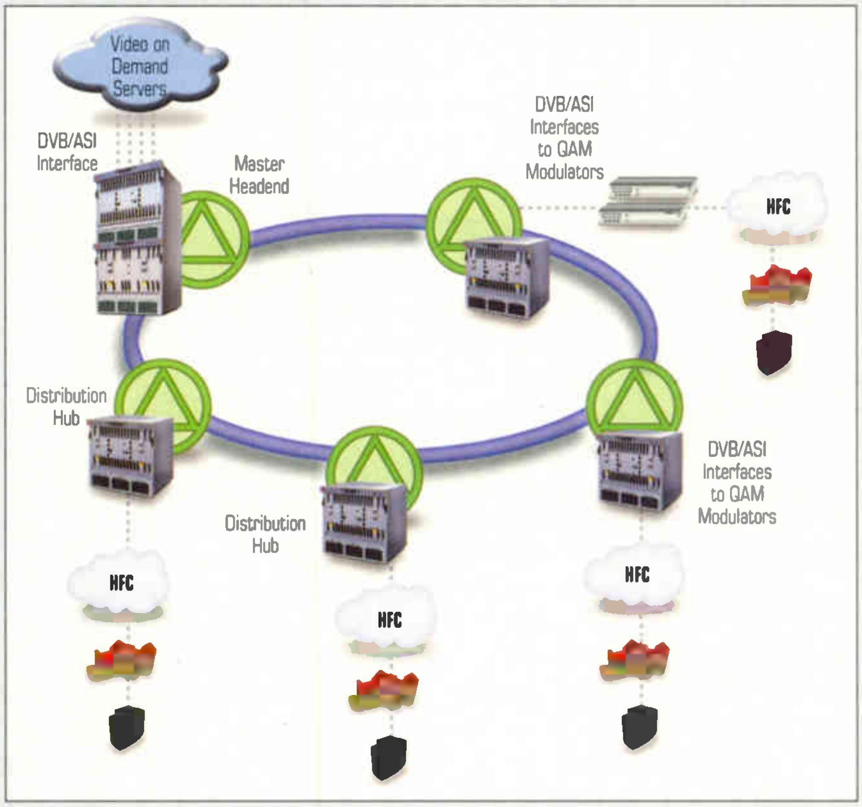
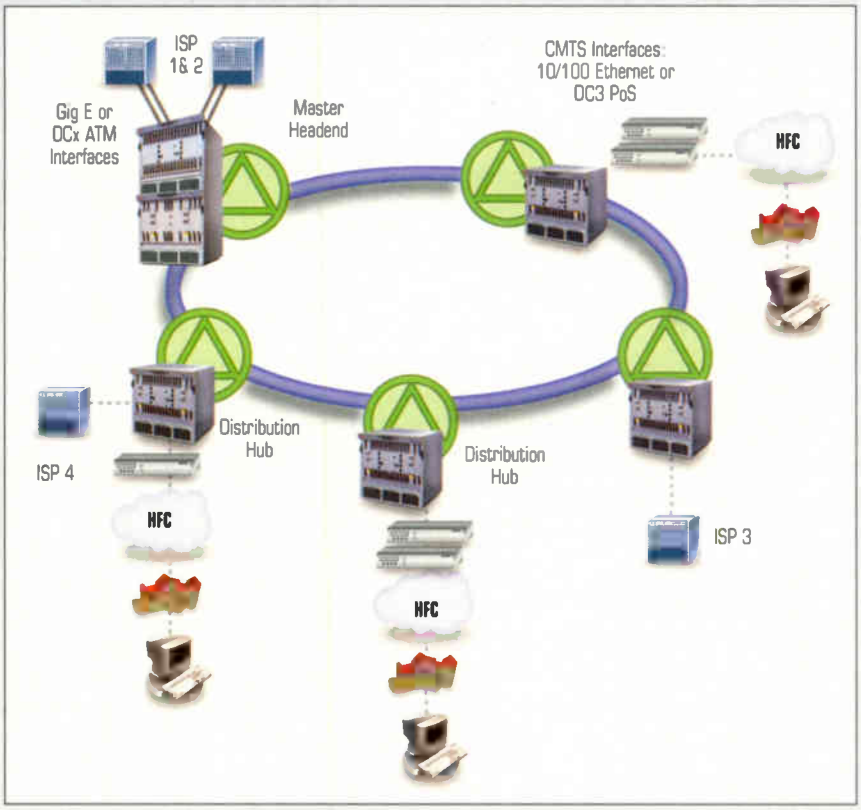


FIGURE 2 DATA OVER CABLE MULTIPLE ISP NETWORK



ed via several digital video broadcast/asynchronous serial interface (DVB/ASI) to the video servers. MPEG-2 digital video signals are streamed out of the servers on a DVB/ASI interface to the optical transport NE. Each stream will be encoded at approximately 3.5 Mbps to 4 Mbps.

The MPEG-2 streams will be transported digitally to all hub sites on the ring and may be configured to drop, add or pass content. At a hub site, the NE delivers the MPEG-2 signals to QAM modulators for insertion on the HFC portion of the cable network.

Data over cable

The data over cable application transport network connects regional data centers (RDC), cable headends, and distribution hubs for delivery of DOCSIS or proprietary IP residential services.

An NE is placed at the primary headend/RDC and collects hub site IP traffic from 1 or more 10/100 or gigabit Ethernet, or OC-3 packet-over-SONET, or POS, connections. The hub site NE aggregates traffic from one or more cable modem termination systems (CMTSs) and transports it over a protected optical ring back to a central location, the RDC. There, the NE aggregates traffic from multiple hub sites and hands it off via gigabit Ethernet or OC-12/48 connections to a terabit router connected to the Internet backbone.

In the event that connection to multiple Internet service providers (ISPs) is required, additional NE connections to additional routers may be deployed. By using a VLAN IP scheme, you may provide any connection throughout the network.

ISP routers are connected to the network via gigabit Ethernet interfaces and establish IP connectivity to the CMTSs by a VLAN connection. The CMTSs in the hub sites are connected to the network via 10/100 Ethernet interfaces and maintain IP connectivity to the ISP routers via a VLAN connection.

Building-ready Internet

Delivery of high-bandwidth IP services to business customers in large

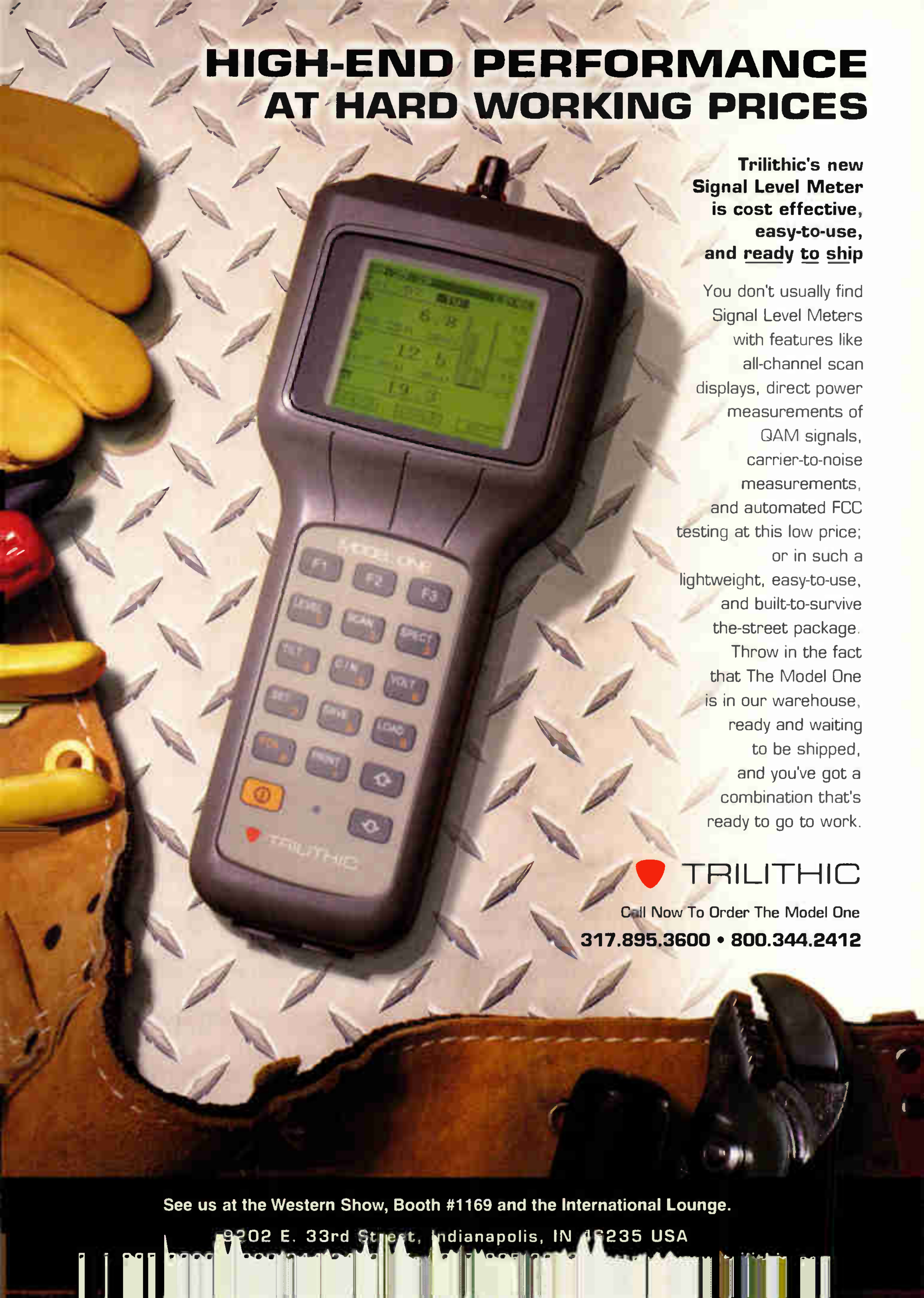

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FIGURE 3 METROPOLITAN AREA NETWORK REPRESENTING BUILDING-READY INTERNET

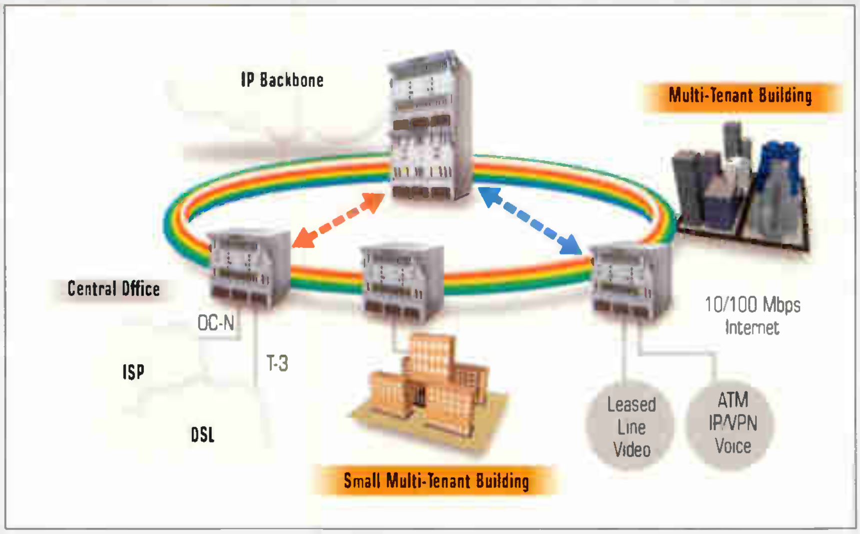
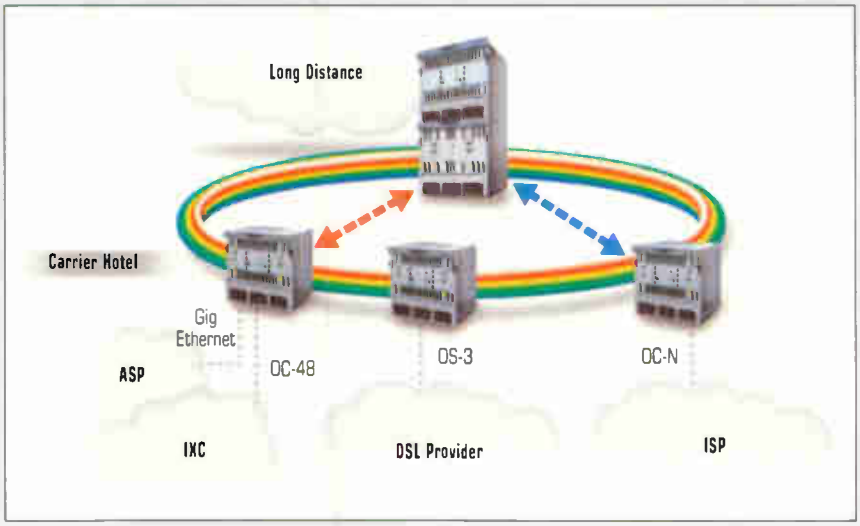


FIGURE 4 APPLICATION FOR WHOLESALE SERVICES



BOTTOM LINE

> **Keeping Up**

Operators of broadband networks are faced with myriad service applications to deliver to residential and commercial customers.

While some of the applications driving future revenue for broadband network providers have been trailed throughout the cable industry over the past few years, none of them have made it to full-scale commercial deployment in major markets. As network infrastructure is designed, operators must keep in mind all of the service offerings when choosing the correct transport platform.

The goal of the cable operator is to provide efficient and scalable delivery of all these protocols, services and applications onto a single transport system.

multi-tenant buildings may be accomplished with building-ready Internet.

An NE is placed in a high-rise building and collects customer IP traffic from multiple 10/100 Ethernet connections. The NE aggregates the traffic and transports it over a protected optical ring back to a central point of presence (POP) location. At the POP location, an NE aggregates traffic from multiple buildings and hands it off via gigabit Ethernet or OC-12/48 tributary connections to a terabit router connected to the Internet backbone.

The service provider may put an NE into a co-location space on the same metro ring and begin providing carrier-to-carrier services such as digital subscriber line (DSL) backhaul and high-bandwidth (OC-3/OC-12) transport to local ISPs. Network capacity may easily be added via selective wavelength division multiplexing (SWDM) or DWDM to meet service needs as new customers are added.

Wholesale bandwidth

The transport network in a wholesale bandwidth application provides network capacity for the resale of wholesale bandwidth to ISPs, IXCs, CLECs and DSL providers throughout the metro area.

Many ISPs and IXCs have invested heavily in building high-bandwidth, IP-optimized backbone networks. However, to leverage these investments and realize their revenue potential, they now must be able to distribute this bandwidth to customers cost-effectively. Unfortunately, the existing SONET infrastructure connecting most customers to the core network was not designed for the efficient delivery of high-bandwidth data services. As a result, these metro networks have emerged as a major bottleneck in the race to roll out broadband data services. A significant opportunity has materialized for carrier-to-carrier wholesale of high-bandwidth transport in order to circumvent the slow and expensive process of acquiring OC-N transport facilities from incumbent LEC regional bell operating companies (RBOCs).

A high-capacity multi-service optical transport platform is ideally suited to service providers pursuing a carrier-to-carrier service model. Each NE ring should provide scalability of up to 32 OC-48s worth of fully protected TDM or ATM bandwidth on a single fiber pair. In a typical configuration, an NE is placed in a carrier hotel or co-location space co-resident with other carriers' equipment. Capacity at any rate

from DS-3 to OC-48 may be sold to ISPs, IXCs or DSL providers for transport across a metro area back to their switch POP locations. A multi-service platform may deliver services in any format or rate the customer desires including ATM, POS, channelized TDM or Ethernet/gigabit Ethernet. Also, by using an integrated switching fabric, the NE may efficiently groom this traffic into fully utilized pipes to minimize transport and switching costs throughout the network. Network capacity may be continually increased as required by adding additional wavelength cards and tributary interfaces. At high-capacity switch POP locations, an NE terminates traffic from multiple co-locations and carrier hotels and provides service fans out to terabit routers, voice switches and long-haul DWDM systems.

High capacity ATM trunking

The transport network in a high-capacity ATM trunking application aggregates multi-service traffic from the edge of the network using ATM and providing scalable trunking to other switching POPs.

Many network service providers use ATM as their access and aggregation technology of choice for a broad portfolio of services, including voice, frame relay, DSL, Ethernet and cell relay [ATM user network interface (UNI)]. An edge ATM switch performs adaptation as well as aggregation and grooming of traffic coming from DSL access multiplexers (DSLAMs), frame relay switches, and lower-bandwidth customer premises equipment (CPE)—multiplexing these onto one or more DS-3 and/or OC-3 uplinks. These higher bandwidth connections are then transported back to a core switching POP over SONET facilities. Such an approach presents several cost and management issues for carriers, including separate NEs for traffic aggregation and transport; separate physical ports required on the core router or switch for each physical DS-3 or OC-3; and expensive stranded bandwidth in the local transport facilities because of under-utilized uplinks coming out of the DSLAMs and other edge devices. >

FIGURE 5 High Capacity ATM Trunking

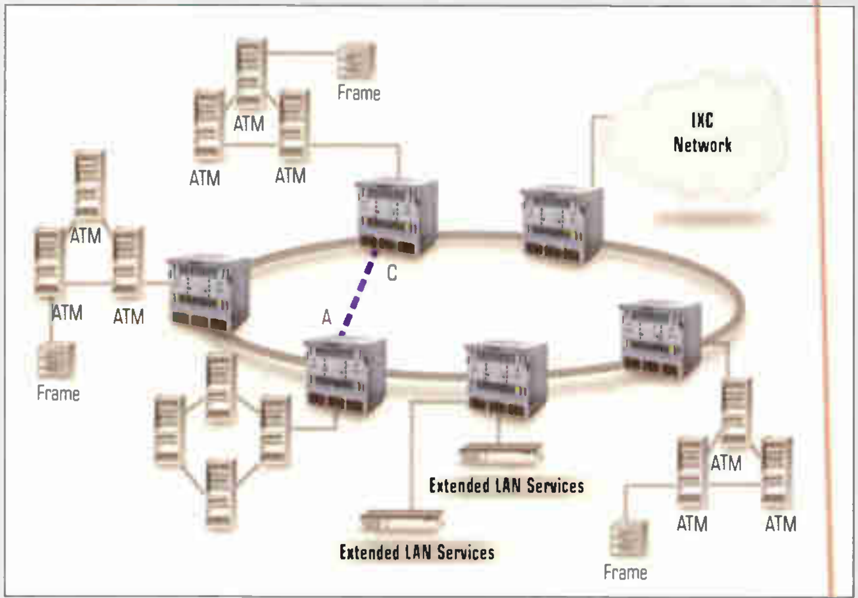
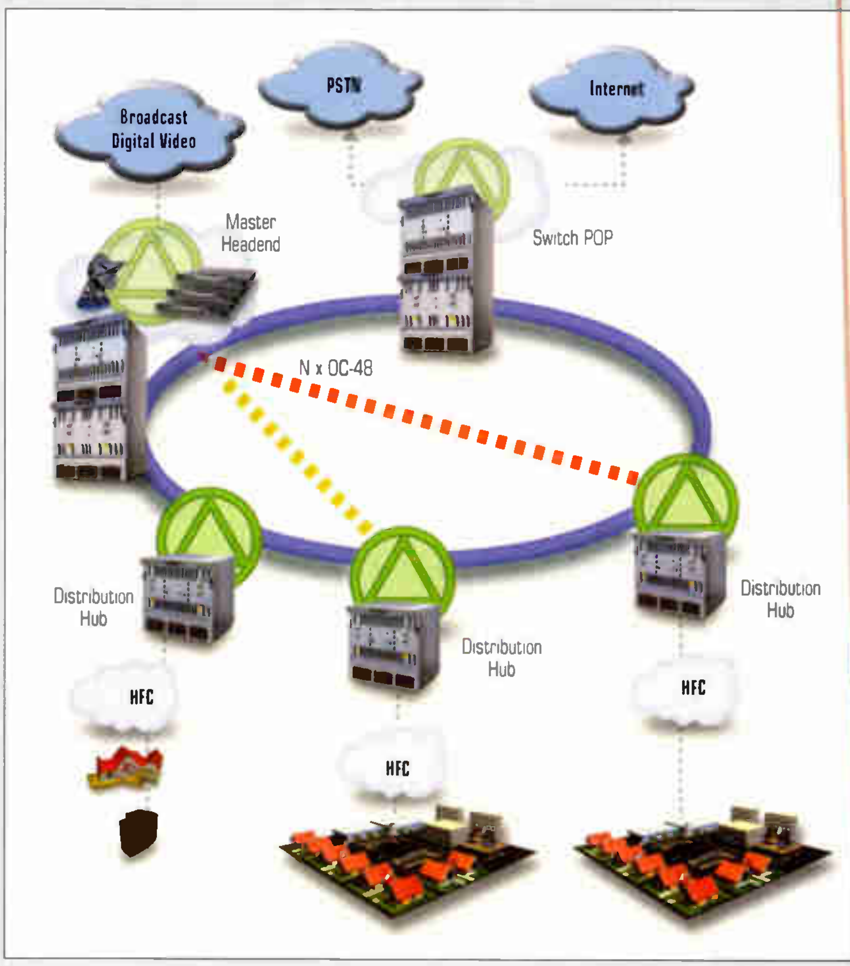


FIGURE 6 Multi-Service Cable Network



An NE may be placed in the central office or co-location space, connecting the service provider's access multiplexers, ATM switches, DSLAMs and frame relay switches. An NE grooms incoming traffic across all tributary interface ports into one or more tightly packed OC-N channels via its integrated ATM switching fabric, thereby optimizing transport bandwidth and minimizing the number of physical switch ports required throughout the network. The NE also connects directly to the carrier's fiber infrastructure to provide scalable and protected transport to all other switches in the network, eliminating the need for a separate SONET add/drop multiplexer. Trunking capacity between switches may be increased quickly and easily via SWDM or DWDM. For example, if an additional OC-48 is needed between switches A and C (see Figure 5, page 68), the service provider need only add a single optical module into each NE and immediately begin provisioning new service across the network.

Multi-service cable networks

Multi-service channel networks interconnect cable headends and distribution hubs for delivery of analog and digital video, cable modem, cable telephony and CLEC services over an integrated optical transport network.

The traditional proprietary video transmission equipment used by cable operators to carry analog video presents severe limitations to the profitable delivery of new cable services. These existing TDM-based transmission networks were not designed to handle the requirements of high-bandwidth broadband services creating the following problems for MSOs:

- **Network overlays:** Services such as VOD, cable modems and CLEC transport are extremely bandwidth intensive, and until now, have required separate overlay networks to be built and managed. This complicates the business case for new service deployments since existing networks are not leveraged across multiple services.
- **Stranded bandwidth:** Channelized TDM multiplexing employed by existing transport equipment and the inability to groom unfilled data channels results in expensive stranded bandwidth and poor utilization of network resources.
- **Network-wide upgrade requirements:** The existing cable transport network cannot scale to meet the bandwidth requirements of new broadband services, forcing the need for network-wide capacity upgrades.

A multi-service platform provides cable operators with a single, integrated platform that may deliver a full range of video, voice and data services over a protected and scalable optical transport network. An NE may be placed in a secondary headend or distribution hub, connecting to CMTSs, cable telephony gear, Ethernet switches or directly to the HFC distribution network. The NE grooms incoming traffic across different tributary interface ports onto one or more tightly packed OC-N channels via an integrated multi-service switching fabric, thereby optimizing transport bandwidth throughout the network. Traffic from each secondary headend or distribution hub is transported back to the MSO's master headend or core switching POP over a protected optical transport. Capacity between hubs may be increased with SWDM or DWDM. For example, if an additional two OC-48s are needed for VOD service, a cable operator only needs to add an optical module into each NE at each location and immediately begin delivering these new services across the network. As a result, the business case for VOD is greatly improved, and the cost of the existing network is amortized over a greater number of revenue-generating services. CT

Joe Thomas is a network consultant for Lucent Technologies. He may be reached at jt67@lucent.com.

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- Cable Set-Top Boxes
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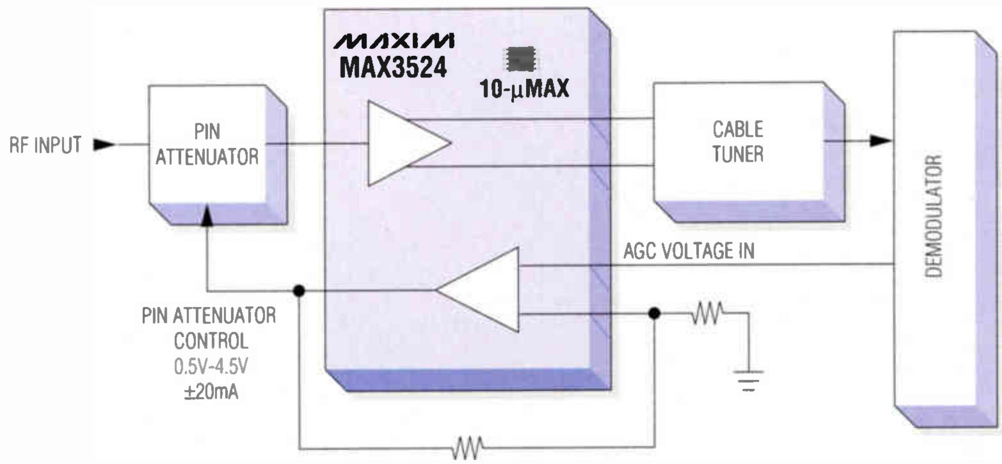

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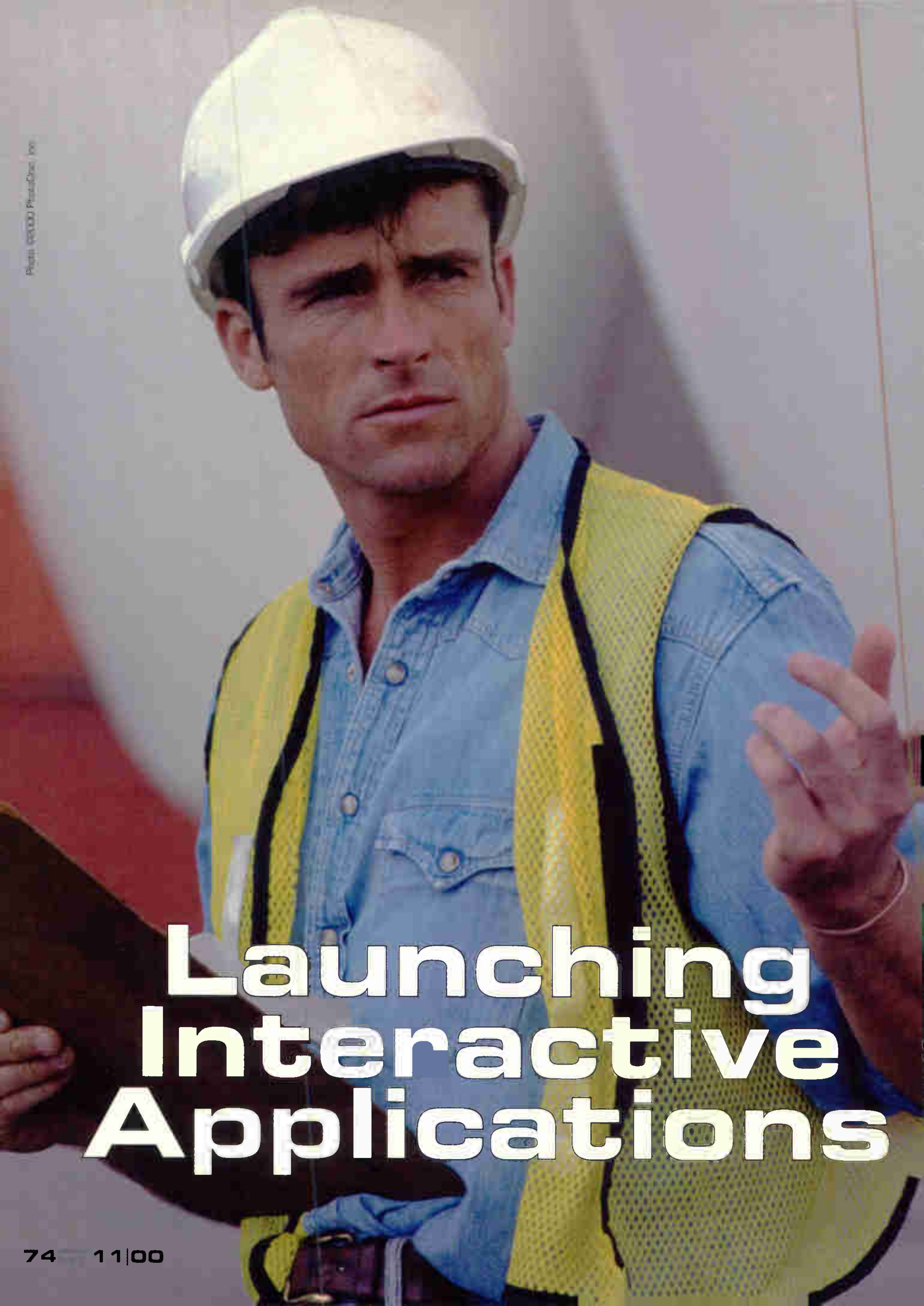

Launching Interactive Applications

Ensuring Network Availability and Site-Readiness

By Sherita Ceasar

In the rush to launch interactive services, operators should consider carefully whether their networks are fundamentally prepared to handle the onslaught of new business. There's an urgency to launch and competition is intense. How do you get ready?

Wall Street is looking more closely at a multiple system operator's (MSO's) financial picture. What formerly concerned most operators was cash flow. Today, analysts want to know what the revenue per subscriber is? How much churn? What are your penetration rates? Stocks are now being evaluated on having a predictable revenue strategy, expenses and efficiency of operations.

Applications like Internet protocol (IP) data, IP voice, video-on-demand (VOD) and home gateways and networks provide excellent opportunities to obtain more revenue per subscriber, increase penetration and potentially reduce churn.

It is crucial in this environment, however, for operators not to rush into launching interactive services without first ensuring the networks are fully optimized. Understanding the network, what the metrics are, and how to put the processes in place to keep them there, are the keys to maintaining long-term profitable growth and stability. Focus should be on reliability and how to migrate toward "always two-way" capability. "Always two-way" metrics may be derived by monitoring real-time, two-way messaging and calculating link connection times versus total available time, average time a link is down and the average time between link failures.

What is network availability?

One of the key factors to consider is network availability, or the percentage of time a digital network, a component or an application is available for users. If an operator offers a service, it should be available. And once it is implemented, it must meet subscriber expectations for quality of service (QoS). When subscribers get a dial tone, they expect to be able to use it. With a cable modem, a certain high speed data-rate is implied. When customers try to view the programming guide, does it come up and allow them to select the channels they want? Factors that affect network availability are: radio frequency (RF) into demodulators and set-tops, media access control (MAC) slot utilization, network routing, IP address assignment, server application set-up and forward path bandwidth utilization.

Traditionally, network availability has been looked upon in terms of a reliability model. In the world of broadcast analog, operators were mostly concerned with specific RF specs on the forward path. Did we properly align the forward path? In single point of failure areas, is there redundancy built in? If we do experience a failure of a network element, does that result in the service being interrupted? If those conditions exist in that network, how does an operator provide continuous services to a customer, even if there are disruptions?

For today's interactive two-way network, planners must look well beyond the traditional hardware-only based model.

RF, IP and continuous communications

Basically, an advanced digital interactive set-top is a personal computer (PC) residing on an IP-based network. Just like a PC connected to the Internet or a local area network (LAN), a set-top needs an IP address. Once it does, then it uses IP as a vehicle for two-way communications from the server in the headend to the client in the home. Thus, the reverse path is now equally as important as the forward path. Not only is the QoS the customer receives important, but so is the information going from the client back up through the server managing the network.

To ensure continuous communications through this path, today's MSO has to manage the full network computing open system interconnection (OSI) model, from the physical layers through to the application layers, including:

- In the physical layer, forward and reverse path must meet similar RF parameters such as carrier-to-noise ratio (C/N) and power levels, which exist in the analog world. These are even more important with digital. With analog, there is graceful degradation. If power levels or C/N ratios were low, the picture became grainy. But subscribers still had a picture. With digital, if noise goes past the threshold tolerances, Moving Pictures Experts Group (MPEG) lock is lost and the picture is no longer displayed. Thus, when designing these RF parameters in the digital world, it's important to design for enough margin, so if there are impairments in the network, they will not degrade performance.
- Utilization of the MAC layer where all subscribers contend for a link and where data traffic gets concentrated and fed up to the headend.
- The network layer, should be able to determine whether end-to-end communications from a client-server perspective is present, allowing server applications to talk to client applications.
- The application layer runs the service. An interactive program guide (IPG) has value in that it permits a user to find the channel they want. Therefore, the IPG application in combination with the downloaded IPG data, provides the service. The guide without the data is an unavailable service.

"For today's interactive two-way network, planners must look well beyond the traditional hardware-only based model."

Conducting an operational assessment

So how does an operator put together a framework and infrastructure to address all these needs, both operationally and technically? Some choose to outsource to a services organization, while others have the necessary information technology (IT) and network management resources in-house do it themselves or outsource a portion of the requirements.

In either case, a thorough operational assessment procedure will identify whether current operating practices optimize or degrade network availability. Items to consider include installation and authorization of set-tops, call-center procedures, marketing and pay-per-view (PPV) operations, installer and service technicians, headend operations, dispatch and lobby. What are the proper procedures for all these disciplines? What impact do they have on the network? Some operators have not thought through the trouble trees, or scenarios from headend to home, nor how they affect operational personnel throughout the process. Nor have they figured out how these individuals communicate, and how they log and track these important issues.

Streamlining the process

This entire process involves communications between a diverse group of cross-functional disciplines—everything from dispatching, staging, installation, to PPV events-marketing and network engineering.

In the past, it was acceptable to communicate with a set-top only periodically. Managing non-responding set-tops was not a big problem. If an operator could collect PPV information within two days, that was still within most billing cycles. Thus, the reverse path could afford to be less than robust. Now services like e-mail, true VOD (with start/stop, pause, rewind and so on), online purchasing and e-commerce will not work without continuous sessions.

It is therefore critical to have installation procedures and testing to ensure that you have two-way communications all the way to the home. You test your procedures with a technician-based install, for which the testing method is different than a self-install, where a customer goes to an operator's lobby, picks up a set-top and hooks it up themselves. In either case, the set-top still needs to be tested, but the process is different. For instance, consumers probably will not verify that a just-installed set-top has two-way communications, and so

BOTTOMLINE

> Ensuring Network Availability

In the rush to launch interactive services, operators should carefully consider whether networks are fundamentally prepared to handle the onslaught of new business. Understanding the network, its metrics, and how to institute processes are keys to maintaining long-term profitable growth and stability.

An important factor to consider is network availability, or the percentage of time a network system, component or application is available. Today's multiple system operator (MSO) has to manage the full network computing open system interconnection (OSI) model, from physical to application layers.

How does an operator put together a framework and infrastructure addressing all these needs, both operationally and technically? Some choose to outsource the different phases, while others with the necessary resources train in-house. In either case, a thorough operation and technical assessment is essential prior to launch. Also consider:

- Reviewing call center procedures;
- Minimizing service-affecting issues;
- Streamlining the installation process; and
- Performing ongoing data analysis.

will not know that something is wrong until they use impulse pay-per-view (IPPV) or an interactive service, and find a problem. The test process must document what boxes were self-installed and checking that these boxes have an IP address assigned, that they can communicate, and that purchases are being reported by these boxes.

"The ultimate goal is to expand the network in a way that allows total optimization and smart bandwidth utilization."

It's also important to document whether subscribers are getting the channels they ordered. Are the channels available as ordered? A well-planned subscriber management process ensures customers receive what they requested.

Ensuring problem resolution

It's a whole new world of customer service interaction when managing performance expectations for digital services. Take, for example, the old cable environment. When subscribers had static on their screen, they called their customer service representative (CSR), who probably would have dispatched a technician to tweak the RF levels. We have to consider what the response might be with today's digital TV, with three services integrated on a single gateway or if that same CSR going to be trained to tell a subscriber how to find a lost e-mail. Or whether to offer advice when the credit card information gets lost in the system. Expectations will have to be built into the service so subscribers understand new service paradigms. Operators will create a new infrastructure to manage the expectations. Technicians will need to become multimedia experts. Network operations centers (NOCs) will be established and staffed with specialized engineers who can quickly respond to these issues.

Minimizing service-affecting issues

Once network management metrics are set up, an operator must put processes in place to maintain them. However metrics are defined, it's important to have operational procedures and support tools to make sure they remain in place. Operators must look at ways to minimize mean time to repair (MTTR), with initiatives like sparing programs, logistics procedures or even progressive repair programs to proactively perform maintenance to the network before it breaks down. They must understand the reliability of the components, what they need to do to keep operating, and what intervals they should perform these maintenance procedures. Part of the process includes taking periodic measurements on the network and performing data analysis, tracking trends and relationships in data and trying to pinpoint pieces of networks where network congestion or other potential problems exist.

The ultimate goal is to expand the network in a way that allows total optimization and smart bandwidth utilization. This effort will be a continuous and evolving process. Ever-vigilant operators will scope out the customer base and dynamically shift resources as needed. They will change architectures, redeploy personnel and reconfigure processes based upon where they think the utilization of bandwidth will be in a given market with interactive services. Only then can operators successfully ready networks for the future. CT

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Synchronizing Cable Networks:

Why You Should Care

By Ed Butterline

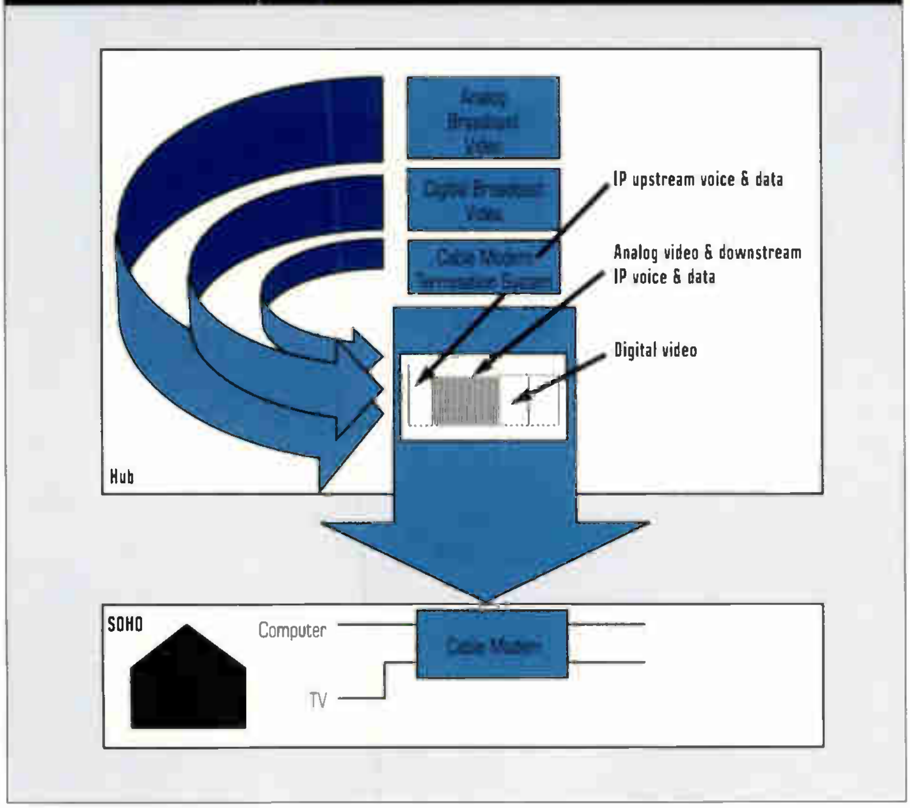
In the world of data and telephony, digital networks often require synchronization to master clocks for reliable operation. Digital video and voice over Internet protocol (VoIP) drive the need for synchronization in cable networks.

It's a fact. All communications networks—whether wireless, wireline or long-distance, local or cable—need three essential items: power, ground and synchronization. Networks simply won't provide high-quality communications without the third element—synchronization.

Synchronization in a network is the operation of the network clocks at the same nominal rate, accomplished by selecting a master clock and locking all other clocks to it. In short, this allows communications to be transferred properly throughout a network.

American National Standards Institute (ANSI) document T1.101-1999 defines procedures for synchronization, with the master clock source as

FIGURE 1 CABLE SPECTRUM UTILIZATION



one of several possible choices. The current clock of choice for the public switched telephone network (PTSN), based on economics and availability, is the signal from the Global Positioning System (GPS) network of satellites, which is traceable to the national standard. In operation, clock signals are distributed throughout the network. Master clocks are located at major network nodes and lower performance clocks are located along the edge of the network. Distributing the sync signal through the network results in the receiving local clock operating at the same frequency as the clock at the transmitting or originating site.

As illustrated in Figure 1, video, voice and data migrate toward a single protocol and transport technology, and cable networks are changing to support more services in a different manner. A truly competitive local telephone service will only come from the operator with the


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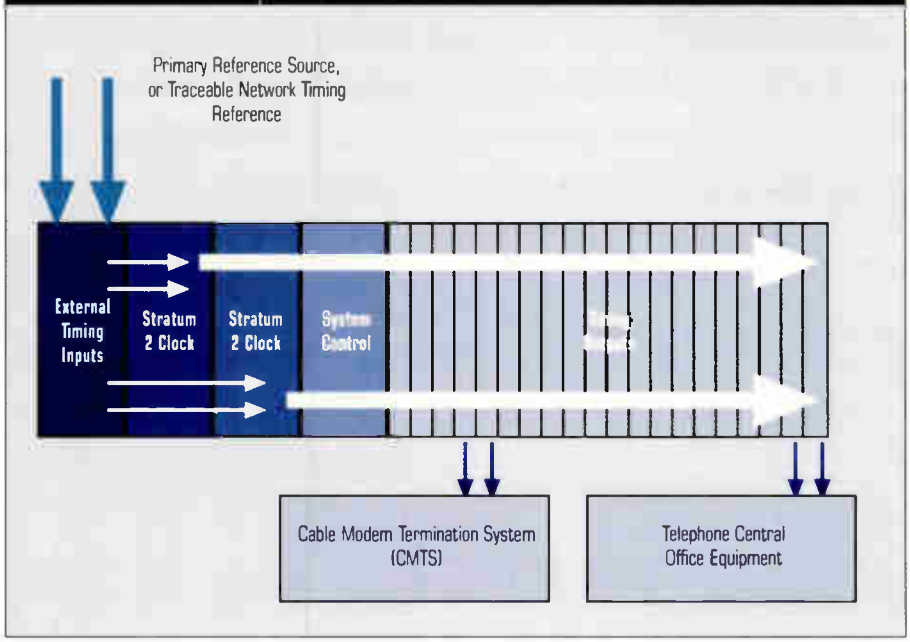
FIGURE 2 TIMING EQUIPMENT SHELF



most bandwidth. The first network to deliver that bandwith will foreclose the market to that competitor.

Even so, why should a cable network be concerned with sync? The world of telephony is very different from that of cable. If a network is only delivering analog television signals, sync is not a concern. When a network operator adds Internet protocol (IP) service, it is still not a concern. The need for sync surfaces only when VoIP and digital video enter the picture.

These services suffer from the transmission anomalies of jitter, wander and phase transients. Jitter is phase variations greater than 10 Hz, which generally are caused by network elements regenerating or reconfiguring traffic. Wander is phase variations less than 10 Hz, which generally are caused by lower frequency events, such as temperature diurnals and variations in the transmission characteristics of the media and equipment, including disruptions in sync reference distribution. These impairments accumulate as traffic traverses a network.

The PSTN controls these effects by utilizing the building integrated timing supply (BITS) concept. A BITS clock, as illustrated in Figure 2, is the only clock permitted to receive timing from outside the office where it is located. It, in turn, is the sole source of timing within its office. Following the

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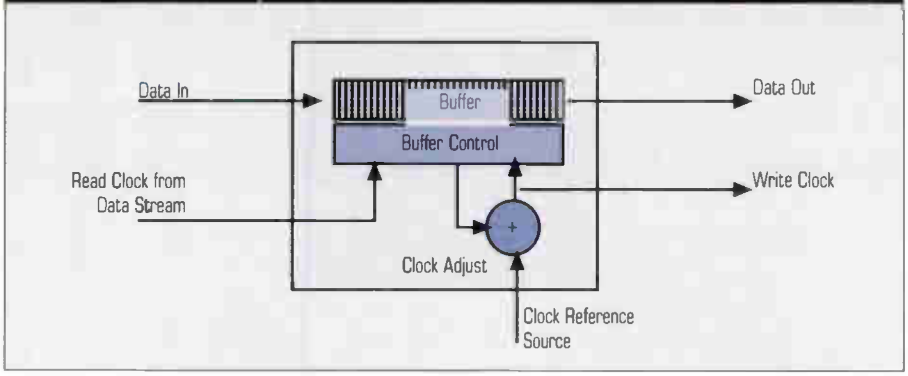
FIGURE 3 SIMPLIFIED BUFFER OPERATION



BITS concept, and the stratum clock hierarchy prescribed in T1.101-1999, the PSTN keeps itself synchronized.

An additional way to control jitter, wander and prevent slips in the PSTN is by using 125-microsecond or one DS-1 frame buffering. VoIP networks generally use buffers that are larger than the four-millisecond buffers used by asynchronous transport mode (ATM) switches. When "stuff" happens in a network, buffers will overflow or underflow, causing a slip, as illustrated in Figure 3. A slip is a deletion or repetition of a complete frame of data. The effect of a slip may range from trivial (a click on a voice service) to disastrous (a multi-second freeze frame on a video service). Data services are affected by retransmissions and reduced throughput. A fax will lose 0.08 vertical inches with every slip. Encrypted transmissions may suffer serious degradation, even requiring the retransmission of the encryption key.

Another major concern is the vocoder itself, which converts analog voice to digital and compresses it. A vocoder is required on each end of a connection, and frequently more are used as a call traverses multiple networks. As traffic is passed from network to network, the synchronization interface requirements of ANSI T1.101-1999 come into effect. Simply, these call for every carrier or operator to be synchronization-traceable to a national clock at the interface. Several operators maintain GPS clocks should be placed at every headend and CMTS to keep the network in sync.

The emerging need for syncing

The new services of digital video and VoIP will drive the need for synchronization in the cable TV network. As digital video is implemented, distribution from the head-end to the customer will require sync at locations where video is switched or where video payloads are reconfigured.

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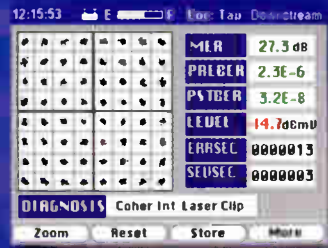

Downstream Display

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While data transmission via IP is forgiving in regard to sync, voice, analog modem, fax and other constant bit rate services transmitted via IP will not tolerate poor sync or packet discards due to network congestion.

The cable TV service provider strategizing to migrate from a broadband TV distribution network to a full service, two-way network delivering voice and high-speed Internet services must include synchronization in its plan. The new network must also match the legacy carrier's quality of service (QoS). For the cable network, new standards such as the IEEE 802 and the Data Over Cable Service Interface Specification (DOCSIS) 1.0 and 1.1 will prescribe how these services will be delivered. DOCSIS 1.1 is focused on methods to coordinate the 5 MHz-to-42 MHz bandwidth on a coaxial cable plant to provide high-speed downstream bandwidth with upstream bandwidth. It also addresses QoS standards for high-speed Internet connectivity, cable modem termination systems (CTMSs) and VoIP cable modems. This new cable TV network will support both analog and digital video as well as two-way voice and data services.

As cable systems begin to offer a wider range of services, they will need to begin guaranteeing service quality by offering service level agreements (SLAs). Synchronization will play a key role in meeting the QoS requirements outlined in these documents. In time, SLAs will call for the same quality lega-

BOTTOMLINE

> **Get Synchronized**

Once a cable TV network operator decides to step up, move into the digital arena and give the legacy telephone carrier a run for the money, synchronization needs to be part of the plan. Generic analog TV doesn't need sync. Data over Internet protocol (IP) is the same story. But once you cross the line into digital TV and voice over Internet protocol (VoIP), if you don't implement a good sync plan, you will not provide an acceptable quality of service.

The experience of the public switched telephone network (PSTN) taught us early how to incorporate synchronization. In fact, it now serves as a background technology along with power and ground.

Today, a cable operator may implement a synchronization plan similar in quality to the PSTN for a lot less money than the PSTN spent just five years ago. Don't make the mistake of waiting. Your quality of service—highly influenced by your network synchronization—can make or break your VoIP business.

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cy carriers now provide, resulting in some challenges for cable operators.

Recent VoIP field tests show latencies in the order of hundreds of milliseconds. Customers complain when latency reaches 200-300 milliseconds. A precise QoS time stamp in the neighborhood of 50-100 milliseconds will be required to meet SLAs. GPS is the only practical source of such a traceable absolute time-of-day stamp. Another challenge will be providing sync for legacy equipment such as PBXs and T1 multiplexers now synced from an access line. Again, GPS provides the answer.

There are some simple rules that will enable the cable telephony operator to meet and exceed PSTN voice quality. Place GPS PRSs with holdover clocks in all headend locations. Follow the BITS concept at all locations where sync is deployed. SONET transport nodes should be equipped with sync status messaging (SSM) and a PRS, or access to a traceable source such as the SONET-derived T1. If practical, deploy a PRS at all CTMSs. It is recommended that one refer to the key telecommunications synchronization standards as illustrated in Figure 1 (page 82) for a detailed review of common synchronization practices and associated equipment.

Synchronization is required for new VoIP cable telephony and digital video services. GPS quality synchronization signals may now be received virtually everywhere, using a rooftop antenna, a through-the-window antenna or an inside-the-building antenna. Fortunately, synchronization equipment has evolved with GPS technology, enabling lower-cost components and simple installations everywhere capable of producing highly accurate signals traceable to the national standard. All these tools are available to provide PSTN QoS for cable multiservice networks. CT

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MONIT

CUSTOMER PREMISE EQUIPMENT

By Bruce Bahlmann

Monitoring options for partial-node outages offer a way to reduce your dependence on customer calls to detect outages. Deciding which option is the trick.

You're in charge of a network, consisting of a vast collection of hardware that is interlinked in different ways. Each component is maintained by different organizations within your company that independently monitor their portion of the equipment. None of their monitoring systems can communicate with one another.

The vast collection of hardware described above includes cable modems, residential service units (RSUs), intersects, lasers, cable modem termination systems (CMTSs), switches, routers,

ORING:

END-OF-LINE

S.

and hybrid fiber/coax (HFC) actives (amplifiers, power supplies and so on). Each of these devices is connected by fiber, coax and category 5 cable, and are monitored by a diverse group of both standards-based and proprietary network management systems (NMSs). A little known fact is that these monitoring systems collectively yield far less than comprehensive network coverage. As a result, broadband operators must remain dependent on customer calls to detect a large number of outages. Overcoming this dependency involves solving the pesky problem of monitoring for partial-node outages.

HFC's weakness

The single most challenging task of broadband operators today is monitoring for partial-node outages (see "Before the Customer Calls: Problems with Network Maintenance," October 2000, page 131). Partial-node outages occur when a portion of a node becomes damaged (for example, when animals chew through plant—this really happens!) or experiences an equipment failure (for example, an amplifier fails). For customers, the results of a partial-node outage range from noisy reception and intermittent high-speed data (HSD) services to a loss of all services. The number of customers affected by partial-node outages depends greatly on the size of the node (how many customers are served by the node) and where the break occurs (near the beginning of the node or further down the line).

Unfortunately, HFC is not designed with sufficient detail that would permit partial-node outages to be detected and located. Traditionally, HFC is designed around 'actives' and everything is related back to these actives. An active is generally a piece of hardware—such as an amplifier or laser—that requires some type of power and 'may' be visible remotely.

Figure 1 (page 94) shows a very simplified node with its actives highlighted in red. This node splits into three lengths (runs) of coax that terminate at various distances. Along each run lies a variety of taps that permit connections and amplifiers to boost the signal. In a more typical node, multiple runs and sub-runs exist. A sub-run is generally a small length of coax that branches off a main run. The key characteristic about sub-runs is that they typically do not connect to the main run via an active.

Because sub-runs do not interface directly with an active, they are generally invisible to broadband operators (unless they contain a remotely monitored active). "Invisible," in this case, means that sub-nodes are not monitored by an NMS and sub-nodes are not labeled on a node map. Therefore, most outages that happen on a sub-node are undetectable by broadband operators. The only case where one could 'currently' detect a partial-node outage would be some 'slight' rise in return noise, but since sub-runs are not labeled, broadband operators would be hard-pressed to localize the source of the noise (that is, it is often dismissed).

In addition, any portions of the node that are not directly between two actives are also invisible to broadband operators. This means that the portion of each run beyond the last active also is invisible to broadband operators. Figure 2 shows the portion of the node (seen in Figure 1) that is invisible to broadband operators. This portion of the node is shown in red and can represent as much as 40 percent of the plant on a working node. In terms of the numbers of customers this represents, its projected that somewhere between 30 percent to 50 per-

FIGURE 1 EXTREMELY SIMPLIFIED NODE

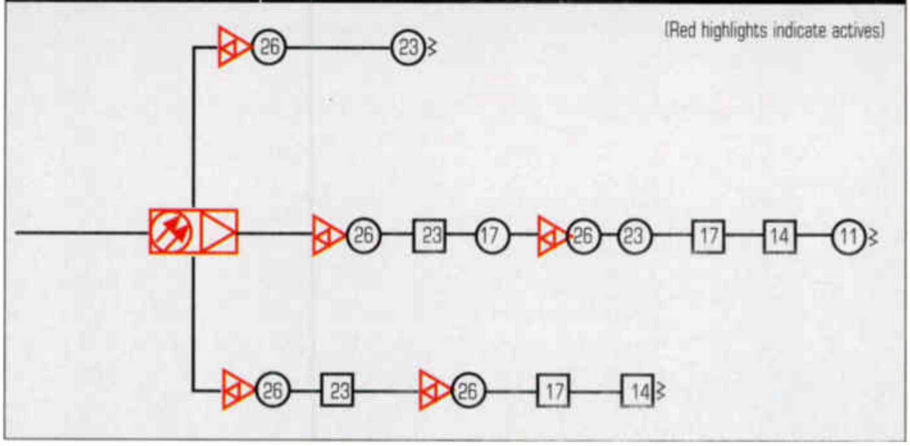
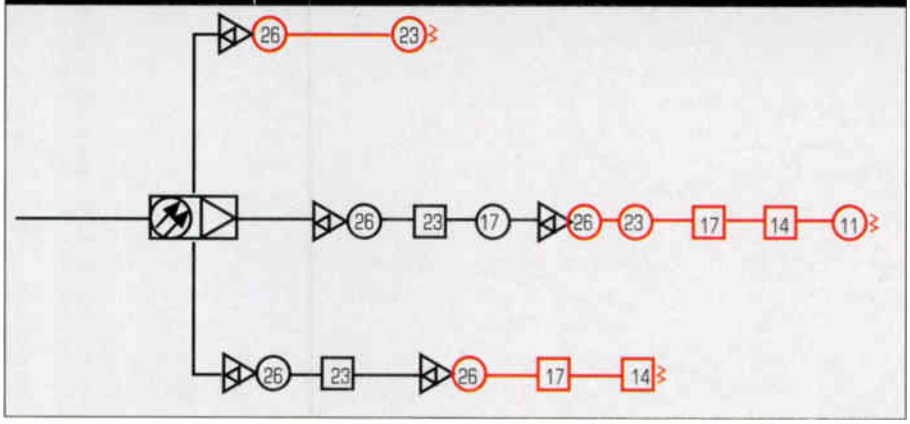


FIGURE 2 PORTION OF NODE INVISIBLE TO BROADBAND OPERATORS



cent of all customers on a node fall into an area of the node that is invisible to broadband operators.

CPE monitoring options

Though a large portion of the node is invisible, broadband operators are seeking ways to monitor this portion of the node in whole or in part. One attractive option is to monitor customer premise equipment (CPE). The information gained from sampling CPEs—such as cable modems, telephony RSUs and so on—in a specific area may provide information regarding the health of the plant in that area. In theory, these devices would be used to complement the coverage of monitoring actives. Unfortunately, unless this is done correctly, it may also lead to inconclusive information. Attempts to use CPEs as a means of detecting partial-node outages greatly depends on a high level of penetration of these services on fiber nodes. Thus, if you're planning on monitoring CPEs, you should be aware of the following trade-offs:

- CPE monitoring may utilize customer-purchased devices (no additional hardware required—sounds great but what is the catch?), as well as the same network management station used to poll other HSD resources in exchange for basic node-outage detection.
- Coverage for all nodes may be years away. Take a city of 30,000 with a penetration of 5 percent for HSD and 30 percent on telephony in an area where the maximum customers per node is 250. A total of 10,500 customers would have to be polled to determine partial-node service interruptions on the city's 120 nodes. This would mean that approximately 88 subscribers per node would provide sufficient information to enable us to detect partial-node outages. While this is reasonable to expect good coverage across the whole node, most broadband operators are nowhere near these numbers for both services (HSD and telephony).
- Correlating polling information with physical location so that one can draw conclusions from devices on similar stretches of plant also is a problem. Polling customer modems in an area is further complicated in the DOCSIS model because of the use of combining. This is because customers with the same network address or CMTS interface may all be on separate fiber nodes. Thus any polling that is done among them "may" not be usable. For example, two non-responding subscriber devices could mean that two node segments are down or only one is down. This depends on how the plant runs through the community because two people who live on the same street could reside on different nodes.
- There is also an issue regarding the interval of polling. For example, when multiple modems are polled, the period of time between modems geographically close to one another may vary. If this time varies too much, the samples taken from the modems would have no relationship to one another.
- There is also the subject of scalability in terms of polling an increasing number of RSUs and cable modems to determine partial-node outages. Since this number is directly proportional to the number of customers, it

BOTTOMLINE

> **Improving Reliability**
> The only way that broadband operators may achieve their stated availability numbers is to seek total-node visibility (TNV). TNV may be achieved by monitoring customer premise equipment (CPE) or by installing end-of-line monitoring. Although broadband operators regularly monitor CPEs, this method of TNV has a limited shelf life and is riddled with problems. End-of-line monitoring offers the only long-term solution for TNV.

will require an increasing amount of resources (hardware, software, and perhaps most importantly, network bandwidth) to manage this system.

- The subject of ownership may have a negative impact on reliability. Since broadband operators do not maintain the CPE, they cannot ensure it is always on. This means the customer may decide to rewire their home, shut off the CPE when they go on vacation, and so on—all of which could lead to false alarms. Thus any information gathered cannot be taken as fact but instead must be averaged to get a sense of the general health of each node. Determining this general health requires intelligent handling of all devices that may always be on or mostly on (unfortunately, none of these devices is under the broadband operator's control).

End-of-line monitoring options

The reality of monitoring CPEs is that it cannot possibly overcome all these technical challenges. This leaves only one other option for broadband operators interested in detecting partial-node outages—end-of-line monitoring.

Because customer devices will never represent 100 percent of the end-of-line for each and every fiber node, the need exists to seek a more reliable measure of this important operational aspect. Knowing the operational status of ALL the ends-of-line replaces other incomplete monitoring systems. End-of-line monitoring also represents a fixed number of devices that may be modeled by location.

The following challenges exist before end-of-line monitoring may be realized:

- A rework of the way broadband operators label nodes is needed. This new naming convention must allow broadband operators to reference specific sub-runs of a node rather than the existing naming convention that keys on various actives along the node. The naming convention also must help relate sub-runs to their respective run and amplifiers so as to leverage as many existing naming conventions as possible.
- Although end-of-line monitoring represents a fixed number of devices, the number of end-of-line devices required for each node is staggering (anywhere from 3-20+ per node). Thus each of these devices must be very inexpensive (perhaps in the sub $20 range). This cost could be 'partially' offset by broadband operators NOT placing end-of-line devices on portions of the plant where no customers reside.
- End-of-line devices must be plant-powered. Since not all ends-of-line have external power available, the cost of bringing power to every single end-of-line in a broadband distribution system could be cost-prohibitive. The availability of power on broadband networks pre-

sents an opportunity for plant-powered devices over those requiring an external power source.

- End-of-line devices also must be compact. Ideally, end-of-line monitoring agents should be no larger than a small filter and be able to screw into the last tap on each run or sub-run. The recent development of a cable modem on a chip is a step towards one such end-of-line monitoring device.
- Since the number of end-of-line devices required to monitor a large system could easily exceed the capacity of a carrier class NMS, great care must be taken to select the appropriate polling frequency. The information gathered during these polls (if used correctly) may help predict outage conditions.
- End-of-line devices should be mapped by GPS for their exact location so as to direct service personnel to problem areas with the highest level of accuracy. Current detection only tells plant maintenance personnel which node—meaning they'd need to traverse long stretches of plant and test several points to find the problem. It also would greatly help service personnel locate defective end-of-line devices in times of limited visibility (fo example, snow storms, heavy rain or fog).
- End-of-line devices must be spectrum-focused rather than service focused. Effective end-of-line monitoring cannot be achieved by service-focused devices (such as a telephony RSU or cable modem). This is because they only monitor the health of their specific portion of the overall spectrum. The best kind of end-of-line device would report the health of the entire spectrum or perhaps just the portion that is questionable or failing. In this way, the monitoring would be service-independent and benefit all broadband services.

The subject of total-node visibility (TNV) is an area no broadband operator is prepared to discuss, yet many claim multiple nines (such as 99.99%) in overall network availability. Perhaps this availability figure only applies to the portion of the plant to which broadband operators have visibility?

Regardless, a significant portion of the plant that services customers remains invisible. This is why broadband operators must rely on customers to detect plant problems and why to this day no vendor has stepped forward with a cost-effective solution to this problem. CT

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Did this article help you? Let us know your thoughts. Send an e-mail to snaylkar@phillips.com.

The One Box One Solution Cable Network "Find & Fix" Guide

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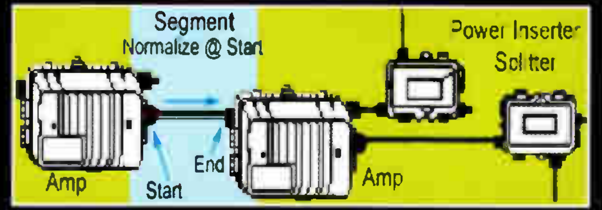
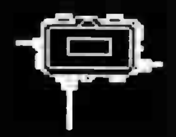
Sweep and Balancing: Still the Best *Find & Fix* Tool

- Analog or digital, the cable plant is one seamless HFC network. Defective network components that cause analog signals to fail also can impair digital signals. The best way to find these faults is to use normalized sweep.
- Key Sweep tips:
  - Divide or segment the plant between actives by using normalization. Test each segment to plant specs. Normalization requires that you take a sweep reference at the 'start side' of each segment.
  - Sweep provides a non-invasive, in-service measurement for analog and digital signals. Sweep is compatible with all digital DTV and cablemodem formats—use sweep and spectrum tools with QAM measurements to diagnose digital faults!



Bad Sweep Trace:
Cause: amp is over-driven, or the Tilt is bad. Too much amp gain can cause CTB/CSO-intermodulation. In the reverse path case, too much gain can cause the reverse optical node to clip. Gain set too low can deteriorate C/N and MER.



Finding Tap and Connector Problems

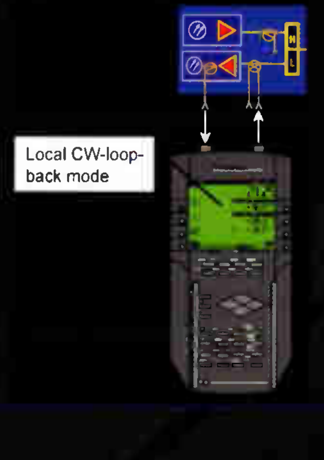
- Bad taps or connectors can cause a suck-out (notch) in frequency response. Suck-outs cause in-channel and/or adjacent channel impairments.
- Tip: Sweep (upper display) is the best tool for finding these faults. Sweep is used up to 750/862 MHz.. SCAN mode (lower display) is fast, but may not show the real problem. SCAN modes are limited to the channel plan.
- Tip: SDA meters also allow viewing of in-channel spectrum.
- Causes are:
  - Humidity problems.
  - Bad connector mountings/housings.
  - Small RF leaks to ground.

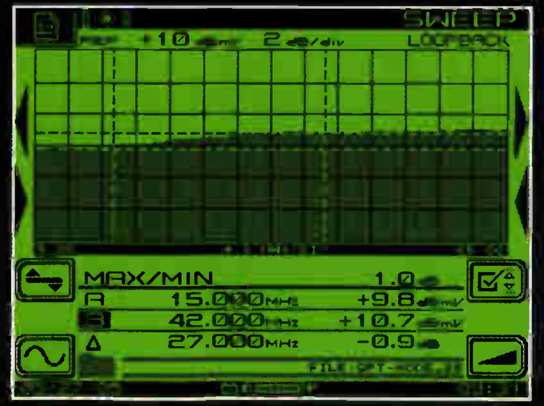
Bad Forward Sweep Trace with Suck-out.

On SCAN, Suck-out is Less Visible.

Optical Node Test and Reverse Measurements

- In cascade maintenance, alignment of the Reverse Path driver-amp laser must be done first. With a loop-back mode, the generated test signal is measured back through the driver-amp.
- After the driver-amp is aligned, the reverse sweep and alignment can be performed for accurate balancing of the return path. SDA's reverse alignment display shows the absolute reverse levels in dBmV/dBuV.
- Tip: with the absolute levels displayed, you can see the signal behavior of the cable modem signals during this setup and test.





Local Sweep Loop-back Mode.

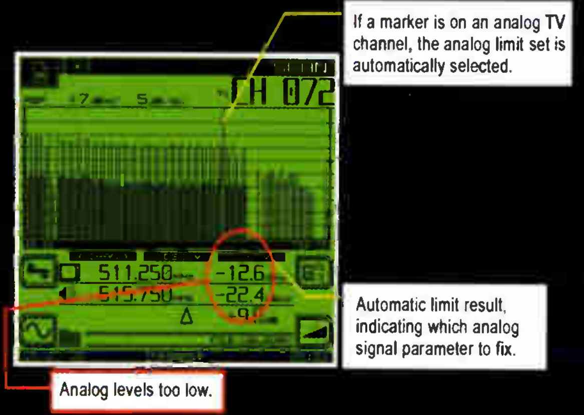
Reverse Alignment Sweep Trace.

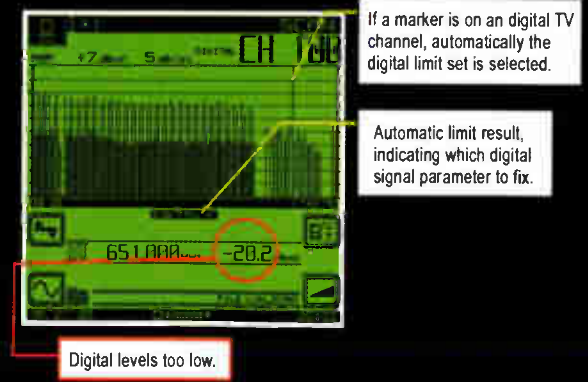
Level Problems

Sounds obvious, but you must first fix problems before you can perform final tests. This is why SDA provides the usual Go/No-Go measurements with a complete set of analysis tools to find faults.

A spectral-scan is the best tool to view in all channels in one-shot. If there is any trouble, view frequency response, notches, roll-off, standing waves, etc. If 'clean,' then run an AutoTest.

A spectral-scan with on-line limit check gives a real-time indication of proof of performance pass/fail. However: two limit sets–one for analog carriers and one for digital–are required for Auto/Log testing to work.





HUM Problems and Carrier-to-Noise Problems

- HUM problems appear as one horizontal bar (50 / 60 Hz) or two bars (100 / 120 Hz).
- Causes of HUM problems:
  - Bad power supplies in amplifiers
- Bad C/N appears as "snow."
- Causes of C/N problems:
  - TV-carrier levels too low.
  - Not enough amplifier gain

New Problems on the Reverse Path

- To quickly find & fix ingress problems, SDA's Interoperation tool is vital. With it, two ingress spectrum measurements are done simultaneously, one at the headend

When to Use Go/No-Go and When to Use Find/Fix Tools

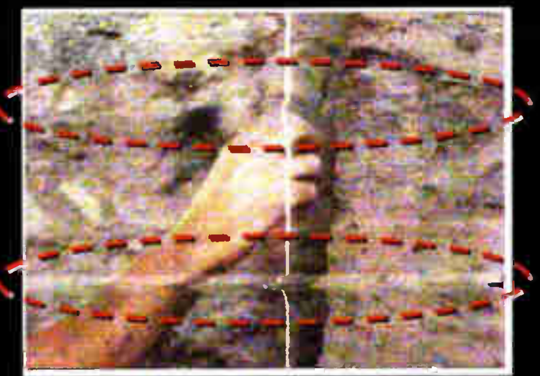
- BER is number of Bad Bits for every total bits.
- Reed-Solomon Forward Error Correction (FEC), when working, will output >10-11:
- Due to the cliff-effect, BER measurements are unreliable. Similarly, other Go/No-Go tools, such as "Errored Seconds" or "Severely Errored Seconds" (SES) don't help to clearly diagnose what

C/N vs. BER/SES* vs. MER

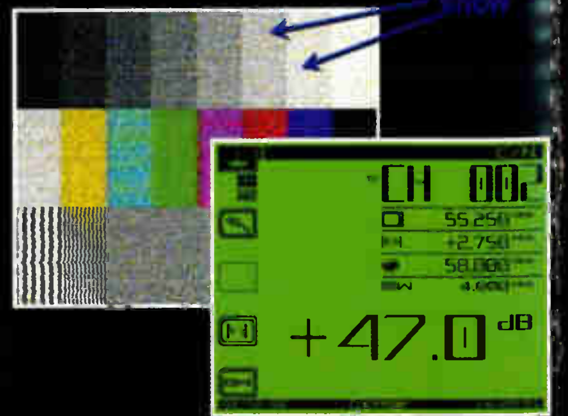
*Bit Error Rate/Severely Errored Seconds

spectrum traces are then compared in
real time on the SDA meter display.

- Earth-loops on coax cables.
- Bad ground blocks.
- Bad connection to ground.
- Earth-loops in headend, interfering with the TV modulators.



- Tools to find and fix C/N problems.
  - Use SWEEP-mode to find gain/loss problems.
  - Use SCAN-mode and/or LEVEL-mode to find individual level problems.



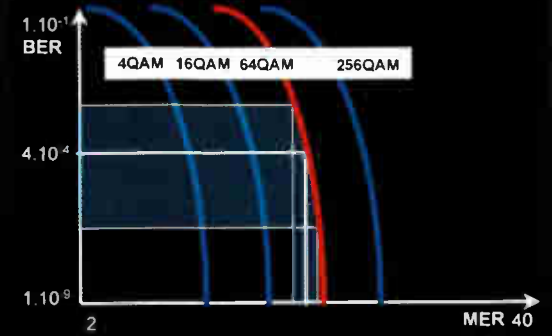
Advantages of SDA Interoperation:

- Avoid self-inflicted errors.
- Easy and fast faultfinding by seeing in which direction to diagnose to/from the head end.
- Isolate the cause of Common Path Distortion (CPD). Common path distortion is a mechanical problem, which requires real-time feedback to measured spectra in the hub-site.
- Quick commissioning and confirmation of the repaired fault. Ability for one person to check if the repair efforts solved the problem.

Common Path Distortion.

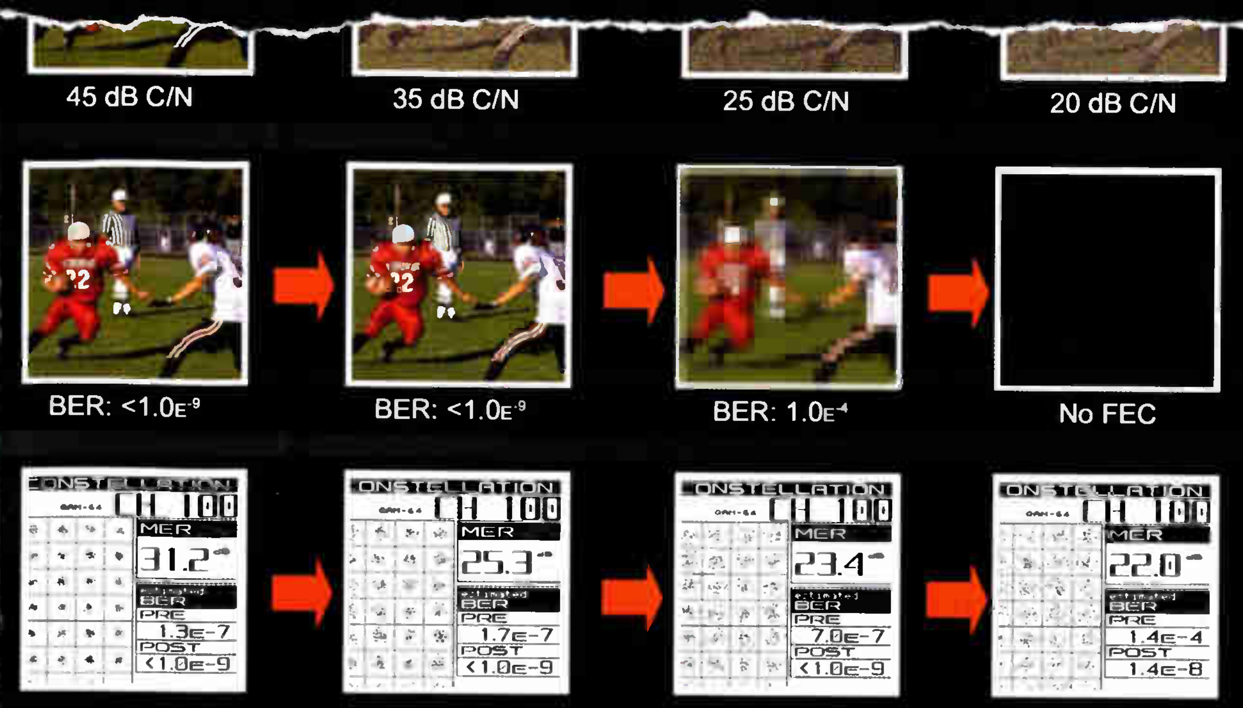
- Common Path Distortion can result from corrosion or oxidation on connectors. This causes a diode-effect, introducing potentially harmful 2nd and 3rd order intermodulation beats every 6, 7 or 8 MHz (channel plan dependent). Appearing in the reverse path, these beats are very small but accumulate when several reverse paths are combined at the node.
- Tip: Use of a low-pass filter is recommended. This filter (built into the SDA meter) removes the channels on the forward path that could interfere with the instrument's RF input section.

  - 1 error in 100 billion bits.
  - 1 error every 46 minutes.
  - MPEG-2 needs a good BER.
- FEC will work to about 10^{-4}:
  - 1 error in 10000 bits.
  - 1 error every 276 usec.
- FEC causes Cliff Effect, as illustrated below.



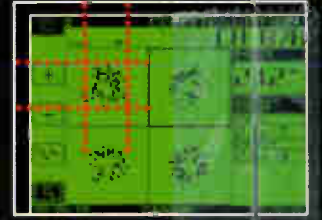
to fix or 'where the cliff' is.

- Tip: use multiple tools to qualify digital carriers. An MER of 23 dB still can show an excellent BER (<1.0E-9), but is actually only 1 dB away from the 'breaking point.' Use MER, spectral display, constellation, Equalizer Stress (micro-reflections/reflections), etc.
- Using only BER, SES etc., will result in call-backs.



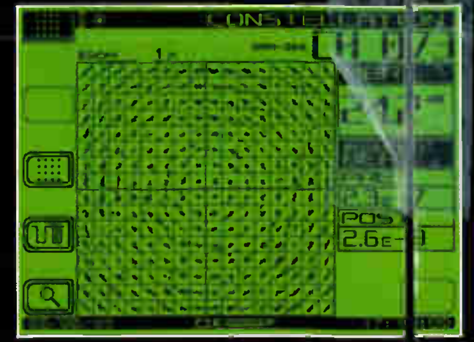
Constellation Displays: Headend or Field Fault?

- Constellation is an ideal tool to find QAM modulator problems. Distinguishable shapes/patterns of the constellation reveal modulator issues in the headend versus faults (ingress, CTB, CSO, etc.) in the field.
- Tip: Constellation displays shows noise or ingress, but usually only if the interference is very severe. Also, microreflection faults aren't visible. Use SDA Stealth Ingress and EQ modes to diagnose and find ingress, noise and micro-reflection problems.



Constellation diagram showing severe ingress

- Typical errors originating from the head end:
  - Phase Noise
    The constellation appears to be rotating at the extremes while the middle dots remain centered in the decision boundaries.Such phase noise is caused by headend converters.
  - Gain Compression
    The outer dots on the constellation are pulled into the center while the middle dots remain centered in the decision boundaries. Gain Compression is caused by bad filters, IF equalizers, converters, and amplifiers.
  - I Q Imbalance
    The constellation is taller than it is wide. This is a difference between the gain of the I and Q channels. IQ Imbalance is caused by baseband amplifiers, filters, or the digital modulator.
  - Carrier Leakage

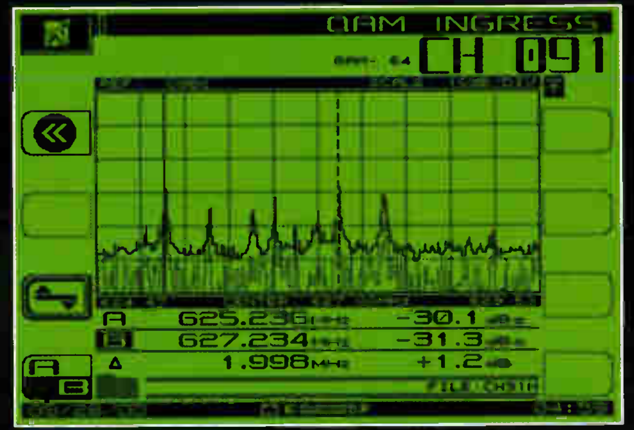


What's Going Wrong, Where and Why?

Don't forget In-service spectrum measurement "Under the Digital Carrier."

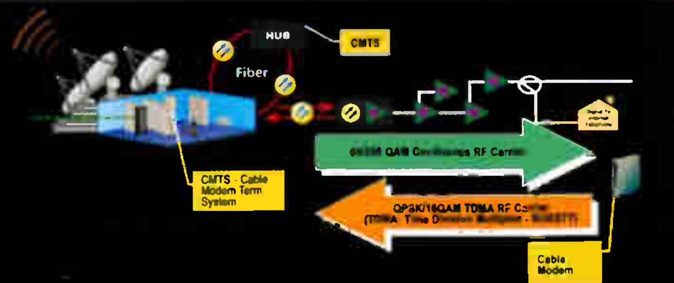
- The most common problem with digital-TV and cablemodem services is interference under the digital carriers.** Most common sources are:
  - Ingress due to off-air UHF TV channels.
  - Intermittent ingress due to pager transmitters or two-way radio base stations.
  - CSO/CTB-intermodulation.
- Tip: intermittent ingress under the digital carrier can easily captured by the SDA's in-service spectrum view in peak-hold mode.

** Source: interviews with top 50 operators with 100,000's digital subscribers.



In-service ingress spectrum showing CSTB/CSO-intermodulation problems due to analog-TV channels.

For Cablemodems, Two Digital Formats Require Two Measurement Methods

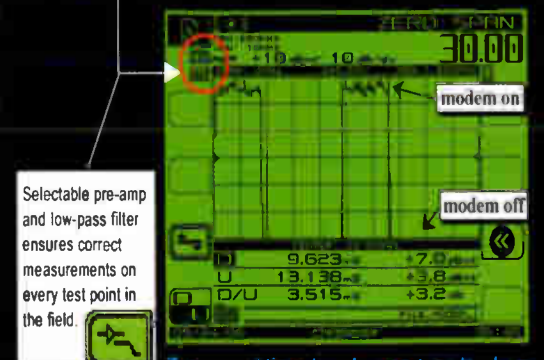


1. Measure digital-TV signals downstream, 64 and 256QAM, annex-A, -B, or -C.
2. The capability to measure cablemodem signals downstream, 64 and 256QAM continuous carrier, and upstream, QPSK, 16QAM or 32QAM, DOCSIS, EuroDOCSIS, EuroModem, etc., and bursty TDMA carriers.

In-Service Cablemodem Analyzer – All Formats

- Operators' largest problem is interfering signals on the return path:
  - Ingress from the homes.
  - Common path distortion (CPD).
- An in-service spectrum mode is needed to show all relevant interference under the digital return cablemodem carrier.
- Because cablemodem standards are still evolving world-wide, it is recommended that the measurement method is independent of any standard.
- A common measurement solution is the time-domain mode of a spectrum analyzer. This time domain mode works for every relevant TDMA cable modem standard and is in-service.

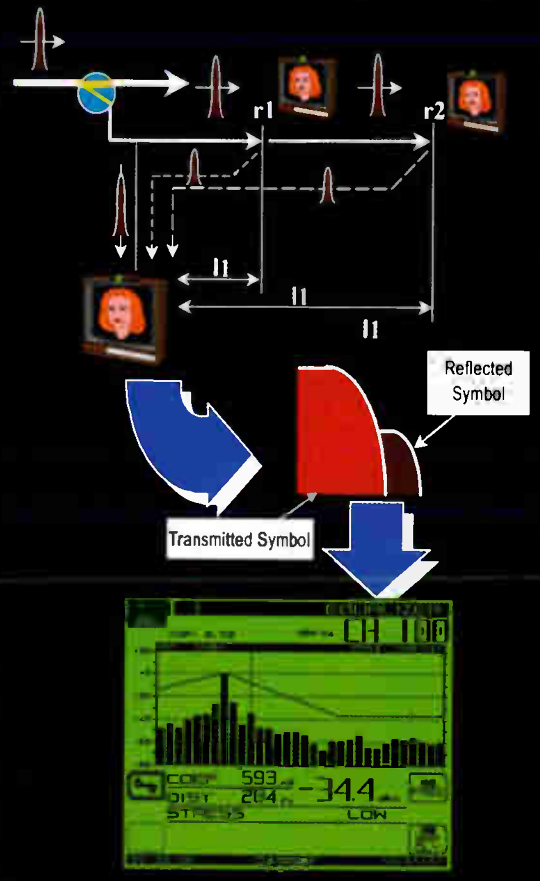
Easy to use, one-push-button, in-service C/N measurements on TDMA return path cable modem signals. (DOCSIS, EuroDOCSIS, EuroModem, etc., compatible.).



Zero-span / time-domain expert mode, showing the TDMA busty return path cable modem power ramp of 3.5 ms.

Intermittent Network Reflections: Difficult to Diagnose (especially in home installations)

- Caused by: connector cracks, bad taps or splitters. SDA's ultra fast Equalization Graph reveals intermittent reflections. Other sources of intermittent ingress:
  - Wind blowing the above ground cable plant.
  - Heavy trucks passing-by under ground cable plant and road cabinets causing intermittent mechanical stress on connectors.
  - Outside temperature and humidity changes.
- Tip: Measuring the time-delay of the "spiking" intermittent reflection-bar can give an indication of the distance to the fault.
  - Distance to fault is: 1/symbol rate * tap number * speed of light * velocity of propagation / 2. At a symbol rate of 5.057 MHz and VOP of 0.7, the bars are spaced 67 feet apart. Also displayed in meters.
- Tip: Bad home installations cause micro-reflections– which appear as a noise. The Equalization Graph will distinguish the right cause of the problem.



The One Box One Solution
Cable Network
"Find & Fix" Guide

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CNIN01791000

Designing Tomorrow's Headend

Ramping Up for Increased Traffic

By Dean Rockwell

While it is impossible to predict the future, operators know today's headends will be affected by the added burden new applications and services place on them. Headends will need to evolve to accommodate what's coming not only several years out but months from now.

Is your network really ready for the big changes ahead? Have you taken a good look at how proliferation of interactive applications such as telephony and video-on-demand (VOD) will impact your system's headend?

To put that impact in perspective, consider this: Suppose you serve 400,000 subscribers in your market and in the next three years, half of them—200,000—opt for digital set-tops. Now let's say your peak take rate for an interactive service such as VOD is 10 percent. That's 20,000 potential buyers—and 2,000 6-MHz channels tied up for your VOD service alone. When you consider those channels may be tied up for hours at a time, that's a significant peak traffic increase that may cause substantial problems in most of today's systems.

Cable operators are adding services such as targeted advertising, Internet access and telephony. The combination of video, voice and data is placing tremendous loads on cable systems. When other services, such as telephony and VOD, are added, it becomes even more critical that networks are structured to handle huge traffic volumes. The burgeoning demand for capacity is leading to major changes in network design and management, both in topology and equipment. Now more than ever, networks need to focus on managing and routing traffic, as well as delivering it to the correct subscriber. The headend plays a significant role in this effort. Digital receivers and quadrature amplitude modulation (QAM) modulators are currently in place in many headends As cable networks and applications evolve and digital technology spread headends will house routers, switch multiplexers and digital servers.

Costs associated with headend ation are growing, along with the r for more equipment. Faced with th added expenses, cable operators a consolidating their headends to m service and management easier an more cost-effective. But this move consolidate headends, coupled wit growing traffic and bandwidth-inte sive applications, has resulted in ex demands on headend resources. To deal with the changing landscape and to accommodate the traffic and applic

tions of the future, master headends are becoming large, sophisticated network operations centers that will eventually house huge server farms for VOD, and be manned around the clock by managers and skilled professionals.

Emerging approaches

New-and-improved technology and network modifications impacting headends will enable the handling of huge traffic volumes and provide the tools for delivering a large number of services to distant subscribers. In the network of the future, the large number of fully equipped headends that proliferated in the early days, combined with those developed using hybrid fiber/coax (HFC) and 1550 nm or digital fiber technology, will see another permutation. As new approaches, such as driving fiber deeper into the system, become more pervasive, primary and secondary hubs will become intermediate points between the master headend and the end-of-line (see Figure 1). Instead of linking headends, a single location will be designated the "master headend," with other headends becoming "primary hubs" and existing hubs becoming "secondary hubs."

BOTTOMLINE

> **Futuristic Logistics**
>
> With the surge of new interactive applications on the horizon, cable operators are racing to keep up. Inevitably, to accommodate the increased growth and demand, headends will need to evolve to accommodate what's coming not only several years out but also months from now. To deal with the changing landscape and accommodate the traffic and applications of the future, master headends are becoming large, sophisticated network operations centers that will eventually house huge server farms for video-on-demand (VOD), and will be manned around the clock by managers and skilled professionals.

With this change, operators can eliminate redundant antennas, receivers, processors and sometimes modulators from these "headends-turned-hubs," leaving little more than an optical hub converting 1550 nm to multiple 1310 nm forward nodes. Labor no longer required at the former headend sites may be reassigned to support the master headend. In addition, reliability will improve with less equipment, and the space antennas, receivers, processors and modulators occupied will be freed up for expansion to handle future services.

Hubs located between the master headend and the termination point are ideal launch sites for localized services, local government and educational channels, as well as revenue-generating applications including targeted local advertising. These kinds of channels may be inserted into the downstream path at the hub and directed to a highly targeted subset of the subscriber list.

Since the hub also is the intermediate point for reverse (upstream) traffic from the home, this network design approach also provides easy access to both downstream and upstream signals in a smaller area. In addition, network reliability is enhanced and maintenance costs are lower. As a result, customers will enjoy new applications and receive better overall service.

Hubs also will play an increasingly important role in protecting the master headend from the burden of heavy traffic loads generated by interactive VOD, data and telephony applications. Secondary hubs may become primary hubs to accommodate increased subscriber demand, driving fiber deeper until a balance between demand and capacity is achieved. Depending on the situation in any given system, reverse traffic may be handled locally at the hub or optically transmitted back to the master headend for processing.

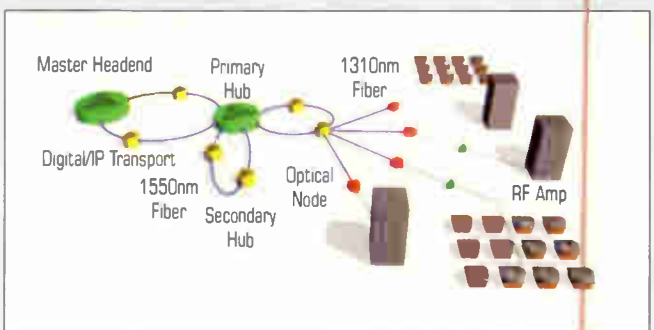
As headends and hubs evolve, more hubs will be used to provide additional bandwidth and enable new services for subscribers. Because of the large number of hubs required and manpower limitations, most of these hubs will exist as unmanned sites with automated status monitoring and network management equipment. These advantages will keep the operator, now located at the master headend or a network control center, informed about network performance and provide alarm and fault recovery if trouble occurs. This approach, which will deeply impact telephony, helps operators anticipate problems and enables faster problem correction.

A headend revolution is underway

The ramp-up to digital is about to transform headend capacity and capabilities dramatically. Digital broadcast services mirror the analog model, using digital-satellite receivers and digital-cable modulators in place of the analog equipment. But with compression technologies, the number of programs each channel can carry may be multiplied by a factor of up to 12. The bigger changes, however, will be seen in the transition to interactive services.

Interactive services require data networking capabilities that use Internet protocol (IP). The data networking capabilities need to be installed in head-

FIGURE 1 THE OPTIMAL HEADEND CHART



ends and hubs, together with IP routing and switching equipment. Headend technicians will have to acquire additional skills to handle multiple data, voice and video services. Data networking expertise will become a necessity for headend personnel, who will be called upon to add new services and troubleshoot.

"The ramp-up to digital is about to transform headends capacity and capabilities dramatically."

One of the obvious benefits of digital technology at the headend is it will facilitate revenue-generating applications such as next-generation targeted advertising and VOD. The convenience and impulse factor inherent in VOD, for example, is likely to lead to rapid growth of the acceptance and use of this service. For the operator, this means there needs to be a way to process orders in the system, either at the video server or at the headend, depending on the network design and the capacity to deliver videos to many customers at one time.

Approaches addressing the bandwidth crunch require changes to the network and the headend. For example, dedicated fiber dense wavelength division multiplexing (DWDM) technology could be provided to each primary or secondary hub. With DWDM, hundreds of 256-QAM signals may be delivered from the headend to the appropriate hub, each with up to 10 streams of video/audio programming. In this approach, RF processors would be used to tune the appropriate 256-QAM signal from the DWDM feed and place it in a dedicated "frequency slot" of the main RF feed for each node, although QAM signals also could be carried "on-channel" at times. Frequencies may be allocated to areas based on demand, so no single frequency slot would be overloaded.

Among other challenges for the headend of the future is the likelihood analog transmission will need to coexist with digital in cable networks. There is a huge installed analog base that will need to continue to be supported as new digital services and applications become increasingly complex and demand additional resources.

High definition television (HDTV), already deployed in some systems, also could have a major impact on headend design. To allow subscribers to receive HDTV, operators will usually decide to install conversion devices at the headend to receive the over-the-air vestigial sideband (VSB) signals and convert them to the QAM format.

As cable networks upgrade to deliver telephony, the overhead previously associated with telephone company operations will become headend functions, and headends will need to comply with federal telephony regulations.

The master headend, once a small facility with a small staff, will change forever as convergence progresses and new applications are implemented. Many cable operators are already moving to add the bandwidth, reverse plant and the digital technology needed to meet customer requirements. How successfully the challenge of providing more channels and more services to their subscribers is met will depend on the efficiency and scope of their network's headend. Operators who have not yet begun evaluating their network as a whole and at the headend need to consider doing so soon, or risk their position in the rapidly changing world of cable television. CT

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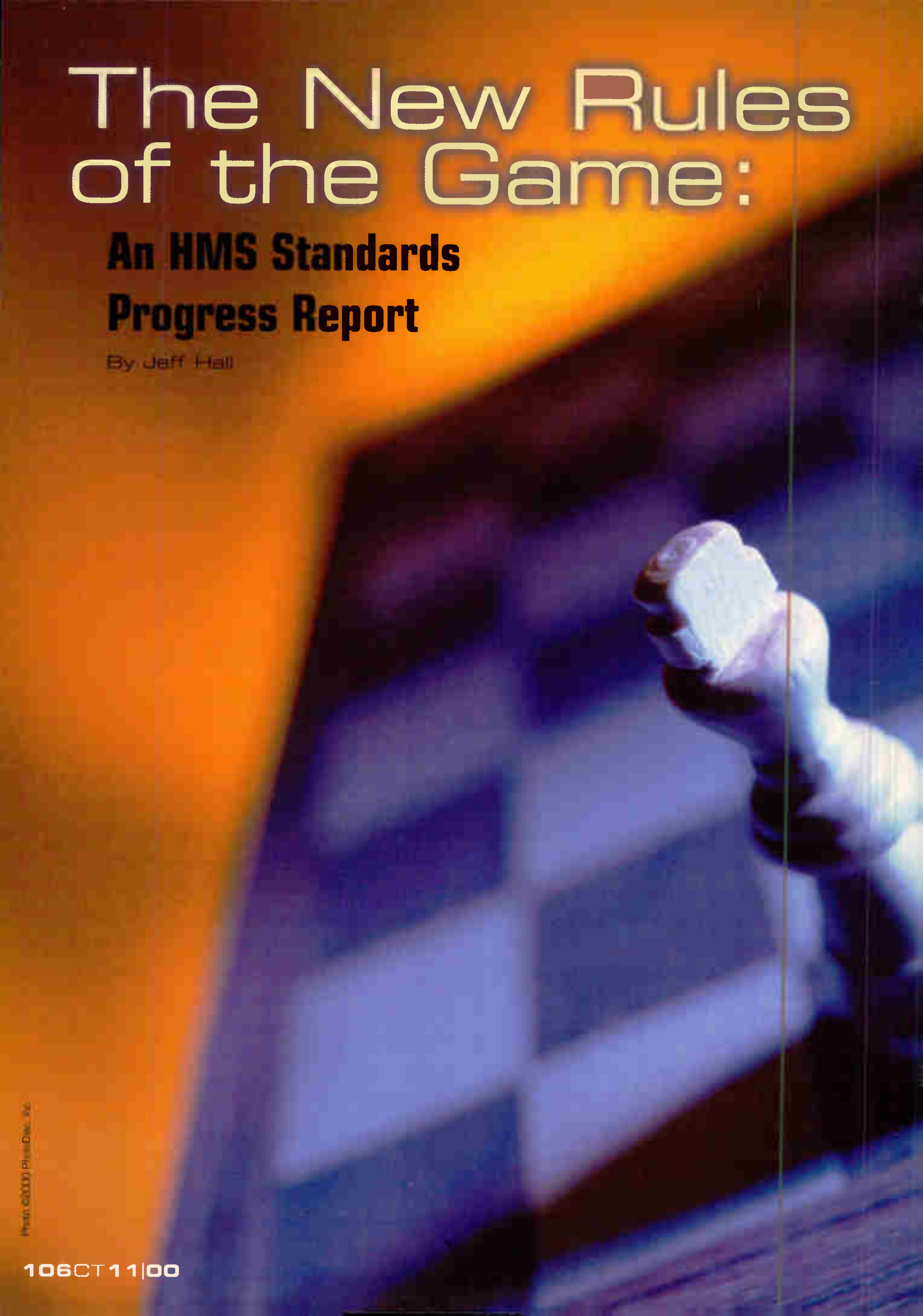
The New Rules of the Game:

An HMS Standards Progress Report

By Jeff Hall



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Operators and vendors are realizing that to win at the high-speed interactive technology game, careful strategic planning is everything. Changing the rules of hybrid fiber/coax (HFC) network monitoring helps too.

The process of defining, testing and approving hybrid management sublayer (HMS) specifications and standards has been underway for about two years and HMS-compliant status-monitoring transponders will be available next year. The ultimate goal is to develop HMS standards ensuring the interoperability of transponders from any vendor—a plug-and-play compatibility similar to that achieved through Data Over Cable Service Interface Specification (DOCSIS)-compliant cable modems.

Having outgrown the restrictions of proprietary systems architecture, the cable TV industry has been systematically evolving into a standards-based environment. Status-monitoring technology will provide operators significant advantages in open-systems architecture.

HMS standards enable a wider selection of network monitoring, maintenance and management options, gradually lowering overall costs while simplifying network operation, thereby improving the quality of service.

Representatives from U.S.-based multiple system operators (MSOs) and equipment vendors have been working together on the **Society of Telecommunications Engineers** (SCTE) HMS standards subcommittee to achieve a common purpose of information services-compatibility among manufacturers and service providers.

The subcommittee is developing a protocol suite that will support cost-effective interoperability of various management systems, combining physical layer, message layer and electromechanical standards within a single protocol. The SCTE subcommittee also is endeavoring to create an HMS qualifications test plan.

Why HMS standards?

HMS is an emerging SCTE standard for HFC network management designed to create an entire class of transponders meeting the same hardware and software interface specifications (see Figure 1, page 108). The benefits of HMS technology are substantial.

- HMS-compliant transponders func-

"The HMS subcommittee has been careful providing for a rich set of feature requirements while considering the costs involved."

tion without implementing vendor-specific solutions on the headend controller (HEC), providing operators with an interoperable transponder that may be used with any headend system.

- HMS-compliant transponders will be required to meet final HMS interface design specifications. While these transponders will speak the same language, end-users could find vast differences between suppliers' products.
- Network operators will be able to make HMS transponder choices by comparing the relative functionality of various providers' offerings. Thus, a wise buyer will test HMS transponders/headend systems from various vendors to determine which fits their specific network monitoring system (NMS) needs best.
- The elimination of the need for multiple "custom" transponders will reduce training requirements, simplify provisioning and provide for significant long-term efficiencies.
- Implementing standards in this area also creates an environment where vendors of similar products can combine knowledge and technology in more synergistic ways. This allows vendors to utilize their combined industry expertise to develop advanced network management solutions.

Standards development process

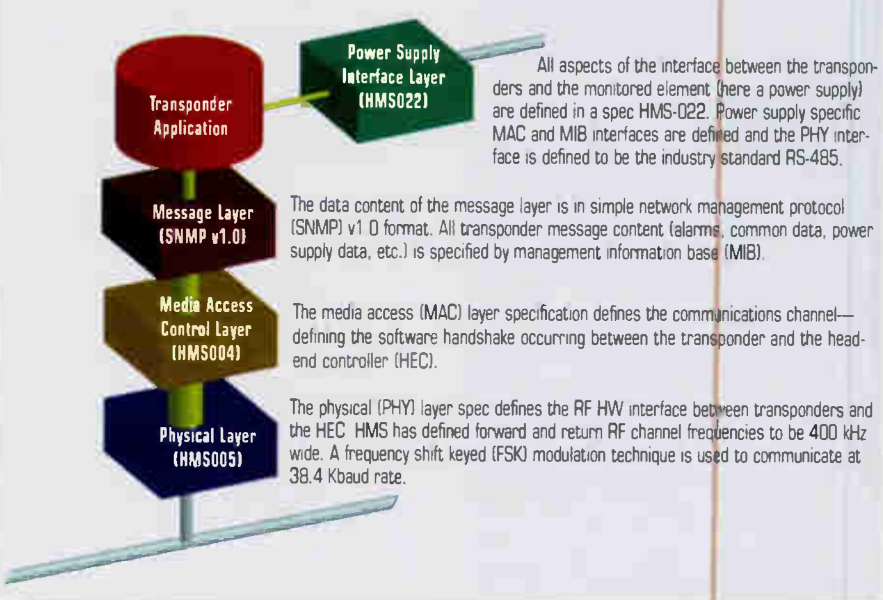
Changing the rules to create standards for the interoperability of evolving technology is a critical process. Each step must be thought through carefully and all the possible variables examined thoroughly. Because making mistakes is a risky proposition, it is essential that the adoption of HMS standards follows a deliberate process.

So while the marketplace eagerly awaits HMS-compliant products, a multitude of cable entities are working carefully toward developing standards in the interests of both cable operators and vendors. In cooperation with cable operator engineers, engineering teams from major monitoring vendors have been resolutely working in the research-and-design trenches, breathing life into this project and understanding their work is essential to gaining maximum benefits from HMS standards.

Each participating company has assigned a group of engineers to contribute ideas and expertise. Over time, the number of companies involved in

FIGURE 1 Structural elements of the HMS Transponder

The HMS standards process is influenced by the complexity of the HMS transponder structural elements pictured below.



BOTTOM LINE

> Changing the Rules

To win at the high-speed interactive technology game, operators and vendors realize they must change the rules of hybrid fiber/coax (HFC) network monitoring. Working in cooperation with the Society of Cable Telecommunications Engineers (SCTE), the ultimate goal is to adopt hybrid management sublayer (HMS) standards for HFC network management ensuring interoperability of transponders from any vendor.

Creating functional standards that take into account the best interests of all relevant parties is a complex process. HMS standards must provide a rich set of feature requirements while considering the costs involved, and remain flexible to encourage future innovation. They also should take full advantage of monitoring systems already in place.

HMS standards and compliant transponder technology is in the final stages of development and will be available next year. However, the critical issue of qualifications test remains undecided. Who will certify that HMS transponders are fully compliant—vendors or an independent entity? Vendor qualification testing may keep costs down initially, but those involved wonder if it's worth the risk of trivializing the credibility of HMS standards and potentially costing cable operators much more in the long-term.

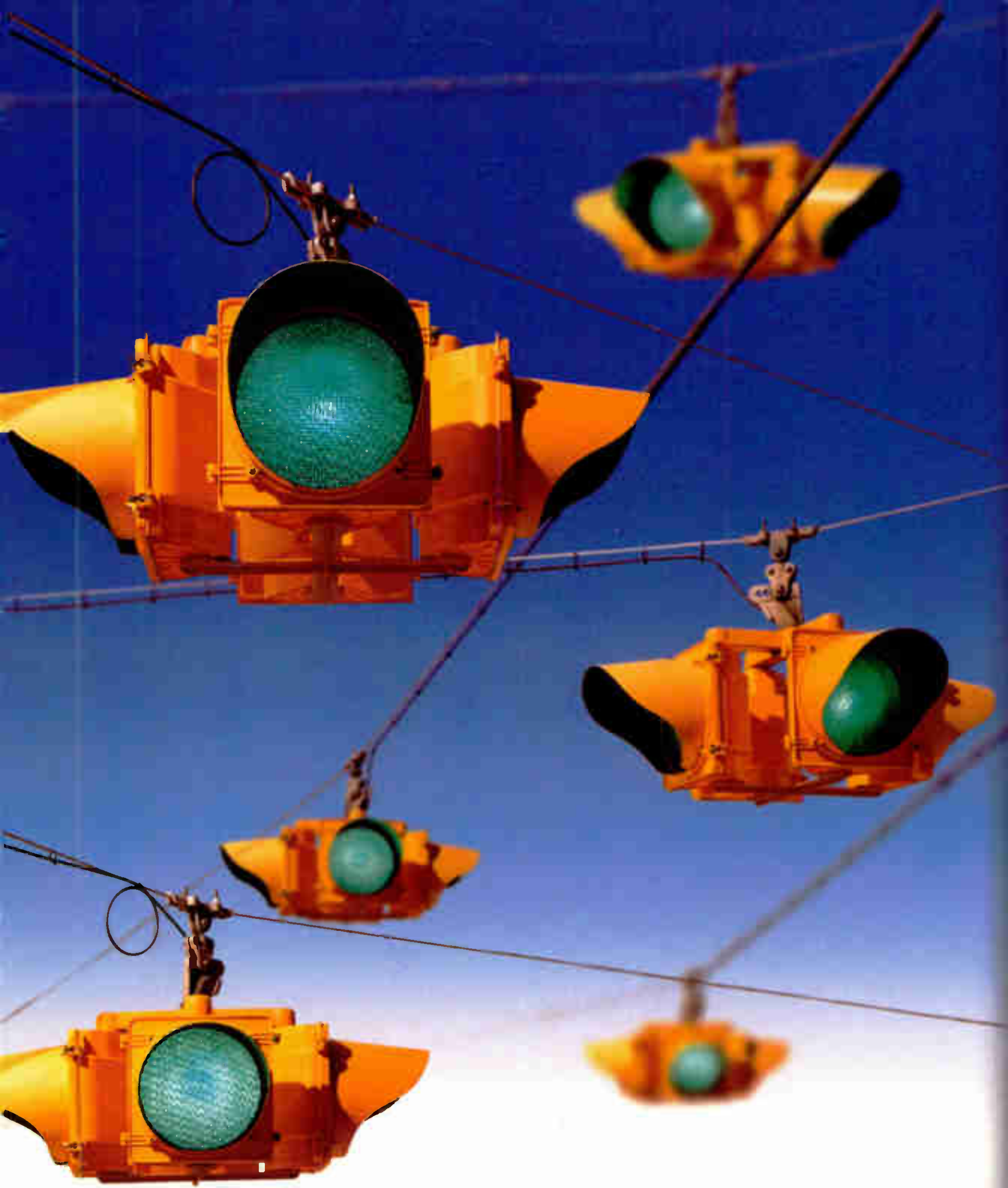
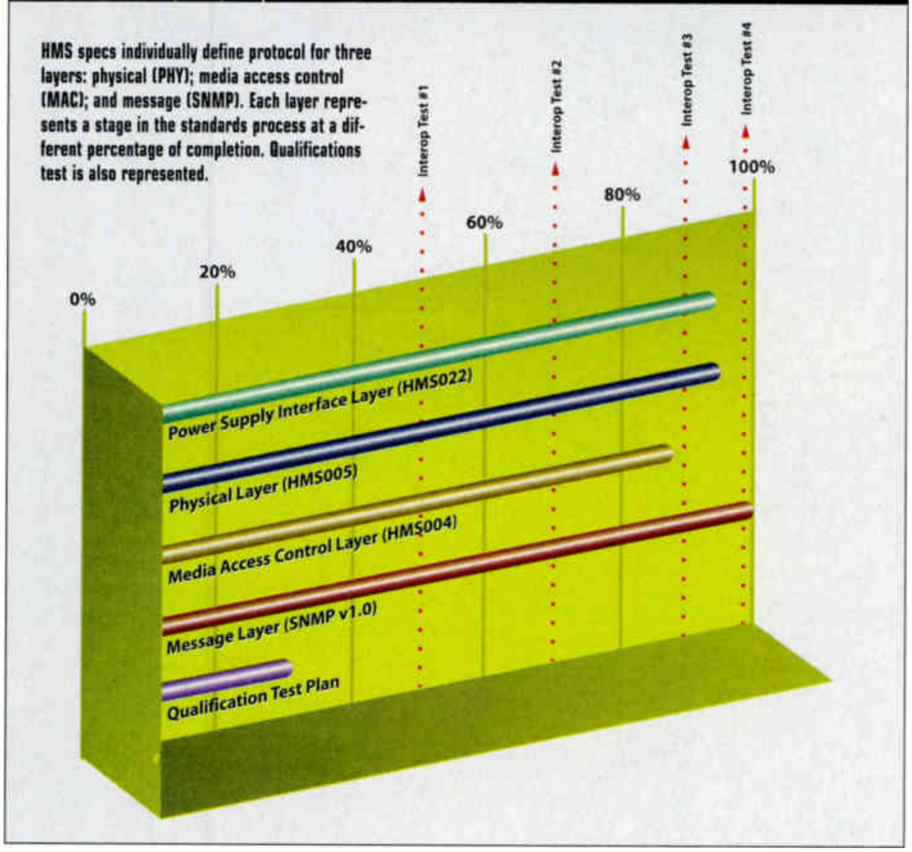


FIGURE 2 Standards Approval Progress



the standards process has expanded. This group has brought fresh ideas and stimulated the discovery process toward the best possible standard. New ideas also act as a countermeasure, ensuring key process steps are taken and stagnation does not occur.

The HMS subcommittee has been carefully providing for a rich set of feature requirements while considering the costs involved. A balance must be struck between standardizing transponder interoperability and ensuring standards remain flexible enough to encourage future innovation.

In addition, the standards committee has been sensitive about taking full advantage of monitoring systems already in place. In the end, the standard should take into consideration critical issues visualized by those involved in the process.

Are we there yet?

Simply put, we're not quite there yet. To allow monitoring equipment from different vendors to interoperate, HMS specifications must define components of a protocol for three layers. The specifications for these layers must be defined individually. They are the physical (PHY) layer, the media access control (MAC) layer and the message layer. Each layer represents a stage in the standards process at a different percentage of completion. Key layer specifications are nearing completion and will be tested for HMS interoperations (see Figure 2).

Key interoperation tests are used to verify not only that the standards work, but also to allow the discovery of flaws in standards' wording. The removal of ambiguities and implicit actions is an important step in the standards-development process.

One goal in the standards definition is to thoroughly identify and incorporate the numerous devices that would potentially require an element manager. Currently, attention is on management of power supplies. Generators and fiber nodes also are being discussed. Other elements will likely follow, although this area is nearing completion.

Until the SCTE completes and publishes all of these elements, there are no actual standards in place—only recommendations. In addition, the all-important qualification test process is still in the early stages of being defined and must be mapped out in much the same way as the layers.

Independent vs. vendor qualification

After HMS specifications have been defined and standards agreed upon, the committee must decide the best method of qualifications-testing for HMS products.

This issue is far from trivial. In fact, many believe this decision is the most critical. Because of its importance, the committee is paying particular attention to how the qualification test process will be implemented.

There has been discussion that having vendors validate their own compliance may speed delivery to market. The concern here is that relying on vendor, rather than independent, qualification may put the credibility of HMS standards into question and cost cable operators significantly more in the long term. As with any new technology, HMS-compliant transponders will not have a track record in the field.

In addition, the availability of the standard may encourage new vendors with limited transponder technology experience to rush new products to market. The risk here is that so-called "compliant" transponders may not be fully compliant, meeting only part of the range of specifications.

Partial compliance might not be visible in early product shipments, but manifest later during plant expansions and modifications. Complicating the validation process for cable operators will be a complex distribution model where manufacturers may sell transponders through the original equipment manufacturers (OEMs) of power supplies, nodes and other network elements.

With independent qualification testing across the full range of specifications, paid for by monitoring vendors, cable operators and OEMs may be assured that HMS-compliant transponders are compliant. This will speed successful implementation of the standard, ensuring its credibility and eliminating the possible need later for cable operators themselves to "test" the compliance of transponders.

We have made considerable progress in the HMS standards development process. Even though there are unresolved issues, HMS-compliant transponders will be available next year. In the coming years, the industry will reap the benefits of the hard work put forth by this endeavor.

If you would like more information on the standards development process, HMS standards or the SCTE subcommittee, there are a number of resources. SCTE provides information on the various standard subcommittees, including an events schedule, at its Web site at www.scte.org. CT

"HMS standards enable a wider selection of network monitoring, maintenance and management options, gradually lowering overall costs while simplifying network operation, thereby improving the quality of service."

Jeff Hall is Acterna's director of systems engineering and is an active member of the SCTE HMS standards subcommittee. He may be reached at jeff.hall@cheetahtech.com

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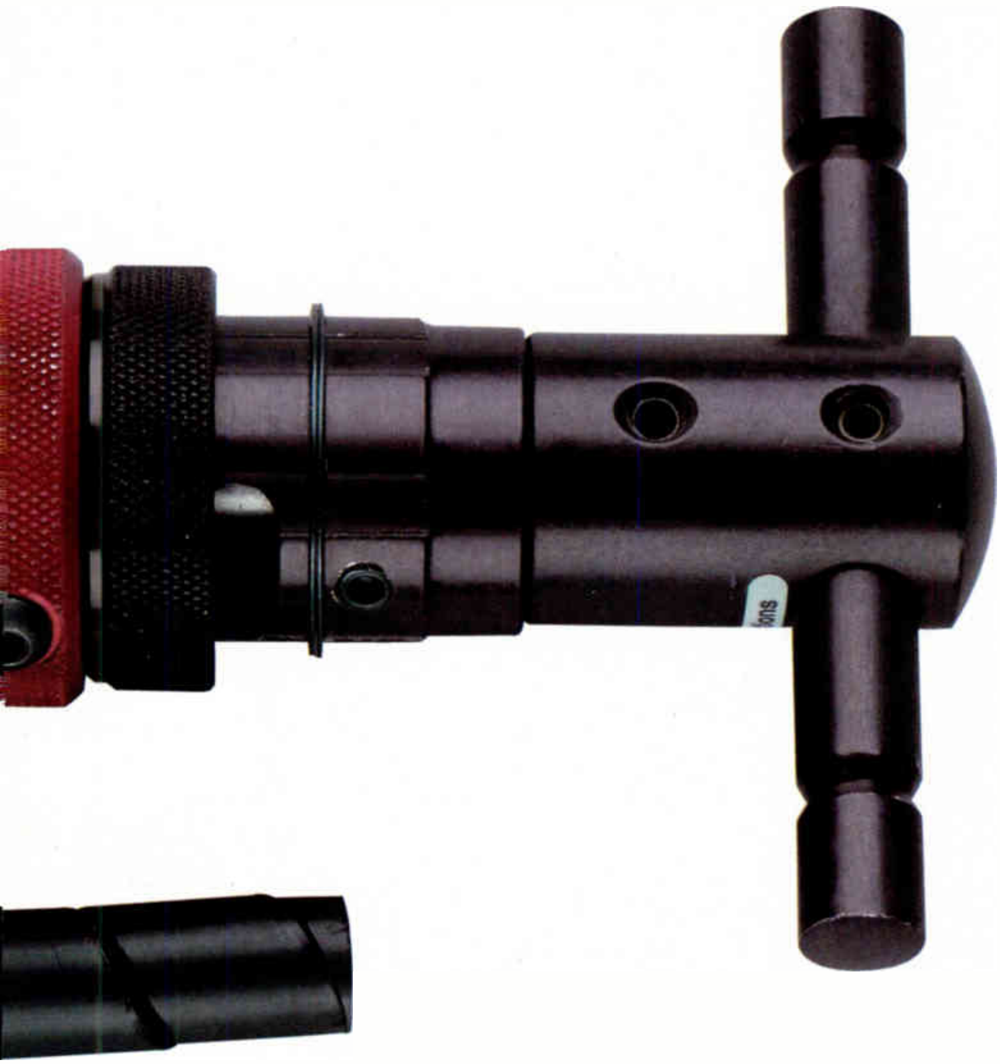
CONNECTING WORLDS
TRANSMITTING IDEAS

Connectorizing Your Coax


A one-step coring tool

Techniques and Troubleshooting Strategies

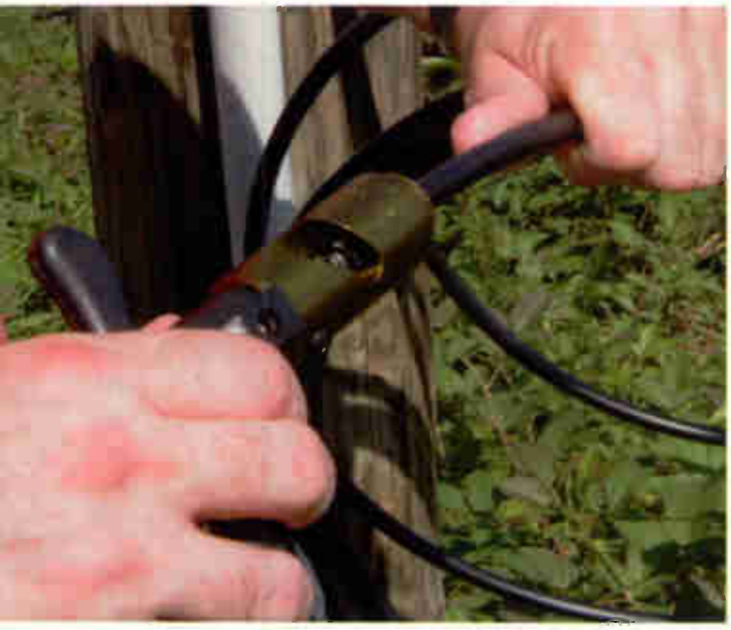
By Mark Alrutz and Jim Crunk



As the race to upgrade steps up, attention to craftsmanship is imperative. We explain the best way to prepare and connectorize coax, and how you can head off potential problems down the road.

Upgrade. This one simple word has completely transformed our industry in the last few years. Networks are being redrawn, redesigned and rebuilt at an unprecedented pace to facilitate the many new revenue streams available, from digital video to high-speed data to telephony. In order to make this happen, new testing techniques and technologies have to be learned, all with fewer staff and less time than ever before. This second article in a series of three addresses a foundational issue—also known as coaxial connectorization, or splicing—that is more critical in today's broadband systems than ever before.

Craftsmanship in coaxial construction has always been an area of concern, but one overlooked easily in the rush of progress. We haven't heard of a system yet that feels it has received enough training. Fortunately, coax has proven to be



BOTTOMLINE

> **Getting Connected**

Systems operating at higher frequencies are more sensitive than ever to craft issues, splicing in particular. A loose or improperly prepared connector interface which was unnoticeable at 450 MHz can cause a terrible response problem at 860 MHz. The foundational steps that can be taken to prevent these problems in your plant include:

- Using proper tools and procedures. This requires time and attention to detail.
- Following proper connector installation procedures.
- Utilizing new available cable technologies, tools and connectors.

Troubleshooting and repairing frequency response problems require systematic searching for the root cause, followed by simple application of standard craft procedures. While frequency sensitive issues can be difficult to trace, they aren't ghosts and don't require any new "techniques" to address. Proper craftsmanship, consistently applied, will eliminate frequency response issues well into the future.

a somewhat forgiving product, at least at lower frequencies. A loose fitting here or there is a minor offense, and doesn't matter much at 450 MHz. The advent of stricter signal leakage requirements in 1990 brought a lot of issues to the forefront, but not all.

Today, with systems upgrading to 750 MHz and beyond, craft issues that were once hidden, specifically splicing, require particular care and attention. A loose fitting or improperly prepared center conductor may induce frequency-dependent loss into your system, and be difficult to isolate and repair. We address this issue with a discussion of how to properly prepare and connectorize coax, then how to troubleshoot a frequency-response issue. Finally, we describe some new advances that should help lessen craft-sensitivity.

Preparation and splicing

Proper splicing begins with proper preparation and a simple review of critical elements. Before splicing, make sure you have the correct tools. This includes a review of tool sizes used, which may seem obvious, but could easily be overlooked with many different cable types and sizes in each upgrade. Make sure the tools are clean enough, and check that they aren't damaged or misaligned. These tools include a coring tool, a file, a center conductor cleaning tool, wrenches sized for the connectors and cable cutters. A high-torque, low-speed drill or a ratchet are optional, but will speed up the process. Wearing safety glasses and gloves is recommended. >

Top: An installer uses an F-connector crimping tool to fasten an F-style connector securely.
Center: Coaxial cable-cutters are used to cut the cable to length.
Bottom: A coring tool removes dielectric material, shielding and the jacket, enabling preparation of the center conductor.

Non-metallic center conductor cleaning tools

You will notice knives and slip-lock pliers are not mentioned, simply because they should not be used. Knives may damage cable components, leading to premature mechanical failure and high-frequency suckouts. Slip-lock pliers may damage the connector and slip, which may lead to damaged shrink boot or other problems.

Once the correct tools are ready, prepare the cable by trimming it with the cable-cutters to a smooth, round end. Straighten the cable slightly to ensure a better core. For traditional cables, use a jacket-removal tool or one-step tool to remove the jacket, and remove the flooding compound as necessary. Low-loss cables often utilize one-step tools that do not require jacket removal first.

Remove the proper amount of shield and dielectric with the coring tool. Slide the cable into the tool until it stops. With slight forward pressure, twist the coring tool—either by hand or mechanically with the ratchet or drill—so that the blade begins to strip and core the cable. Continue to turn the coring tool until it spins freely—many tools have a preset stop that requires no adjustment. Clean the dielectric and shield residue from the tool to help ensure the next cable you prepare will be correctly cored as well. The key to proper coring is to let the tool do the work, and do not perform secondary operations unnecessarily. This may be particularly tempting with bonded cables, which may leave a residue on the inside of the shield. If the tool leaves a residue, it is by design, and should not be manually removed.

Clean the center conductor by using a non-metallic cleaning tool. Score the coating on the center conductor at the shield and scrape it toward the end of the conductor. The conductor is clean if the copper is bright and shiny. Do not

Top: A coring tool as it is used. Note the excess material being removed.
Center: A prep tool removes bonded dielectric material from the center conductor.
Bottom: Rotating the jacket prep tool until it spins freely ensures a good connection between connector and shield.

Left: A pin-type connector is installed in three parts. ***Right:*** The third part of the connector (the pin section) will connect the cable to a distribution node.

use a knife or other metal tool because it may damage the copper cladding. Any residue left on the cable may cause frequency response issues.

Generally, entry connectors come in a two-piece or three-piece design. It comes down to personal preference as to which one you use. First, slide the shrink tubing over the cable end. With two-piece entry connectors, install the entry connector into the housing using 15 foot-pounds of torque.

Remove the clamp nut from the connector and slide it over the cable until it bottoms inside the ferrule. Insert the cable over the mandrel until it bottoms. Using a back-up wrench, tighten nut firmly to the positive stop or whatever foot-pounds of torque the manufacturer recommends.

Tighten the seizing device inside the housing for the entry connector terminal and install heat shrink if applicable.

Note: if you are using a heat-shrink boot, apply the flame carefully. Overuse of the torch may melt the cable's jacket and dielectric.

For three-piece connectors, start by installing the entry connector into the housing using 15 foot-pounds of torque. Remove the clamp nut from the center housing and slide it over the prepared cable end. Install the heat shrink if applicable.

FIGURE 1 TWO-PIECE INSTALL

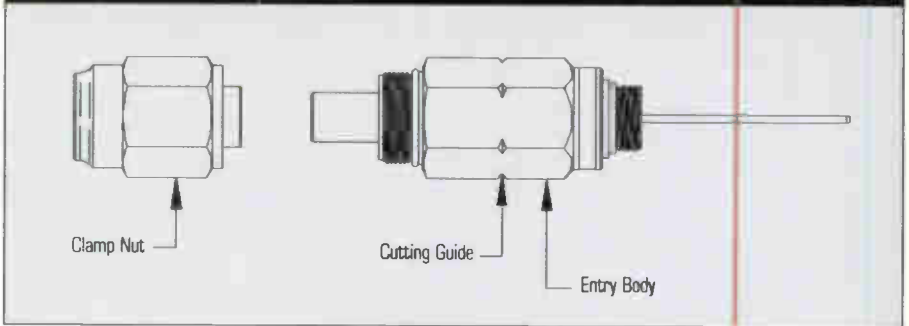
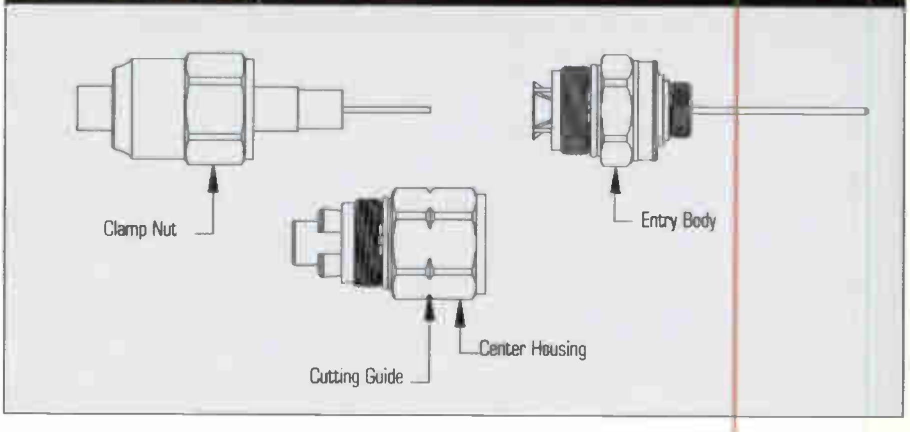


FIGURE 2 THREE-PIECE INSTALL



Remove the center housing and insert it into the prepared cable end until bottomed. Insert the cable center conductor into the entry body until it bottoms while tightening the center housing firmly against the positive stop on the entry body or use the proper foot-pounds of torque the manufacturer recommends. Use a back-up wrench on the entry body.

Slide the clamp nut up to the center housing and tighten firmly against the positive stop. Use a back-up wrench on the center housing. Tighten the seizing device inside the housing for the entry connector terminal. Now it's time to install the heat shrink if applicable. And again, be careful with the flame around the cable. >


Official League

Troubleshooting frequency-response issues

Proper craftsmanship will eliminate frequency response concerns. Unfortunately, older plant, particularly those built by a variety of contractors, may hold some hidden surprises. We have found that trouble spots may be isolated by careful sweep techniques. Often a frequency suckout, or "notch," can be traced to a single connector or splice location by systematically moving from the end of the line to the amplifier, one tap at a time. This procedure is required because a troublesome splice may project its frequency response problem all the way through a tap run.

In the majority of systems with response issues, loose connectors somewhere in the system most often were found to be the cause of a frequency "notch." In other cases, improperly cleaned center conductors or connectors assembled from mismatched components were to blame. In all cases, a properly prepared splice, using recommended procedures, corrected the issue.

Splicing advancements

Splicing tools have improved as system demands have increased. New tools often perform coring and jacket-removal in one step. New connector designs for premium cables, which reduce craft sensitivity in the critical higher-frequency bands, also are available. Careful cleaning and tool maintenance are still required for proper tool use. Proper care and craftsmanship, combined with these new products, will ensure solid high-frequency performance for the future. CT

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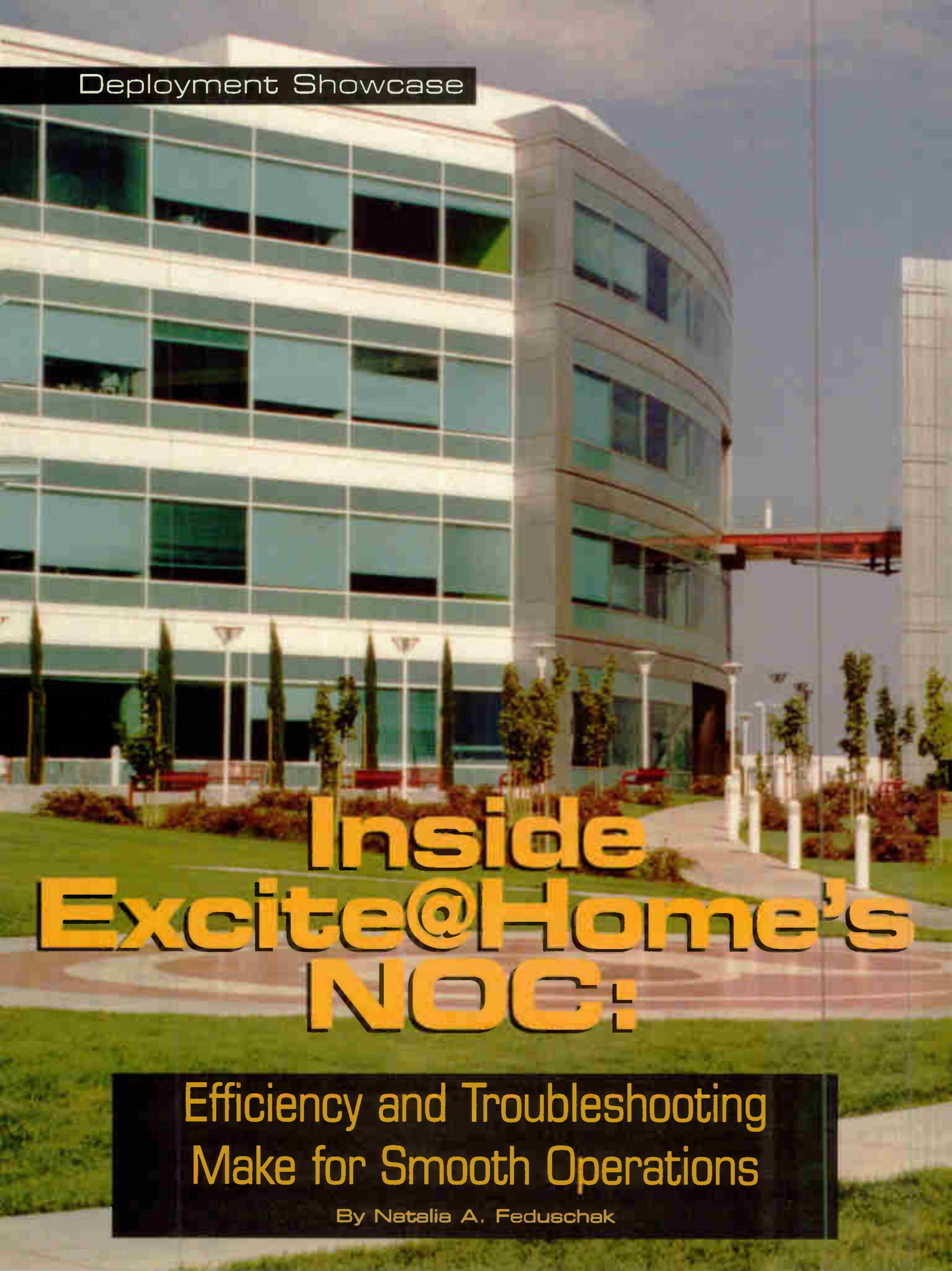

Inside Excite@Home's NOC:

Efficiency and Troubleshooting Make for Smooth Operations

By Natalia A. Feduschak

The network operations center (NOC) is the lifeline of any Internet service provider (ISP) or multiple system operator (MSO), monitoring the overall health of the network. *CT* goes inside **Excite@Home's** residential and commercial NOCs to see how networks operate and how daily problems are resolved.

In the middle of last summer, business came to an abrupt halt for the 7,000 or so customers dependent on the NOC that serves Excite@Home's corporate clients. Early on the day in mid-July, a train wreck in Canada had cut through 120 strands of fiber, disabling communication between their network systems and the Redwood City, Calif.-based NOC.

"If there's a physical outage...there's nothing that a tech over the phone can do," Gary Catalano, manager of network operations for @Work, the service for Excite@Home's business customers, says. "Everything else doesn't work if the physical (layer) doesn't work."

By the middle of the day, repairmen had painstakingly fixed each strand of fiber, allowing business to resume as usual.

While extreme, the fiber cut is just one of the many issues network operations engineers must tackle on a daily basis at the two NOCs that serve Excite@Home's more than 2 million residential and commercial customers in North America.

"We're like a firehouse," Catalano says. "For a long time, you stand around and polish the engine and make sure your hoses are laid out correctly. But there's always going to be fire, just like there are always going to be (network) problems."

The heart of a system

Because it is responsible for the day-to-day care and feeding of a network, the NOC is the nerve center of any ISP or MSO. Excite@Home, the nation's largest cable ISP, has two NOCs in North America—the @Home NOC, which serves the company's nearly two million residential customers, and the @Work NOC, established in May to cater to the company's 7,000 business customers. Several smaller NOCs in Japan, Austria and the Netherlands serve the company's international customer base.

Excite@Home aims for end-to-end management. Because its system is centrally managed, the company can identify and address network quality as well as service and performance issues before they affect consumers.

Several components make up Excite@Home's network infrastructure—a fiber-optic Internet protocol (IP) backbone, a system of regional data centers and local caching servers and modems—all of which are coordinated through the company's NOC.

The NOC uses proprietary network management tools and systems to monitor the network around the clock, identifying and resolving issues before they affect the network. The NOC also facilitates the end-to-end management of performance from the content provider to the home computer. A sophisticated system configuration allows the NOC to provide overall system security and reliability.

How NOCs work

Excite@Home's main NOC has been housed in one of the buildings that make up the company's sprawling headquarters in Redwood City, about 40 miles south of San Francisco, since 1997. Because their customer base is smaller, @Work's network operations engineers monitor their network on computer screens in a small work area just a few steps away from the main @Home NOC located in the same building.

The goal of both is to have a network reliability of 99.95 percent, George Hoffman, @Home's network operations manager, says.

The primary tool used for monitoring both networks is a popular program called Net Expert, which monitors simple network management protocol (SNMP) traps. Network operations engineers watch for interface changes that go up or down, errors that might appear in the router, problems with temperature and other environmental issues, powering problems, and routing issues where open shortest path first (OSPF) or border gateway protocol (BGP) errors might appear.

In addition, the NOCs use an Internet control message protocol (ICMP) tool called Rover, a configurable tool that uses custom-built host files. Rover performs a continuous two-minute review cycle of system devices by going through and 'pinging' all of the devices, as well as those in the host file.

"If a device fails twice in up to five minutes..., (Rover) throws an alert to the screen so engineers are able to see it," @Work's Catalano says. Rover, however, will only show if an interface with an IP address moves up or down, but it won't show if a router, for instance, is getting close to shutting itself down because it is too hot, Catalano says. Net Expert, on the other hand, provides a more detailed description of what a problem might be.

"Anything that is a binary yes or no is what we use the Net Expert for," says Catalano.

Whenever possible, the @Home and @Work NOCs try to share tools because of the lengthy development time that goes into creating them. Rarely, however, do engineers from both NOCs review the same information since their responsibilities are clearly defined.

The main NOC is responsible for monitoring the backbone devices, cable aggregation routers and actual cable modem termination systems (CMTSs). The @Work NOC monitors a few parts of the backbone that it hangs from, the @Work aggregation routers, as well as the routing and connectivity between those devices and their customers' routers.

Inside the war room

The @Home NOC has an almost Space Age feel to it. It is located in a large room that has the look of a war room, with lights dimmed and information from several computer terminals projected onto a large white wall. The chamber is cool, a necessity because the servers are housed in a room next door, Hoffman says.

The projected computer screens, which display a plethora of information, make it easy for engineers to monitor the network.

On the wall's far left are two Net Expert windows. One window shows cable devices, the other, core backbone devices.

"What happens is as an event occurs, it appears on the screen in red and is unassigned, meaning that whoever happens to be working the alerts goes through, clears them out and verifies that the alert comes back," Catalano says. "If it comes back, that means there's a problem—it is actually happening and isn't a fluke...Basically we want to determine the veracity of the information that we're seeing."

A possible problem is reviewed by network operations engineers who go through some 50 home-grown scripts that Excite@Home uses for different troubleshooting and accessing purposes. The network operations engineer uses a script to access the device using **Cisco Systems**' standard Internetwork Operating System (IOS) commands. The engineer verifies whether there had been an interface problem, determines its status, and might review logs to ascertain past problems.

Essentially, engineers want to check that everything is all right on the router, Catalano says. If an alert doesn't appear again, engineers move on to the next problem. If it does, they troubleshoot the problem more thoroughly and might contact the vendor or send someone out to power-cycle the device.

To the right of the Net Expert screens are several smaller windows that show log files from in-house scripts that are running.

One of windows shows the modem-provisioning script. Here, engineers are able to see when a CMTS is provisioned. If the provisioning is broken, the screen helps engineers predict when the NOC will have an influx of calls from either field technicians or other NOCs.

Further to the right are three screens that monitor the ICMP and individual pieces within the network—cable routers, backbone routers, proxy servers and other devices.

The NOC usually has the **Weather Channel** turned on so engineers can see if the weather or other environmental problems might cause the NOC trouble.

One hidden element of the NOC is its backup power system, which provides electricity to ensure the NOC continues to work in case of a power outage, Hoffman says. Excite@Home relies on a diesel generator, with enough fuel to last 24 hours. The backup system is checked and tested once a month.

Cooperative relationships

The majority of the work—99.9 percent—is done on Sun Microsystems' work stations. The @Home NOC uses the Sun Ultra II work station. The @Work NOC uses the Sun Ultra 5. Both are run-of-the-mill work stations, Catalano says.

Problems that network operations engineers encounter on a daily basis run from the mundane to the extreme. An example of a mundane problem is

when customers in a given geographic area experience a throughput problem caused by bad cable lines that slows down their service. A more severe problem is when two of eight Inverse Multiplexer (IMUX) circuits go down. A disaster is the complete failure of a router or a CMTS.

Tickets for problems are updated every half-hour, Hoffman says. A remedy system provides all the necessary information regarding each problem—how many customers are down, the type of outage, where the outage is located and what is being done to fix it.

In case of network problems, there is extensive cooperation between Excite@Home's NOC and its various vendors, which include **AT&T**, **Cox Communications**, **Comcast** and 19 other smaller cable companies. Excite@Home also maintains outage notification lists that keep MSOs updated on the problem, Hoffman says.

Cooperation in times of crisis is needed, Dave Johnson, manager of AT&T's new global operations center, says.

"Generally the NOCs would be in communication with each other," he says. "Everybody is pulling together to resolve problems."

Typically, both the MSO and Excite@Home NOCs know within 30 to 60 seconds that a problem has occurred on a network, thus helping both parties to resolve problems as quickly as possible.

On average, Excite@Home tries to have its mean-time-to-repair (MTTR) within four hours, says Hoffman. The NOC averages between 10 and 15 open issues a day, and has hit all its MTTRs.

Normally eight or nine engineers work an eight-hour shift, with five people filling in on quieter days. The NOC employs around 45 people. That includes a so-called network acceptance team that deals with new headends and cities coming on-line to the network. Because of the company's growth, Excite@Home would like to increase the number of NOC employees to 100 by year's end, says Hoffman.

Good people are hard to find

Excite@Home looks for people who have wide area network (WAN) experience for jobs inside the NOC. Cisco Certified Network Associate (CCNA) certification is always a plus.

Hoffman admits Excite@Home has problems finding qualified employees because of a widespread labor shortage endemic to Silicon Valley. That shortage is so bad that some companies are offering CCNA courses to high school students and the homeless, he says.

Hoffman says Excite@Home has hired people straight out of high school, whose knowledge is self-taught because many have built their own networks at home.

Such individuals will always be looking for new technology and new troubleshooting methods to help them deal with the types of problems that occur daily in the NOC, says Hoffman.

"We want people to learn new technologies and to train other people," he says. CT

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Did this article help you? Let us know your thoughts. Please send an e-mail to snayalkar@phillips.com.

BOTTOMLINE

> **Keeping Tabs**

Excite@Home monitors the health of its @Home and @Work NOCs, which provide services to residential and commercial customers, respectively, by using a complex system of checks and balances. The network operation centers (NOCs) use proprietary network management tools and systems to provide 24/7 monitoring, end-to-end performance management and a sophisticated system configuration that allows the NOC to provide overall system security and reliability.

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Wireless Home

Say Goodbye to

Networking

:he Wired Home

By Arthur Cole

Wiring a home for cable and interactive services may eventually be a thing of the past, as wireless home networking could soon affect your role in installation and technical support.

In the very near future, cable installers and technicians will face a radically new environment the moment they arrive at a service call. Already, there is a lot of buzz about networked homes, in which devices are wired to a central gateway that acts as a switching and control unit. Well, get ready for wireless home networking.

The first wireless home networking products have already hit the market and analysts are predicting up to 5 million units could ship by 2002. For the cable operator, the devices may forever remove the need to pre-wire a home, or office for that matter, to deliver television and interactive services.

The best part? Far from complicating matters for the technician by forcing him to learn new software or the basics of microwave technology, wireless will make the job easier. There no longer will be a need to run cable or conduits through walls or under floorboards. In fact, experts say most new installations simply will require wiring the cable to the outside box and letting an internal wireless device finish the connection to the set-tops or cable modems inside.

"This will be of tremendous value to the installer," Kevin Duffy, director of business development and product management at **Siemens**, says. "You put the wireless access point immediately on the other side of the wall as the (outside) cable box, and you can service the whole house. No more snaking wires around."

System standards

Systems manufacturers are lining up behind three standards likely to govern the wireless networking market, although they are most likely going to complement rather than compete with each other.

The first is 802.11, a commercial-grade networking solution aimed at giving business-users wireless Ethernet capability throughout the office. This is a rather expensive solution and is not likely to show up in the home. It also causes interference to the two home solutions, **BlueTooth** and **HomeRF**. These two will become the main standards for the home, both of which operate in the 2.4 GHz range. BlueTooth, named after a legendary Viking explorer, is backed by a consortium including **Ericsson**, **3Com**, **IBM**, **Intel**, **Lucent**, **Motorola** and **Microsoft**.

BlueTooth offers 784 kbps throughput, although in a very limited range: several centimeters to perhaps 10 meters. Initial applications are likely to affect computer peripherals, such as printers, mice and monitors—anything that requires a short connection to the CPU. Say goodbye to that jumble of wires behind your desk. Wireless earpieces for radios and cellular phones also will be some of the first BlueTooth products to hit the market.

With BlueTooth, there is no central base station. Each device can control or communicate with any devices within range. For example, consumers could access their cable modem through the set-top box, and vice versa.

"BlueTooth is a microprocessor-controlled radio transceiver. Any end may initiate or control other elements of the network," Skip Bryan, director of technology market development for Ericsson's cellular products group, says.

For example, a set-top would send out a signal to inquire what other BlueTooth devices are within range. On the TV screen, the consumer would click the icon representing the cable modem, using it to surf the Internet.

Of course, this will work only if the two devices are relatively close to each other. A typical home is likely to link the cable modem to the CPU(s) via BlueTooth, but the more distant connections are likely to be via HomeRF. HomeRF is principally backed by Siemens, **Compaq** and **Intel**, although numerous companies are developing equipment that conforms to the standard. With an effective range of 50 meters or more, it is better suited in providing whole-house wireless connectivity than BlueTooth.

To the consumer, HomeRF offers tremendous benefits. No longer is cable-modem service tied to a wall outlet. That means laptops and other mobile devices can maintain broadband connections anywhere in the home. It also avoids the costly requirement to wire the entire home for broadband services.

Network installation

How will wireless home networking change things as far as installations and service calls go? The first good news is that there will be no new software to learn, and technicians won't have to take a course in microwave technology. In fact, once cable is connected to the outside of the home, the wireless network pretty much sets itself up in plug-and-play fashion.

"If there are multiple computers to be served inside the home, then wireless greatly simplifies matters," Peter Buechler, product line manager for home networking at Motorola, says. "Right now, for an MSO to support that, (the technician) needs to install a multiport Ethernet hub, and that's a fair amount of cable hauling."

In short, the inside of the home becomes the customer's responsibility. All they will need to do is ensure there are HomeRF adapters on the devices to be networked.

"We recommend a USB adapter so there's no need to open the case," Buechler says. "The steps to install a wireless adapter are analogous to installing an Ethernet adapter. Just follow the install wizard." >

BOTTOMLINE

> No Strings Attached

Wireless home networking allows set-tops, cable modems, computers, telephones and just about any other digital device to be networked without running coax throughout the home. The benefit is obvious: no more lengthy installations. Just tap the cable into the outdoor box and let the wireless adapter finish the job. And since most devices will be self-installed by the customer, there soon may be no reason to enter the home at all.

There are three wireless-networking formats, although only two are suitable for the home. BlueTooth and HomeRF are likely to be complementary in nature, not competitive. The major difference between the two is the effective range of transmission. BlueTooth is designed for short hops of 10 meters or less and is chiefly aimed at connecting printers and other peripherals to a central processing unit (CPU), thus eliminating that jumble of wires behind the desk.

HomeRF is aimed at whole-house networking. It has a range of 50 meters or more, so it can easily connect the set-top box in the living room to the modem in the downstairs den.

Expect the technology to be fairly ubiquitous by the middle of next year. Some devices are already on the market, but the big push will likely come in 2001.

External adapters are likely to be a short-lived phenomenon, however. Already, manufacturers are coming out with built-in wireless units. At the **Intel** Developer Forum Conference in August, Motorola demonstrated the AL 200 multi-user cable modem featuring a built-in HomeRF adapter. The device can service up to 10 computers, all of which may share Internet access simultaneously.

"The first wireless home networking products have already hit the market and analysts are predicting up to 5 million units could ship by 2002."

Backers of wireless home technology say it will be more than easy installation that drives the market. There's also the mobility factor to consider. Broadband access will no longer be tied to the desktop connected to the cable modem. Web surfers will be able to move from room to room while maintaining a steady, secure connection.

What's more, the technology allows wireless Internet protocol (IP) telephones and personal digital assistants to operate off the same network.

For the cable industry, wireless home networking will speed up the roll-out of broadband service. With most wireless devices self-installed by the customer and no need for technicians to even enter the home, connecting new users will become easier and faster than ever. CT

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Digital Signal Carriers: There's NO

Turning Back

By John J. Downey

Digital data service has become a reality. But before investing a substantial amount of time, money and resources in launching this new service, learn how to avoid common pitfalls. In the first of a three-part series, we explain how to properly measure and test digital data and network frequency response.

The engineer designing the digital data system and the technician tasked with maintaining it face a multitude of concerns when attempting to add digital data services. Some of these concerns include:

1. Understanding the difference between bursty and non-bursty data.
2. How to make accurate digital measurements.
3. Making bursty data measurements.
4. How to test the network frequency response with reasonable resolution and speed, without interference.
5. What effect this new service will have on the existing analogue channels.
6. How anomalies affect this new service differently than the analogue service.
7. Suggestions on where to place the "haystacks."
8. Understanding the different modulation schemes and multiplexing techniques.
9. How the 8-VSB (vestigial sideband) modulation associated with the **Advanced Television**

FIGURE 1 Forward Digital Modem Signal

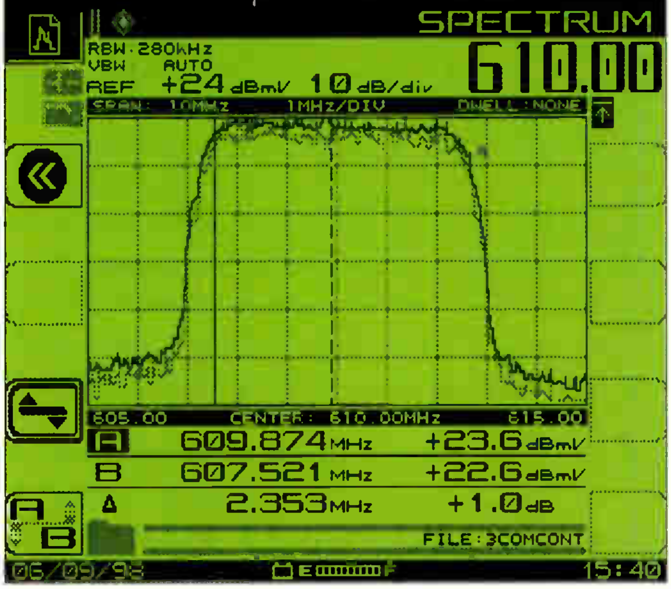


FIGURE 2 Return Path TDMA Modem Signal

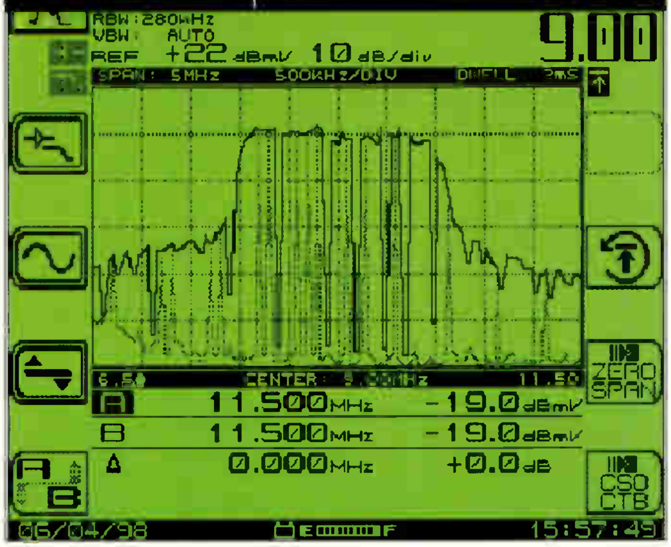
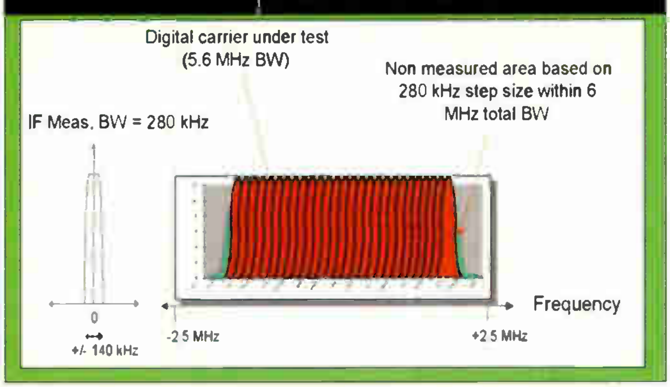


FIGURE 3 How to Make Accurate Measurements



Systems Committee's (ATSC's) off-air digital broadcast standard will affect the cable TV carriage at 64 quadrature amplitude modulation (QAM) and 256 QAM.

10. Transferring pure digital data from one device to another without converting to analog.
11. Providing security and copyright protection of this near-perfect digital programming.

For now, we discuss the first four concerns.

Understanding bursty and non-bursty data

Downstream, or forward path, digital data, is in the form of a "haystack" as shown in Figure 1. Older digital services like Sega and DMX were only about 1 MHz-wide to 3 MHz-wide and resembled a haystack because of their rounded appearance. Most of today's digital signals are generally flat across the channel bandwidth.

This digital traffic is always on and will be time division multiplexed. The Data Over Cable Service Interface Specification (DOCSIS) specifies modem traffic to be compatible with Moving Pictures Experts Group (MPEG-2), which indicates 188 byte packets. This allows it to be multiplexed with other MPEG-2 digital streams and sends filler packets when needed. When viewing a haystack, you really can't determine if there are 10 programs, two high definition TV (HDTV) programs or anything at all inside it.

Upstream data signals from the subscribers' equipment are bursty as in Figure 2. This reverse data is time division multiple access (TDMA), or "time-shared" and intermittent. Older proprietary modems were bursty on the forward and reverse, unlike today's DOCSIS modems. Measurements are easier to make on a continuous data carrier than on upstream, bursty signals.

Note: the reason the reverse modem traffic appears to be bursting at different frequencies is usually attributed to the difference in the analyzer sweep speed, its resolution bandwidth (RBW) setting and the nature of the modem burst.

Making accurate measurements

Measurements should be made with the proper test equipment, such as a thermocouple power meter or test equipment made for an average power measurement. This is critical for set-up to prohibit laser clipping or extreme intermodulation noise. One approach to average power measurements takes small slices of the integrated RF energy, summing them together to one total power reading as displayed in Figure 3.

This method of measuring the total integrated power under the "haystack" is very accurate, especially for "haystacks" that aren't perfectly square. Using an instrument that uses one slice of the "haystack," or peak hold in spectrum mode, may be less accurate. Digital signal level measurements should be made with this integrated power technique for QAM or quadrature phase shift keying (QPSK) digital signals. Technically, it doesn't matter what the modulation scheme is as long as it is always on. The signal could be 8-VSB, code division multiple access

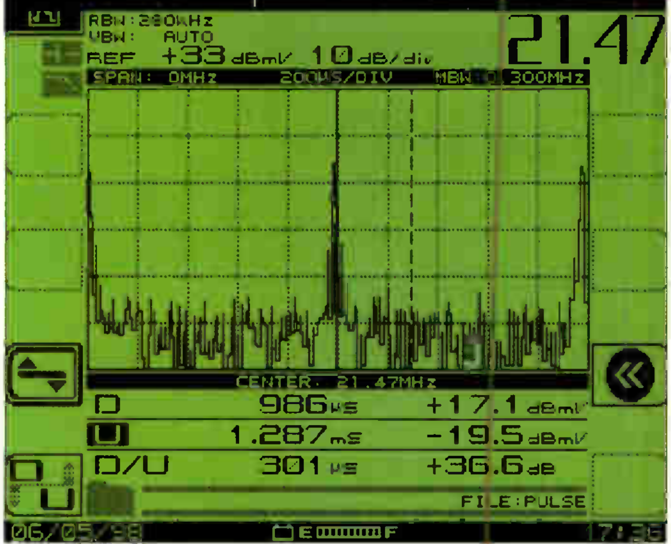
(CDMA), orthogonal frequency division multiplexing(OFDM) or 16 QAM. It wouldn't matter.

Sometimes a quick mode, which measures signals based on bandwidth estimation technique, is warranted for quick verification or for very narrow carriers. User-selectable bandwidth is needed for accurate power measurements when doing these tests.

Digital levels relative to analog

Digital carriers are more robust than analog, but complex digital modulation schemes sacrifice robustness for throughput. You can never get something for nothing. We are compressing and making the modulation schemes very complex to carry more information. This has the detrimental effect of making the carrier less robust than we previously thought. Complex modulated carriers also have a high peak-to-average ratio that could contribute to laser clipping if not considered. Typically, digital signals are set between 6 dB to 10 dB below analog carriers (assuming 6 MHz) to manage overall power loading. Excess signal powering causes laser clipping and increased distortions. Laser transmitters have a maximum total power specification above which clipping will occur. Additional digital channels that are run 6 dB to 10 dB lower than analog will have little impact on the total power loading on the laser. Amplifier hybrids create distortions and the amount of distortions are affected by the total power loading as well. Analog carriers are measured using a peak method and digital carriers use an average method. Don't use a spectrum analyzer to manually set these levels unless you understand resolution and video bandwidth settings and how they affect your readings. If your test equipment has built

FIGURE 4 Reverse Ingress Zero-Span-Mode



in digital channel power measurement capability, use that instead.

Analysing cable-modem signals

Tune to the modem's reverse operating frequency, then switch the analyzer to a zero-span mode to see the modem's upstream signal in the time domain. A time domain view is used for bursty data and to view one frequency over time, as seen in Figure 4, on page 140, and Figure 5 on page 142. With this mode, it is easy to see noise and signal simultaneously to measure desired-to-undesired (D/U) ratios, trigger on infrequent events and see high-traffic periods. All of these measurements are in-service. We could even use this mode to measure the carrier's average power, based off a calibrated calculation related to the appropriated bandwidth.

Preventive maintenance

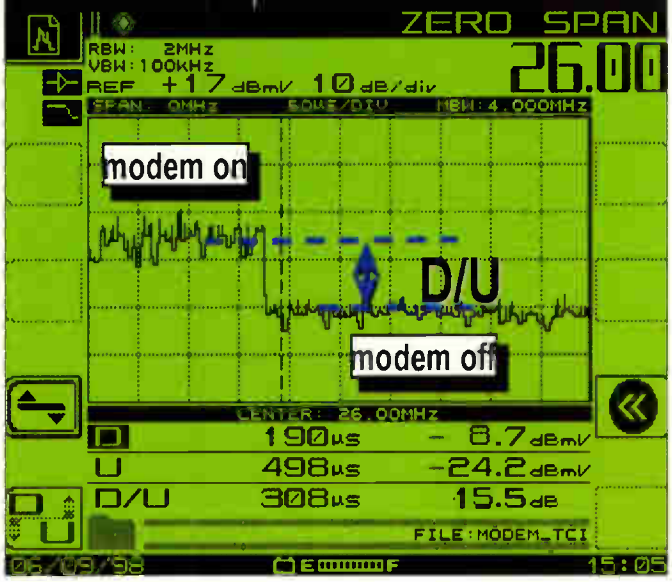
More services are being added daily. It is apparent that our preventive maintenance must also adapt to these changes. Frequency response equipment must be edited to give a true representation of system integrity and limit the amount of interference to the services being offered. It must also be fast. To achieve these criteria, we can construct special sweep plans to keep the preventative maintenance (PM) proactive instead of reactive.

If the sweep update is too slow, it could be caused by the slow dwell time of scrambled and digital channels. Place sweep points in the guardband instead of using actual channels as sweep reference points. A big problem with this could be interference created or loss of bits, depending on placement and level-of-sweep points. Remember, not all televisions and receivers are alike. Just because you experimented with the placement and level of the sweep points while observing a TV in the headend and it looked good, doesn't mean that it will work everywhere.

Approximately 1.1 MHz below the visual carrier frequency seems to be the sweet spot to insert a sweep point for analog channels and in between the haystacks for digital. A more complex modulation scheme is 256 QAM, which requires a higher carrier-to-noise (C/N) than 64 QAM. It also does not have as much guardband, possibly 0.3 MHz vs 0.5 MHz for 64 QAM. Sweep points can be run lower in level, but that may cause a bad sweep response. Another option is to use new algorithms to dwell non-intrusively on the carrier.

When sweeping reverse with digital

FIGURE 5 Reverse Ingress Zero-Span-Mode



signals present, it is imperative not to insert sweep points where these services reside. Even though the sweep is inserting one pulse at a time and the reverse service is bursty, the probability of overlapping is still high enough to cause either data retransmissions or data loss. More services on the return path usually translate to more revenue and more headaches. This also limits the placement of sweep points for return path characterization. The biggest DOCSIS carrier currently is 3.2 MHz-wide. So, we may still have a reasonable resolution by placing sweep pulses between the carriers. Interference is minimized because the reverse signals are bursty and have a 20 percent guardband, and because the sweep points are narrow and bursty.

Less intrusion is better

Home wiring integrity is much more important with digital carriers and the higher bandwidths that are utilized. Conventional analog tests need to be done to ensure the integrity of the system for these new services. We must learn to be as non-intrusive as possible in all our testing and troubleshooting. This includes C/N, hum, depth of modulation, level measurements and digital MER and BER. Any test that I can do without taking the service down or having to perform after hours keeps everyone happy. CT

John J. Downey is broadband training manager for Acterna (formerly Wavetek Wandel Goltermann). He may be reached at john.downey@acterna.com.

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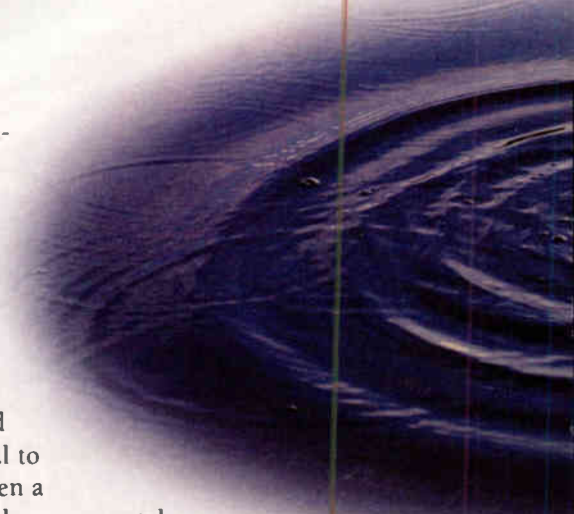
Return

An Old Problem that Still Haunts

By Jim Farmer

At some point in his or her career, every engineer puts the wrong emphasis on return loss. Let's look at what it is and when it is important and when it is not. We'll take a look at the effects in cable systems, both in the RF and optical domains.



What is it?

Return loss is a measure of how closely the impedance of a source matches that of a load. The source might be a signal processor and the load a headend combining network. Or the source might be a receiving antenna and the load the coaxial cable feeding signal to the headend. Return loss is one of several methods of measuring the degree of match between the two. Another, used by ham operators and others who look at power transfer, is voltage standing wave ratio (VSWR). Return loss and VSWR are simply two ways to look at the same thing.

To get an idea of what return loss is about, think of ripples of water in a bucket. If you drop a stone in the middle of a bucket of water, you know that waves will ripple out from the stone, and when they hit the side, they will bounce back again. This is exactly what is going on with return loss: when a signal encounters an impedance discontinuity, a portion of it is reflected back to the source. A coaxial cable (or any other medium) has what is known as a "characteristic impedance" determined by the geometry and the dielectric constant of any insulators involved. This characteristic impedance is the impedance that must be connected to each end to eliminate any reflections. If the source and load impedance are exactly equal to the characteristic impedance, then a wave entering or leaving the cable does not "see" any discontinuity, and it is not reflected. If the source and terminating impedances are not equal to the characteristic impedance, then some power will be reflected. The percentage of the incident power reflected is proportional to the ratio of the source or load resistance to the characteristic impedance.

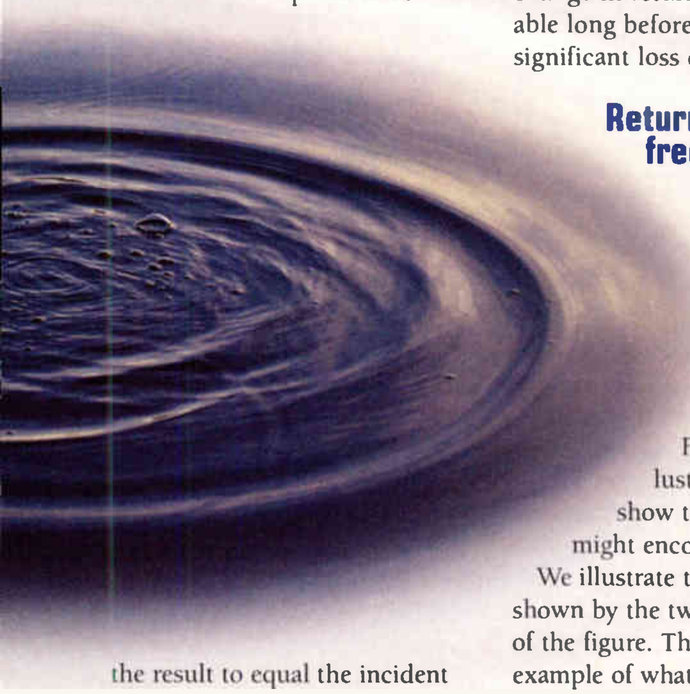
The effect on power transfer

There is some fairly simple math you work in college circuit theory courses that says you must have the source and load impedances conjugately matched in order to maximize power transferred from the source to the load. The term "conjugate match" means that the resistive components of the source and load must be the same. If one has a certain capacitive reactance, the other must have the same reactance, but it must be inductive. To keep it simple, we usually assume that the source and load are pure resistances.

Figure 1 (page 146) plots the return loss against the transmission loss. The figure in the graph shows the model.

LOSS:

It defines return loss (the amount of incident power reflected back to the source, RS) and transmission loss (the amount of incident power delivered to the load, RL). The math is a simple conversion of the reflected and transmitted power, from decibels to fractions of the incident power. Add them up and force



the result to equal the incident power. Finally, solve for the transmission loss as a function of the return loss. This analysis assumes that any power reflected back to the source is absorbed in the source resistance, RS. Often this is a good assumption.

Notice that if you have any kind of a reasonable return loss, you really are not losing much transmitted power. A return loss of only 7 dB means that you are suffering 1 dB loss in transmitted power. If your return loss is 15 dB, you are only losing 0.14 dB of transmitted power. Striving for a good return loss will not get you much in the way of increased power. However, if you monitor the return loss of an antenna for example, you can get an early warning if something is going wrong. A change in return loss will be noticeable long before you experience any significant loss of transferred power.

Return loss affects frequency response

Often of much more importance than the power transfer, is the effect of a mismatch (low return loss) on the frequency response of a broadband system. Figure 2 (page 146) illustrates three cases that show the range of what you might encounter.

We illustrate two different situations shown by the two diagrams at the top of the figure. The left diagram is an example of what we might encounter in a headend, except that we have assumed worse return loss than you should expect in real life. We model connecting two pieces of equipment with a coaxial cable. The two pieces are shown as a combining network and an optical transmitter, but they could be any two pieces. We show two cases for illustration. The first is interconnecting the two with a 6.2 meter cable having a round-trip delay of about 55 ns. The second example is a 3.4 meter cable having about 30 ns of round-trip propagation time.

The signal travels from the combiner to the optical transmitter. If the transmitter does not have a perfect (infinite) return loss, some of the signal is reflected (the first echo) back to the combiner. The output of the combiner has some finite return loss, so some of the first echo is reflected back toward the transmitter as the second echo. The echo magnitude is the sum of the return loss encountered at the two ends of the cable. When the second echo reaches the transmitter, its voltage adds with the incident, or first trip, signal. However, the second echo has traveled the length of the cable two times more than has the incident signal. Thus, the echo is delayed by the round-trip propagation delay of the cable, compared with the incident signal. At some frequencies, the second echo and the incident signals are in phase, so the two voltages add together. At other frequencies the two voltages are out-of-phase and they subtract. And at yet other frequencies, something in between happens. The result is the frequency response shown in the curve labeled 10 dB echo, 55 ns delay.

We show a second case, of a 17 dB echo with a 30 ns delay (the cable is only 3.4 m). Notice that because of the shorter delay, the ripple frequency is lower. Because the assumed echo magnitude is also lower (17 dB as opposed to 10 dB), the amplitude of the ripple is also lower. The curves are not quite symmetrical about the 0 dB relative amplitude axis. The asymmetry is par-

> A Look at Return Loss

Return loss is one of those parameters that gets abused from time to time by every engineer. It is a measure of how much of the incident power is reflected back to where it came from. In some cases, you need really high return loss (little reflected power) and in others you really don't need much at all. We look at return loss from two different views:

- The effect on loss of transferred power; and
- The effect on frequency response where we have a cable between a source and a load, neither of which have perfect return loss.

ticularly noticeable in the 10 dB echo curve, which is correct. If you were to look at a 0 dB net return loss, you would find that the amplitude peaked at 6 dB when the incident and reflected voltages add together. When they subtract, though, the relative amplitude goes to zero or minus infinite decibels. The shape of the curve is scalloped.

The third example is quite interesting. We have made it a bit more realistic. What we are modeling here is shown at the top right of Figure 2. We model a drop from tap to home. The drop is 30.5 meters long, with a propagation delay of 271.5 ns. Since the drop is so long, we have included the effect of cable loss in the computation. We assume that the total return loss of the two ends is 20 dB. This is a reasonable assumption: a television has very low return loss and the tap is typically in the low 20s. We said before that the return loss affecting the frequency response is the sum of the return loss at the two ends, but to compute the effect, you also must add twice the insertion loss of the cable. The reason is that the echo will experience this additional loss on each of its passages through the cable. Since cable exhibits more loss at high frequencies than at low, the frequency response ripple decreases as you go up in frequency.

The effect return loss has is a function of how much signal is reflected at each end of the cable. If either the source or the load had a perfect (infinite) return loss, we really wouldn't care what the other end had. There would be no signal reflection to cause problems with the frequency response.

Jim Farmer is chief technical officer of Wave7 Optics. He may be reached at jofarmer@mindspring.com.

Next month: How return loss creates echos in a digital transmission system, and the effects of return loss in optical systems.

Did this article help you? Let us know your thoughts. Send an e-mail to snayalkar@phillips.com.

FIGURE 1 Relation between Retutn Loss and Transmission Loss

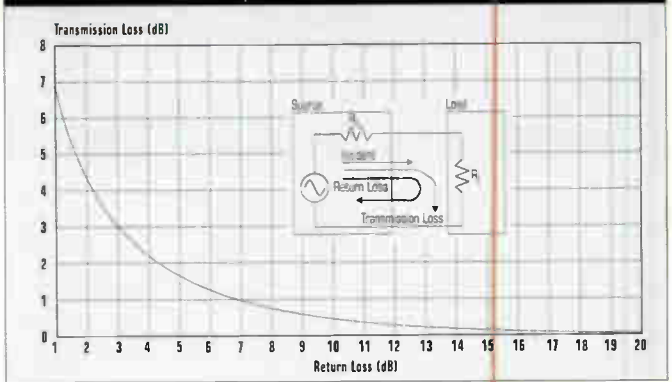
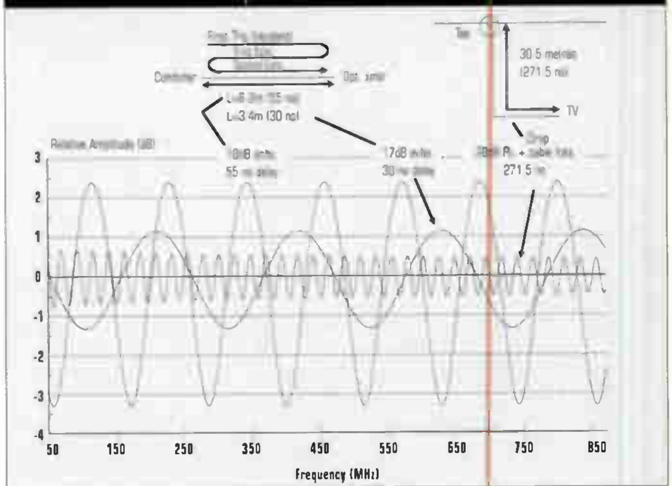


FIGURE 2 The Effect of Return Loss on Frequency Response



FCC & ITU Diverge on INTERNET BACKBONES

By Eric Ladley and Jonathan Tombes

Two weeks after the Federal Communications Commission endorsed a hands-off approach to the Internet backbone, the International Telecommunications Union adopted a recommendation favorable to Internet governance.

In its latest Office of Plans and Policy (OPP) working paper series, titled "The Digital Handshake: Connecting Internet Backbones" and released in late September, the FCC indicated that it would continue to allow market forces to dictate interconnection agreements.

Now that telecommunications companies from different countries are intermixing, the FCC argues it also would be unhealthy to impose regulations on international backbone interactions.

While the study makes no policy and represents the individual view of its author (in this case, Michael Kende, OPP director of Internet policy analysis), it reflects to some extent the commissioners' outlook and sets the tone for future decisions.

Barbara Dooley, president of the **Commercial Internet Exchange**, applauds the FCC study, and says it comes at an opportune time when many foreign companies are clamoring for backbone regulations. The **International Telecommunications Union** (ITU) had been locked in a heated debate over government regulations on backbone interconnection the previous week.

ITU moves, U.S. objects

Two weeks later, the ITU issued its own recommendation. Over strong U.S. objections, the ITU's World Telecom Standardization Assembly in Montreal approved a recommendation on Internet cost-sharing that appears to open the door for Internet governance.

When the original recommendation was drafted in April, critics argued that the language potentially imposed upon the Internet the international settlement rate system now used for voice traffic. Dooley argues for distinguishing the two regimes.

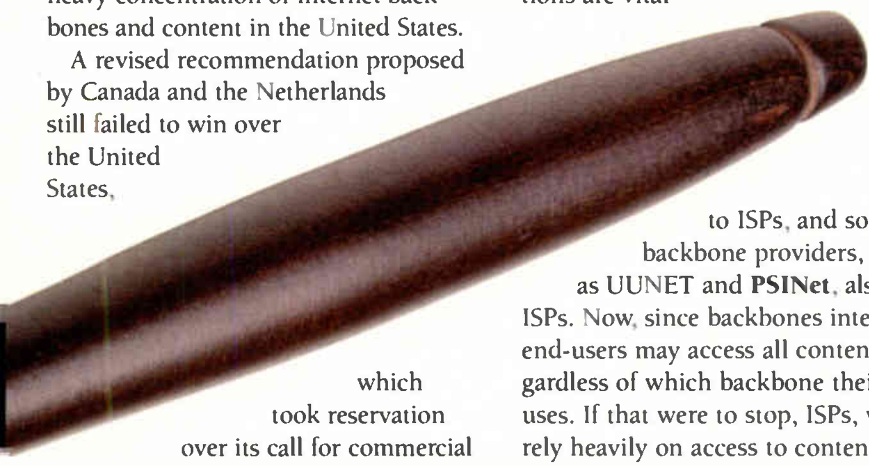
"The history of Internet backbones

is that individual terms and competition have led to diversity," she says. "The principle of the Internet does not fit into the telephony model."

Tricia Paoletta, a vice president at backbone provider **Level 3**, says the FCC release was timed to influence the ITU debate. Third-world countries want regulations, whereas Canada, Europe and the United States are pro-market.

In Montreal, ITU delegates from developing countries raised concerns over an international Internet divide and the heavy concentration of Internet backbones and content in the United States.

A revised recommendation proposed by Canada and the Netherlands still failed to win over the United States,



which took reservation over its call for commercial negotiations between administrations and public network operators to consider various factors, including "traffic flow, number of routes, geographical coverage and cost of international transmission." (See sidebar for complete text.)

By taking reservation, the U.S. delegation signaled that it didn't recognize the recommendation's terms. One point of contention appears to be the ITU's reference to "administrations," which it notes "indicate both a telecommunication administration and recognized operating agency (ROA)."

The United States understands ROAs as public network providers, not Internet service providers (ISPs). Apart from objecting to ambiguous language and the ITU's conditioning of commercial transactions, the United States called the recommendation "premature," saying it failed to advance global Internet access.

Some say U.S. practices could stand some improvement.

Level 3's Paoletta, for instance, welcomes the FCC study, but says the industry could do more to police itself, such as openly posting its peering requirements and developing a peering code of conduct.

"Our position is that government regulation is not a good thing," Paoletta says. "But there is room for better self regulation and transparency."

A backbone, which transports information from one network to another through routers, is provided by only a handful of companies, the top ones being **UUNET**, **Cable & Wireless**, **Sprint**, **AT&T** and **Genuity**.

Backbone interconnections are vital to ISPs, and some backbone providers, such as UUNET and **PSINet**, also are ISPs. Now, since backbones interact, end-users may access all content regardless of which backbone their ISP uses. If that were to stop, ISPs, which rely heavily on access to content and users being able to interact with one another, could be hurt.

The FCC's Kende argues that any regulations imposed on competing backbones would be counterproductive. While backbone providers could cause serious problems if they refused to connect with one another, there are market stimulants that motivate them to work together.

Let's shake

A major reason for cooperation is that backbones are more profitable when more people use them. Some backbones charge other people to interconnect, but the market is likely to maintain a reasonable interconnection price. Backbones want to grow.

"Each backbone provider bases its decisions on whether, how and where to interconnect by weighing the benefits and costs of each interconnection," Kende says, terming the relationship a "digital handshake."

Kende holds out the possibility of future regulation if backbones refuse to interconnect with one another, although he terms the prospect unlikely. An issue that could cause backbones to stop digitally shaking hands is new services, such as quality of service, where one backbone will want to differentiate itself from another. If backbones buy each other up, that could result in one dominant backbone.

There is no dominant backbone now, Kende says, and existing antitrust regulations should prevent one emerging through acquisition.

Kende argues that backbones paying each other for interconnections is not

> The International Telecommunication Union's Cost-Sharing Recommendation

"The **World Telecommunications Standardization Assembly** (Montreal, 2000), recognizing the sovereign right of each State to regulate its telecommunication, as reflected in the Preamble to the Constitution, noting:

a) the rapid growth of Internet and Internet protocol-based international services;

b) that international Internet connections remain subject to commercial agreements between the parties concerned; and

c) that continuing technical and economic developments require ongoing studies in this area,

recommends that administrations* involved in the provision of international Internet connections negotiate and agree to bilateral commercial arrangements enabling direct international Internet connections that take into account the possible need for compensation between them for the value of elements such as traffic flow, number of routes, geographical coverage and cost of international transmission amongst others.

* In this Recommendation, the expression "administration" is used for conciseness to indicate both a telecommunication administration and recognized operating agency."

necessarily a bad thing. When backbones peer to interconnect, they pay for their own equipment and transmission, but traffic is freely exchanged. In a transit agreement, one backbone pays another to interconnect. Transit carries an advantage, though. If one backbone is paying another, the supplier backbone will provide the paying backbone access to all of its peering partners.

A hybrid transit-peering approach often is adapted by the top five backbones. Kende argues that backbones will decide which type of agreement to pursue based on the benefits they'll receive. There are now 42

"Each backbone provider bases its decisions on whether, how and where to interconnect by weighing the benefits and costs of each interconnection."
—Michael Kende, FCC

backbones since the backbone was privatized in 1995. Fiber also is abundantly available, leading to more backbones and more ISPs.

When backbone providers such as UUNET, PSINet and Genuity announced they would not peer with **Exodus**, Kende argues this was not anti-competitive. Nor was Sprint's decision not to peer with Level 3. And, the merger of Sprint-**WorldCom** was blocked by regulatory agencies, he notes, preventing the UUNET-Sprint backbone from uniting.

Eric Ladley (eladley@phillips.com) is editor of sister publication ISP Business News and Jonathan Tombes (jtombes@phillips.com) is CT's deployment editor.

Did this article help you? Send an e-mail to snayalkar@phillips.com.

Installing Cable Modems, Part 3

This month's installment continues a series on cable modem installation. The material is adapted from a lesson in NCTI's new Digital Installer Course. © NCTI

Last month, we covered installing a network interface card (NIC) in the customer's personal computer (PC). Depending on the PC's configuration, you will connect the cable modem either to the PC's NIC, directly to its universal serial bus (USB) port, or via a USB-to-Ethernet adapter. A USB-compatible modem is external and connects directly to a PC's USB port.

Connecting to a network interface card

To connect the cable modem to a PC's NIC, insert the RJ-45 connector of the Category 5 (CAT-5) network cable coming from the modem into the RJ-45 jack of the NIC, as shown in **Figure 1**.

Connecting directly to a USB port

When USB ports are available on the cable modem and PC, connect the cable modem's USB cable directly to the USB port on the PC. **Figure 2** points out the USB port on the back of the PC in relation to the other ports. Utilizing the PC's USB port requires the PC to have Windows 98 or Macintosh operating system (OS) 7.6.1 or higher.

Connecting with a USB-to-Ethernet adapter

When the PC has a USB port but the cable modem does not, an adapter is required. Installing and setting up the USB-to-Ethernet adapter is relatively simple. Plug the adapter's USB connector into the PC's USB port. **(See Figure 3.)** Then plug the CAT-5 network cable's RJ-45 connector into the RJ-45 jack on the adapter. **(See Figure 4.)** Plug the other end into the RJ-45 jack on the back of the cable modem. Finally, properly install the network device drivers (configuring software) included with the network adapter by following the manufacturer's installation instructions.

Initializing the modem

If it's not already hooked up, connect the drop system's coaxial cable to the modem's 75-ohm barrel connector. Even with this connection, a modem cannot yet communicate (transmit or receive data) on the cable network until it has completed the initialization process. This is when the modem acquires its signaling frequencies and establishes an identity with the cable modem termination system (CMTS) or headend control equipment. The process consists of:

1) Accessing a downstream channel;
2) Retrieving the upstream timing and transmission parameters;
3) Completing the RF signal accessing process; and
4) Completing the registration process. CT

FIGURES 1-4 | MODEM CONNECTIONS

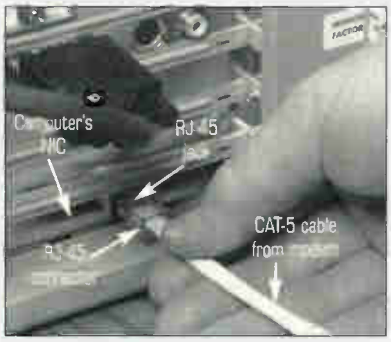


Figure 1: Connecting the Category 5 (CAT-5) network cable from the cable modem to the computer's NIC.

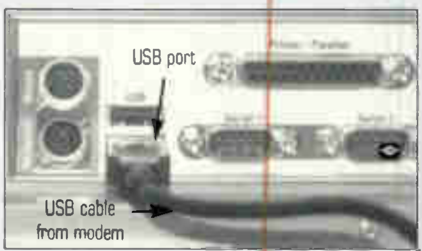
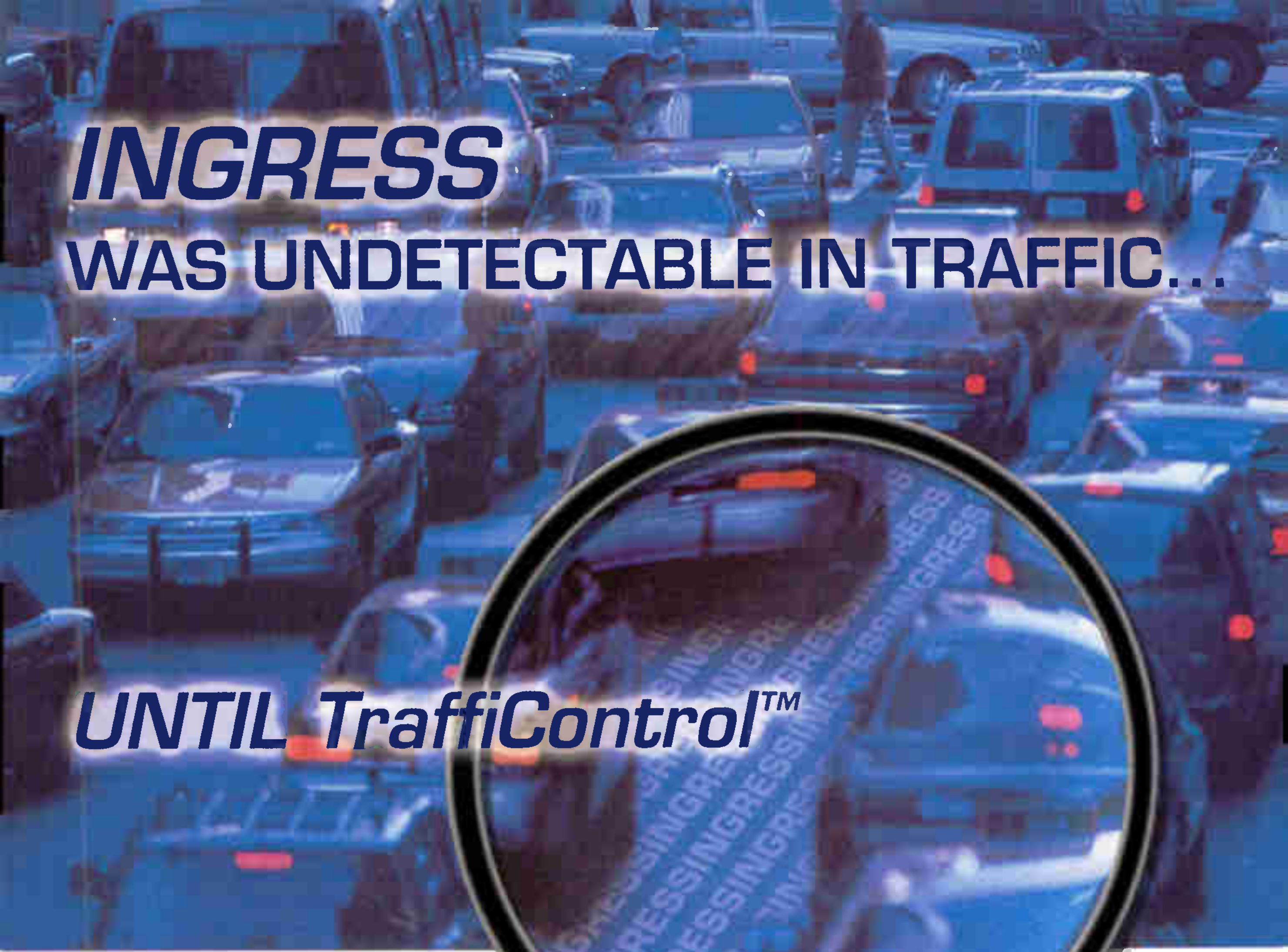


Figure 2: Connecting the modem directly to the computer's USB port

Figure 3: Connecting USB-to-Ethernet adapter to PC's USB port

Figure 4: Connecting CAT-5 network cable to USB-to-Ethernet adapter



Ingress hides in traffic...

but that doesn't mean it's not there, slowing down your internet services, disrupting return path communications, frustrating your subscribers. You can monitor ingress in empty bandwidths and make guesses about what's happening in occupied bands, but your business is growing fast, and those empty bands aren't going to stay empty for long. When they're full how are you going to keep an eye on ingress?

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MARKETPLACE

FIBER NETWORK SADDLE

Richco Inc.'s mini optical fiber network saddle on base (MOFNSB) features an entry point that allows almost no resistance to loading based on nominal diameters, thus minimizing stress on the optical fiber. The space-efficient unit's low profile also allows for better airflow over the board. This version comes with an adhesive-backed base for easy placement. For more information, contact Richco at (773) 539-4060 or on the Web at www.richco-inc.com.

CABLE MODEM

Com21's DOXport 5020 office cable modem (OCM) is geared toward multiple-user environments, such as multi-personal computer (PC) homes, remote offices, small companies and public and educational organizations with broadband connectivity. Each OCM integrates a cable modem, a 10Base-T hub, an enterprise-class firewall and other components required to allow the user to connect multiple PCs and share a single Internet service provider (ISP) account over a data network. A content filtering subscription and a virtual private network (VPN) configuration are available to meet the needs of individual subscribers.

For more information, contact Com21 at (408) 953-9100 or on the Web at www.com21.com.

IP MANAGEMENT SYSTEM

RiverGuide, from **RiverDelta Networks**, enables Internet protocol (IP) service definition and management. The system leverages RiverDelta's quality of service (QoS) technology along with Data Over Cable Service Interface Specification (DOCSIS) 1.1 and Internet standards. RiverGuide integrates provisioning, subscriber management and other operational applications and databases through lightweight directory access protocol (LDAP), Java and eXtensible Markup Language (XML) interfaces. The system offers network operators and their Internet service provider (ISP) or applications service provider (ASP) partners per-flow metering capability, and is designed to complement RiverDelta's Broadband Services Router (BSR) 64000.

For more information, contact RiverDelta at (978) 858-2300 or on the Web at www.riverdelta.com.

MASTER SOURCEBOOK

Jensen Tools' 300-page Master Sourcebook for Fall 2000 features tool kits, cases and carts, test equipment, hand power and specialty tools, wire and cable, soldering equipment, computer and local area network (LAN) products, workstations, shop supplies, storage and handling equipment, lighting and optical products and field accessories. A division of **Stanley Works**, Jensen offers customer benefits such as same-day shipping, free technical support, in-house calibration certification, 30-day unconditional guarantee on all products, lifetime guarantee on Jensen brand hand tools, and a complete on-line catalog with secure ordering.

For more information, contact Jensen at (800) 426-1194 or on the Web at www.jensen-tools.com.

MAXI-MODS

Oldcastle's Maxi-Mod system of communications structures scale to more than 500 square feet by combining as many of its monolithically cast, factory-equipped enclosures as needed. Customers can specify the system's width and length and choose from a variety of color and headroom combinations. Oldcastle's above and below-grade products are made with high-strength, pre-cast concrete, and are vandal, weather and fire-resistant.

For more information, contact Oldcastle at (888) 232-6274 or on the Web at www.oldcastle-precast.com.

FIBER ALUMINUM CAPSTANS

Fiber optic pulling capstans with aluminium drum diameter of 32 and 40 inches are now available from **General Machine Products**. The 32-inch model has torque limiters set at a maximum pull force of either 600, 750 or 1,000 pounds. The 40-inch model has torque limiters set at a maximum pull force of either 600 or 1,000 pounds. Drums are aluminium alloy, are bolted to the inner hub and drive spindle and mount on a 2 7/16 inch diameter drive with either a cross pin or bayonet connection. The working surface for both models is 7.5 inches.

For more information, contact General Machine Products at (215) 357-5500 or on the Web at www.GMPtools.com.

DIGITAL MEGOHMMETER

AEMC's model 1026 compact digital megohmmeter measures insulation at 250, 500 and 1000 volt to 4000MΩ. The device has a 600 volt AC/DC safety voltage check range, a continuity test with an audible beeper for resistances less than 100Ω, a timing feature and a hold function for measurement.

For more information, contact AEMC at (800) 343-1391 or on the Web at www.aemc.com.

CUSTOMER MANAGEMENT SYSTEM

Version 5.1 of **IBM's** integrated customer management system (ICMS) offers communications providers a single customer view across multiple services. Its package builder and ICMS customer hierarchy builder use graphical user interfaces (GUIs) to simplify pricing and promotion discounts. Package Builder enables a business to define discounts for customers who meet specific qualifying criteria. The ICMS Customer Hierarchy Builder allows providers to define complex customer hierarchies for corporate customers. Enhancements such as the multiservice fault management system (FMS) supports both telephony and cable TV services, and has the ability to identify, track and resolve reported faults.

For more information, contact IBM at (212) 320-2317 or on the Web at www.ibm.com.

LOOPBACKS ATTENUATORS

Alliance Fiber Optic Products' Loopback Attenuators are available in Standard LC and MT-RJ configurations. Designed for use in testing transceiver equipment and optical network transceivers, the units are available in multimode, 50nm/125nm, 62.5nm/125nm or singlemode fiber. The loopback features ruggedized packaging, compact housing, and completely enclosed fiber system. Custom-built loopbacks are available.

For more information, contact AFOP at (408) 736-6900 or on the Web at www.AFOP.com.

PROGRAM ENCODER

Philips' GoldLine Program Encoder incorporates ClearView technology to enhance Moving Pictures Experts Group (MPEG-2) compression performance. ClearView technology includes improvements in the MPEG-2 compression algorithms as well as new adaptive input filtering (AIF) techniques, leading to bandwidth improvements of up to 8 percent. Using the encoders in statistical multiplexing mode for multi-channel operations with Philips' StatCast system increases the system's overall efficiency and flexibility.

For more information, contact Philips at (315) 682-9105 or on the Web at www.philips.com.

DIGITAL SIGNAL PROCESSOR

Analog Devices' ADSP-21161 joins the Super Harvard Archicture (SHARC) digital signal processor (DSP) family. Capable of 600 million floating point operations per second (MFLOPs), the system is integrated for applications such as voice recognition, motor control, network analysis and infrastructure and wireless communications. The processor has 1MB of on-chip dual-ported memory, is based on a SHARC core that supports multiple-data execution of 32-bit floating and fixed-point arithmetic and has 14 direct memory access (DMA) channels that assure fast data transfers.

For more information, contact Analog Devices at (800) 262-5643 or on the Web at www.analog.com.

INTEGRATED DOCSIS CHIP

Broadcom's BCM3352 combines the company's "system-on-a-chip" expertise in Data Over Cable Service Interface Specification (DOCSIS) cable modems, HomePNA 2.0 home networking, a 200 MIPS voice over Internet protocol (VoIP) digital signal processor (DSP), a four-channel IP optimized voice CODEC and IP security technology. The BCM3352 meets the power, performance and temperature requirements of PacketCable. It also supports the EuroDOCSIS specification.

For more information, contact Broadcom at (949) 450-8700 or on the Web at www.broadcom.com.

DIGITAL WATERMARKING

Tektronix's AVDC100 automatically detects and corrects audio-to-video delay errors in digital video with digital watermarking technology. The device allows network operators and broadcasters to watermark video with audio timing information and correct lip-sync errors in real-time during live programming. AVDC100 applies the watermark near the point of audio/video content creation, which is then analysed as it measures the delay error and corrects it by adjusting the audio delay. The watermark withstands compression and decompression in Moving Pictures Experts Group (MPEG-2), motion Joint Photographic Experts Group (JPEG) used in disk recording, cascading of compressed formats, conversion among composite analog, low-pass analog filtering and component analog and digital formats.

For more information, contact Tektronix on the Web at www.tektronix.com

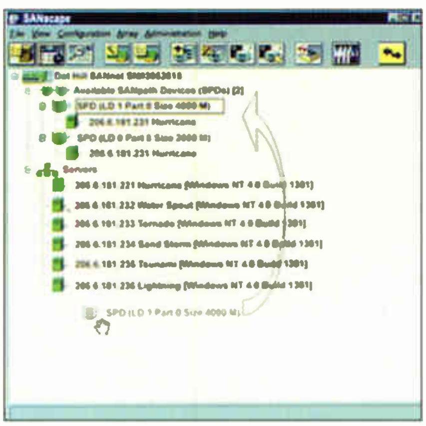
CROSSPOINT SWITCH

TriQuint Semiconductor's TQ8004 4x4 crosspoint switch has a per-point data rate of 2.7 Gbps, and offers capabilities for signal switching and distribution applications in telecom, digital video and datacom. The crosspoint is ideal for protection switching in fault tolerant networks and can be configured as two independent 2x2 switch elements. Other applications include backplane routing of serial data in network and video routers and expansion of large crosspoint switch arrays. The device operates from a 3.3 volt power supply.

For more information, contact TriQuint at (503) 615-9000 or on the Web at www.triquint.com.

ENHANCED SERVER STORAGE SOFTWARE

Dot Hill Systems has added dynamic logical unit number (LUN) assignment capability to its storage area network (SAN) management software applications. This enhancement enables Dot Hill's SANpath 3.1 to allocate and re-allocate server storage resources dynamically "on the fly" without interrupting applications. Dot Hill has added Linux, HP-UX and Windows 2000 to the list of platforms supported by both SANpath3.1 and SANscape 2.3. Combining SAN configuration, monitoring and maintenance tools with a graphical user interface, SANscape 2.3 is compatible with current industry standard platforms and supports single and multi-server environments.



For more information, contact Dot Hill Systems at (800) 872-2783 or on the Web at www.dothill.com.

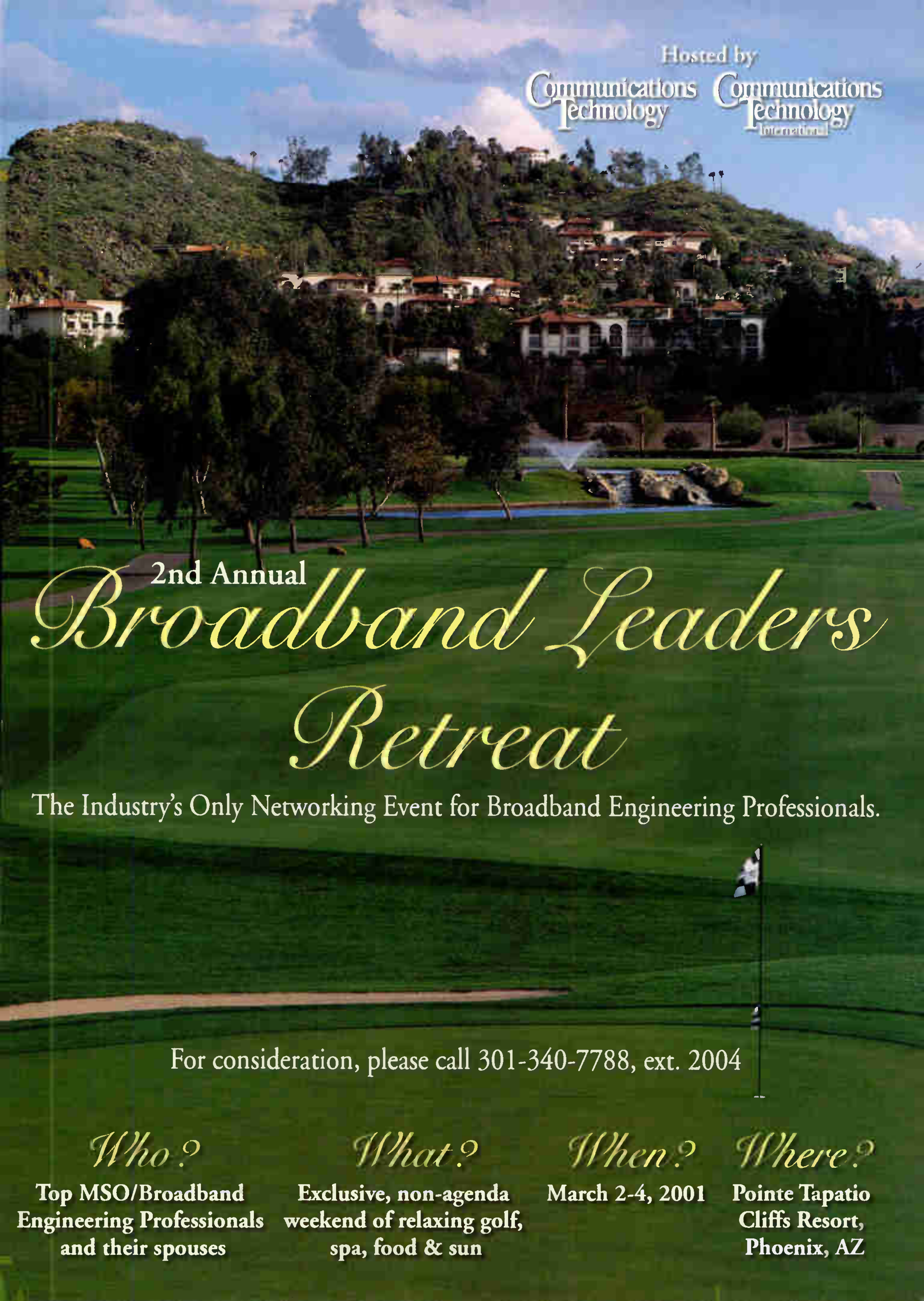
PROVISIONING SYSTEM

> **Core Networks'** CoreOS broadband provisioning system enables high-volume Data Over Cable Service Interface Specification (DOCSIS) provisioning and Internet protocol (IP) address management. The Web-based, user-friendly interface of CoreOS 3.1 enables quick self-provision. CoreOS also monitors RF levels as well as packet loss using real-time modem level probes. Management documents such as the Out-of-Spec Modem Report detail modem level variances by street and node.
> For more information, contact Core Networks at (902) 481-5750 or on the Web at www.CoreNetworks.com.

HIGH-ENERGY LITHIUM BATTERIES

High-energy lithium batteries, capable of packing the energy of those twice its size and weight, are now available from **Tadiran**. The batteries are designed for use in applications such as GPS tracking devices, security devices and utility meters. Offering higher energy densities, the batteries handle high current pulses and have a voltage of 3.6 versus 3.0. They can be shipped as non-hazardous goods, discharge less than 2 percent a year and operate between 40°C to 85°C.

For more information, contact Tadiran at (800) 537-1368 or on the Web at www.tadiranbat.com.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TARGETED SERVICE COMBINER

Alcoa Fujikura Ltd.'s targeted service combiner (TSC) module uses a variable optical attenuator for matching optical power to the broadcast input. Accommodating 1310 and 1550 signals simultaneously, the modules are designed for locations where a headend is being collapsed into a hub site configuration. Off-air signals and targeted services integrate onto a single fiber carrying standard analog or digital channels.

For more information, contact AFL at (864) 433-0333 or on the Web at www.AFLfiber.com.

SERVER GATEWAY

Harmonic's Narrowcast Services Gateway (NSG) 8100 enables multiple system operators (MSOs) to reduce the complexity of launching and supporting video-on-demand (VOD) services, enables service providers to develop a viable VOD business model and manage content more effectively. The NSG supports eight quadrature amplitude modulation (QAM) channels in a single rack unit (RU) and interoperates with other VOD components on the market. Its design eliminates the need for thermal spacing.

For more information, contact Harmonic on the Web at www.harmonicinc.com.

NETWORK MANAGEMENT SOFTWARE, V. 2.0

Micromuse's Netcool/Precision 2.0 completely integrates with the core component of the Netcool suite, the Netcool ObjectServer. A fault and service-level management software, Netcool/Precision discovers data entry and departure port/slot on all network routers and switches and retrieves and analyzes real-time alerts from Netcool/OMNIbus to determine the most probable cause of the fault. Netcool/Precision includes a network topology server and probable-fault engine that analyze information received from more than 200 environments by the Netcool ObjectServer, a high-speed in-memory database. Version 2.0 also includes a "positive feedback" feature, an "exclude" tool and an enhanced graphical display. The software automatically discovers Layer 2 and 3 devices.

For more information, contact Netcool at (917) 344-7053 or on the Web at www.micromuse.com.

FIBER STRIPPER

> A high tensile strength (HTS) stripper from **Alcoa Fujikua Ltd.** is designed to remove outer coatings from 250µm to 400µm ultra violet (UV) resin coasted fibers to ensure high-strength splicing. After heating the fiber to expand its outer coating and decrease adhesive force, the stripper removes the coating without touching the fiber's glass surface or reducing its strength. A four-position temperature changeover switch adjusts the heat intensity. The stripper is used in conjunction with the FSM-30F and FSM-30PF high-strength factory splicers. The device operates from a 100 V-240VAC power source.

For more information, contact AFL at (864) 433-0333 or on the Web at www.AFLfiber.com.

IP CONTROL PLATFORM

> Orchestream 2.1 offers network service providers scalable and fully automated control on an open platform for intelligent activation of services on Internet protocol (IP) networks. This product from **Orchestream** has a multi-threaded communication architecture that links its distributed components, allowing for more than 10,000 customer virtual private network (VPN) connections. Its integration module supports links with other network management systems. Drag and drop on-screen operations allow for creation of VPN sites. Orchestream 2.1 can implement IP services on Cisco, Lucent and Nortel devices. It additionally supports Cisco's updated network based application recognition (NBAR) technology. For more information, contact Orchestream at (408) 244-1880 or on the Web at www.orchestream.com.

PLAYBACK AND BROADCASTING SERIES

Utah Scientific's Max series consists of three components. The Max-MC master control automation system allows broadcasters to orchestrate a master schedule with video servers, cart machines, tape machines and other facility hardware via a network. The event-based Max-RS system provides server and router control. It imports a traffic log, plays video content from the server and creates an as-run log; and it provides a low-cost way to automate mandated HDTV channels. The Max-RX router automation system enables the creation of a seven-day cyclical record and playout schedule.

For more information, contact Utah Scientific at (801) 575-8801 or on the Web at www.utahscientific.com.

PERFORMANCE PROVISIONING SOFTWARE

IPHighway's PerformancePro performance provisioning software is designed to optimize Internet protocol (IP) network performance and prioritize IP-based network services. The software can be administered from a single command center and has a three-tier architecture that incorporates a management console, policy administrator and policy server. PerformancePro supports both UNIX and NT environments through open carrier-class architecture, Frame Relay, ATM and IP networks. The software is able to manage Nortel and Cisco network devices and can accommodate others.

For more information, contact IPHighway at (800) 964-4965 or on the Web at www.iphighway.com.

CABLE TRAYS

An inter-cabinet horizontal cable tray from **Chatsworth Products Inc.** is designed to manage cables connecting computer and communication network systems. The trays work within CPI's MegaFrame cabinets or between

cabinets without requiring an overhead runway. Constructed of high-strength aluminium, they feature radius drops and cable distribution spools to ensure compliance with bend radius requirements. Trays are 6 inches deep, available in either 19-inch or 23-inch-wide versions, can be mounted side-to-side and have vents to help maintain proper air flow.

For more information, contact Chatsworth Products at (818) 735-6100 or on the Web at www.chatsworth.com.

EMBEDDED MEMORY

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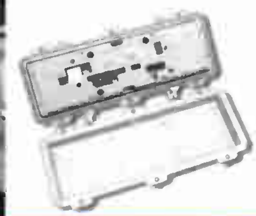

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To be considered for this opportunity, you should have: 3 years CATV/installation/ maintenance experience, 2 years training experience, a Bachelor's degree in communications, adult education (or related field), NCTI Training Certification and a valid driver's license. Additionally, you must be a skilled communicator, have in depth knowledge of adult training principles and their application, able to use a PC and software applications and knowledgeable of new technology and cable television products & services.

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CALENDAR

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1: Michiana Chapter Technical Seminar, Contact Russ Stickney, (219) 259-2112.

1: DOCSIS Deployment, Houston. Contact Jessica Dattis, (610) 363-6888.

2: Chattahoochee Chapter Vendor Show, Atlanta. Contact Joice Ventry, (850) 926-2508.

7-9: SCTE Seminar: Train the Trainer, Dublin, Ohio. Contact Jessica Dattis, (610) 363-6888.

7: Terra Nova Chapter Technical Seminar, Newfoundland. Contact Pat Dunn, (709) 753-7583.

8: Red Rock Chapter Meeting, Las Vegas. Contact Glenda Reffitt, (610) 384-8084.

8-9: OSP Expo 2000, Nashville, Tenn. Contact (847) 639-2200.

10-13: TeleFocus 2000, Aboard the Norwegian Majesty, Miami. Contact Lisa Clark, www.telefocus2000.com.

14: Cascade Range Chapter, Technical Seminar, Wilsonville, Ore. Contact Chris Johnson, (503) 245-0603.

15: SCTE/CTAM/OCTA Joint Conference Meeting, Contact Michael Beat, (440) 366-0416 ext.618.

15: Bluegrass Chapter Vendor Show, Elizabethtown, Ky. Contact Gary Wilson, (812) 339-4680.

16: Music City Vendor Day, Nashville, Tenn.. Contact Gary Wilson, (812) 339-4680.

16: New Jersey Chapter Technical Seminar, Contact Jim Kearney, (732) 420-5936.

16: Central California Chapter Technical Seminar, Fresno, Calif. Contact Roger Paul, (559) 253-4685.

16: Greater Chicago Chapter Technical Seminar, Hinsdale, Ill. Contact Jim Beletti, (630) 871-2727.

18: Cactus Chapter Technical Seminar, Phoenix. Contact Brenda Hunt, (602) 332-2003.

28: SCTE Board of Directors Meeting, Los Angeles. Contact SCTE Headquarters, (610) 363-6888.

28-Dec. 1: Western Show, Los Angeles. Contact California Cable TV Association, (510) 428-2225.

PLANNING AHEAD

> ***Dec. 12: SCTE Seminar, Cable 101***
Chicago. Contact Jessica Dattis, (610) 363-6888.

> ***Jan. 8-10: Emerging Technologies Conference***
New Orleans. Contact SCTE, (800) 542-5040.

> ***Feb. 28-Mar. 1: Texas Show 2001***
San Antonio. Contact Jessica Dattis, (610) 363-6888.

> ***April 11: SCTE Certification Testing***
Exton, Pa. Contact SCTE, (800) 542-5040.

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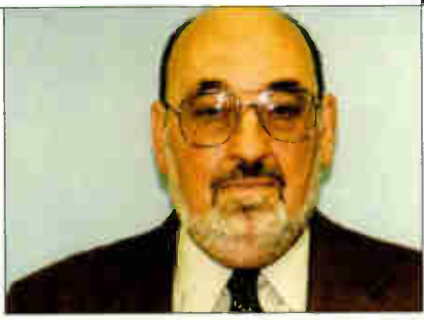

BST Certification and Troubleshooting

The past two issues of *Communications Technology* contained articles in which I explained both the installer and broadband service technician (BST) certification programs.

By my own estimates, there are more service technicians at work in our industry than any other job classification. With this in mind, the BST program is very important and should be high on the training and certification list.

"The troubleshooting exam offers three scenarios that require you to make decisions and take the correct steps to solve each problem."

This month, I would like to discuss the troubleshooting portion of BST and offer advice for your participation in this exam.

Let me start by explaining how this exam is administered. The exam comes to the proctor on a CD to be used with a computer. You will be faced with three scenarios of real situations, requiring you to make decisions regarding the correct troubleshooting steps toward solving each problem. These steps will be offered to you in a group of choices with a system map depicting the area layout. You will need to make these choices with the results printed out on the screen. It will be your job to determine from each result where to go for your next step.

This process very closely resembles the choices you have in your day-to-day troubleshooting experiences. The object, as in real life situations, is to find the source of the problem in a minimal amount of time so as to restore service as quickly as possible. It is important to know you will be rewarded for correct moves and penalized for wrong choices. Points are awarded based on your troubleshooting skills.

Some advice: read the problem carefully and be sure you understand it. Then lay out your steps and procedures based on the information offered and be sure not to take unnecessary steps.

As an example, if you choose to check signal at a customer's tap and find the signal below acceptable standards (those which would result in unacceptable levels by Federal Communications Commission (FCC) standards), decide if it would be smarter to go directly to the preceding tap in the line or to go to the closest amplifying device. By checking the amplifying device, it would be possible to determine which direction you need to move in for your next step. Say that upon checking the amplifier, you find the signals normal and according to system design specifications. Would it be smarter to start checking taps from the amplifier or to check at a tap halfway between the subscriber and the amplifier to determine the next location to visit?

Heavy emphasis is placed on the use of a half-split method of troubleshooting. Continually splitting the system in half, you will arrive at the cause of the problem in a much quicker and more efficient manner.

Remember, proper diagnosis of the problem and a little thought in determining troubleshooting steps also will help you solve the problem more efficiently.

Each step you take toward the resolution of each problem will be downloaded onto a floppy disk, with points added or subtracted accordingly. The disk is returned to the Society for Cable Telecommunications Engineers (SCTE) for grading and recording.

I hope this is of some help to all of you in taking this examination. I also hope the training and effort you have expended will make your day-to-day troubleshooting more meaningful to you and your company.

I urge you to begin this very important training and certification process today! CT

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Did this article help you? Let us know your thoughts. Please send an e-mail to snayalkar@phillips.com.

Training the SCTE Way

Training is a key component of SCTE's mission, and the Society has been working aggressively over the past several years to develop new programs assisting cable telecommunications professionals in upgrading their skills. This is a continuing effort, with many new programs in the works, and I want to take this opportunity to share with you how we develop a training program. There are several key elements that must be present in order for training to be effective.

A training program must be developed with clear objectives. Too often, training has been developed and presented from a nebulous, sweeping objective such as, "We need to train our technicians on the new converters we are deploying." This statement identifies a need, but doesn't go nearly far enough in identifying why training is necessary or what aspects of the technology should be included. This approach nets out to a "brain dump"resulting in the instructor having an opportunity to demonstrate knowledge, but there is no guarantee the student has learned anything.

To ensure training meets the need, an analysis must be done and should have clear and concise statements of training end-results. SCTE training has these outcomes outlined at the beginning of program and training modules.

Once objectives have been stated, the module should be designed around them. This leads to the second key component of an effective training program: structure.

A statement at the beginning of training allows the learner to evaluate whether or not they are ready for the new material. This starting point may be defined in a sentence or two about the assumed knowledge of the student or maybe a list of prerequisites that should be completed first.

Once the starting base has been laid, the training should move forward in a carefully thought-out progression. The objectives can serve as a useful outline for building systematic learning and used as a guide to ensure the material covers all of the needed learning.

The next step in the process is to find ways to engage the learner in the training. It has been shown that adults learn in different ways. The visual learner learns best by seeing, requiring training that includes text and good visual aids. The auditory learner is most comfortable when he hears the information, therefore, clear verbal instruction and well-structured content would help this type of learner grasp the new material. The kinesthetic learner is a hands-on learner who needs to touch or interact with the objects of the learning.

Each of these adult learning styles will be included within any given training exercise. In fact, studies have shown that combining the learner's primary learning style with their secondary style improves the retention and understanding of the material. Therefore, each training program should be reviewed with this in mind.

The last step in developing and evaluating training is to evaluate the learner(learning). Did the student achieve the objectives laid out at the start? SCTE's training programs do this through several mechanisms. First, a review of the material covered is accomplished with multiple-choice questions, testing whether the student has learned and retained training-exercise facts . Secondly, application questions are provided to test the ability of the student to take the learning and apply it to similar circumstances. Lastly, where appropriate, evaluations are provided that offer a method for the student to demonstrate the new learning in real-world situations. All of this should be considered part of the training. While reviewing, applying and demonstrating, the student is continuing to learn.

It should be obvious, then, that developing effective training is much more than just communicating facts and figures. It requires that a great deal of time be spent during the development process to ensure that a knowledge transfer has occurred after the training exercise is over. SCTE believes strongly in these principles and works diligently to ensure they are applied in every training program that is developed by the Society. CT

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