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March 1996

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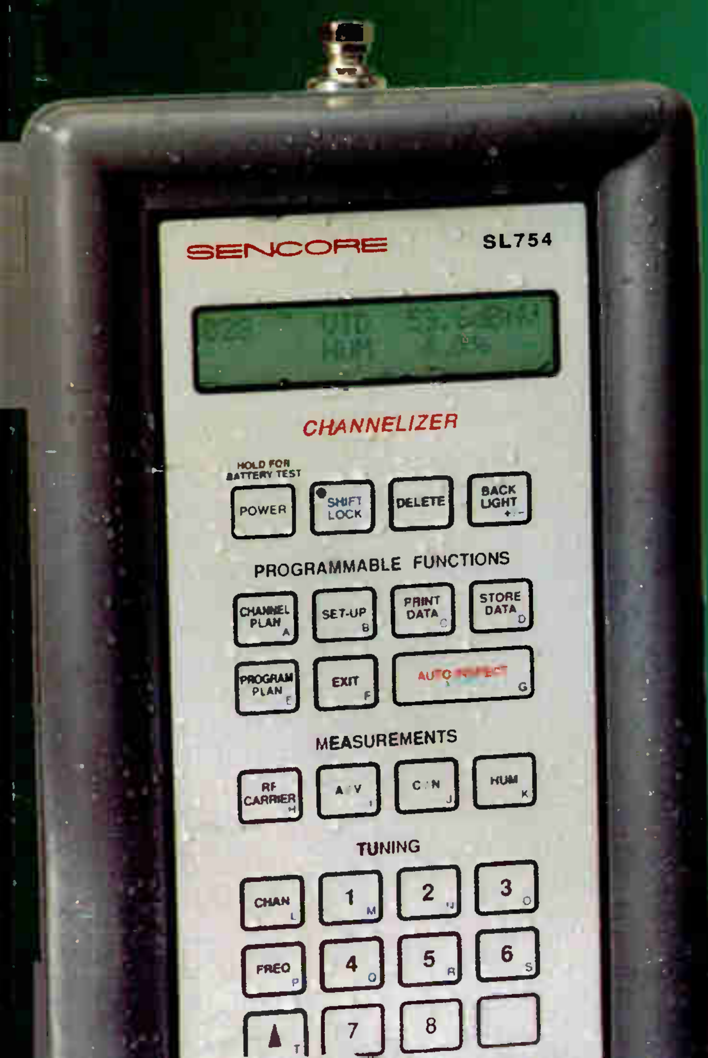

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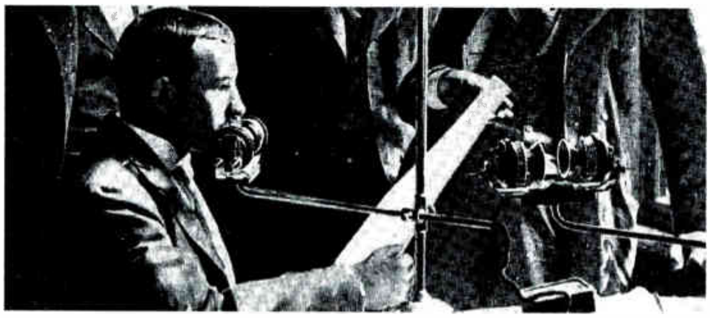

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EDITOR'S LETTER

"Carrey"ing it too far

Okay, so you might have heard that some idiot is going to use a movie with Jim Carrey in it to make fun of cable TV. Do I like it? No.

Will the moviegoer think a comedy about a psychotic stalker dressed as a cable installer is funny? Maybe. Will the public think we operate systems that way? I doubt it, unless you really operate yours that way.

It's hard to believe any company would spend $40 million on a movie featuring a star whose every picture shows his mouth wide open and his eyes bugged out, screaming the same tired old joke in every scene. Do I like him? No.

But back up a minute. Didn't our industry hire a different idiot to represent the cable industry to national TV? It seems they hired him from a network show in which he played a paper boy approaching his thirties. And didn't our PR firm pay him good money to promote the industry by leading a jackass up and down the street? Later, a corn chip company used his nerd image to push their products to ladies whose lines were, "Get out of here. I mean, really, really get out of here!"

The Wall Street Journal claims our industry sees "real horror" when we think about Carrey's new movie. But if you think it is real horror, you should have been around 30 or 40 years ago. Talk about being made fun of! I don't know how many times a mayor or city councilman slapped me on the back and said, "Hell son, we don't need no cable in this town. We got two channels. So if one goes out, we can still watch the other one. After all, you can only watch one channel at a time. Whatcha trying to do to our poor citizens?"

And if you were successful at getting a first reading of the franchise (it usually took three), the next town meeting would be loaded with a local TV broadcaster, TV repairmen and a representative or two from TAME (TV antenna manufacturers). One guy would get up and tell everyone if cable came to town, everyone would have to hook up, whether they wanted service or not, "Cos I heard over in another town how them there antennas on the tall tower actually sucked all the signals out of the air." Or, "I heard that they can hook a TV camera into that cable and watch everything you do in your home ... or was it hear everything you say? Oh well, it was something like that." Or, "I hear they fix it after they been here awhile so you can't watch it good lessen you buy one of their special TV sets from them."

Sure, it would have pleased me to see someone else saddled with the image this movie portrays. But it's us who are stuck with it. We had to learn our way as we built this all-American industry. Didn't we bring local jobs to the people in small towns and large cities? Yes. Didn't we help build local revenues with our franchise fees and taxes? Yes. Have we made mistakes? You bet.

But we didn't linger on them. We spent lots of money learning to serve our customers properly. Be glad you're in cable today, when the right to good cable service is rated right up there with mom, the flag and apple pie. Let's keep our pride and, perhaps, a little extra sense of humor. You have worked too long and hard to let some idiots bother you. It wasn't horror back then and it's not horror now.

They may be dumb. Let's not be dumber.

Rex Porter
Editor

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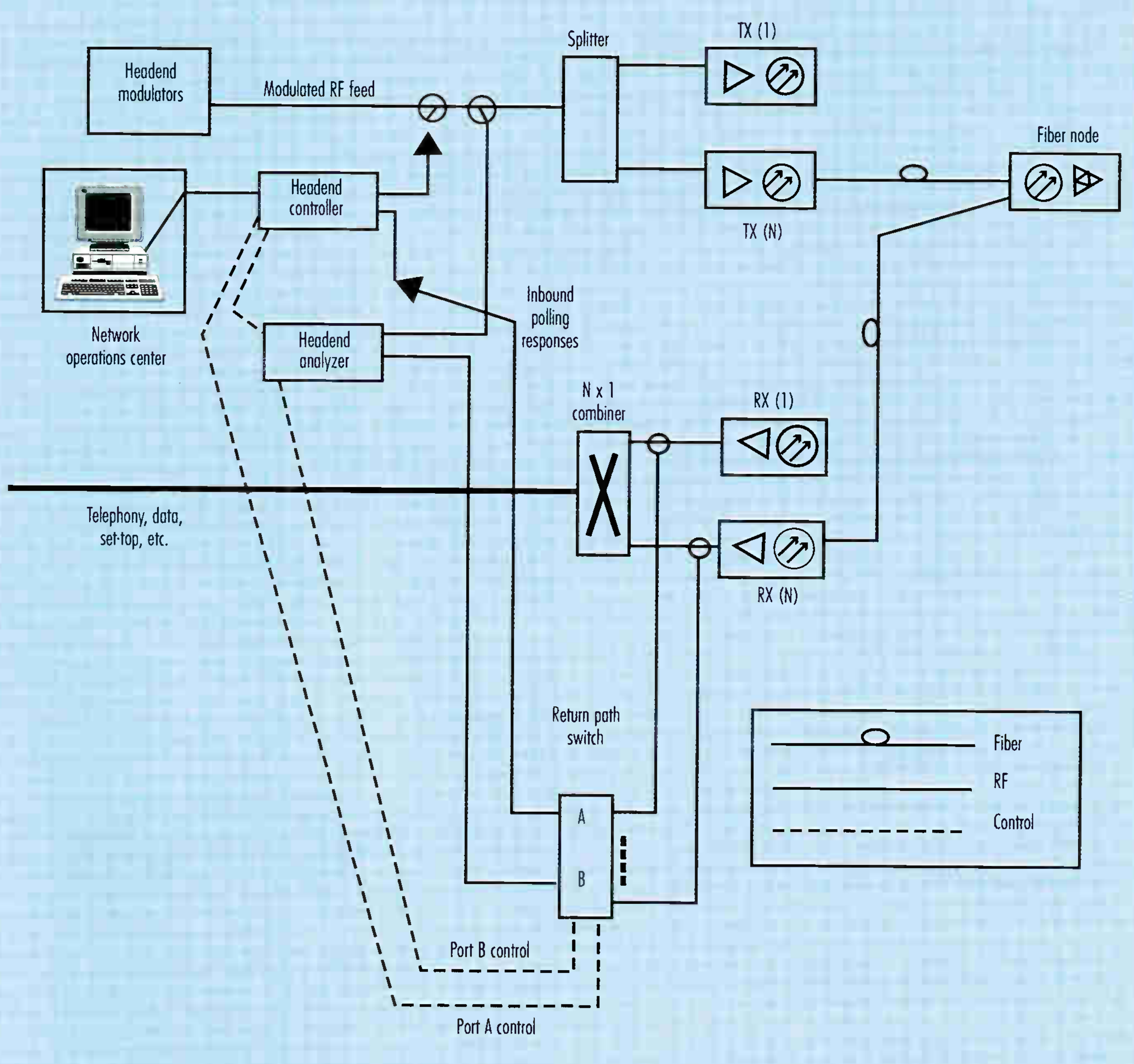
Figure 2: Return path switch and headend signal analyzer



spectrum analysis capabilities in the headend with an existing status monitoring system.

Simply performing spectrum analysis on a combined RF signal does not give an accurate reading of the actual noise and cannot pinpoint the source of noise. To accomplish these goals, the return paths from multiple nodes must be switched rather than combined. This allows the signal analyzer to analyze a single return path at a time, rather than a composite return.

Figure 2 shows a return path switch implemented in addition to the combining network that was shown earlier. The main RF return carrying revenue generating services such as telephony, data over cable, set-top information, pay-per-view (PPV), etc., is combined as usual. This traffic cannot be run through a switch. Each of the RF returns is run through a directional coupler, with the smaller value output run to the return path switch.

The return path switch has two independently controlled outputs labeled A and B. Output A carries polling responses from individual nodes. In this way, noise on the communications frequency from one node does not impact communications with all other nodes in the system. A status monitoring headend control unit controls

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Green to head *CT* advisory board

Communications Technology announced its new advisory board: Richard Green, CableLabs (chairman); Jim Chiddix, Time Warner; Richard Covell, TSX Corp.; Jim Farmer, Antec; Ron Hranac, Coaxial International; Bob Luff, TV/COM International; Dan Pike, Prime Cable; Bill Riker, Society of Cable Telecommunications Engineers; Mike Smith, Adelphia Cable; Tony Werner, TCI; and Wendell Woody, Sprint/North Supply.

Rex Porter, *CT* editor, comments, "I believe this is the ideal group of leaders from every segment of the cable industry. We now have the board to guide the magazine through the fast-changing last few years of the century and into an exciting new millennium."

Cable modems: Who's serious?

The continuing development of cable modem technology depends on creating an application-independent architecture, according to Rouzbeh Yassini, president of cable modem manufacturer LANcity.

Yassini made his pronouncement in a teleconference in late January. He also noted that by the end of the year, the cable industry will "find out who's serious about (cable modem technology) and who's playing with it."

Cable modems operate in either a symmetrical mode (same data rate downstream as upstream) or an asymmetrical mode. Although Yassini sees the value in high upstream data rates, he commented that "the bottom line on all that is immaterial. The key is building an independent architecture."

"One hundred percent of applications are asymmetrical," Yassini maintained. "The problem is they're asymmetrical one minute one way, and they're asymmetrical the next minute the other way. You have to ask: 'Are we creating an application-dependent topology or architecture where we can do one thing but not another?'" Yassini also said that he "welcomes standards; it's the only way able companies can interoperate."

As yet, there is no real "killer application" for cable modem technology, according to Yassini, although he said his company is excited about the work-at-home concept, provided there is sufficient upstream bandwidth for the application.

Asked whether current hybrid fiber/coax (HFC) networks are reliable and robust enough to accommodate the new cable modem technology, LANcity's Director of Marketing Chris Grobicki said yes.

"The cable industry has become cognizant of the fact that ingress is a big issue in cable plant," Grobicki said.
—*Alex Zavistovich*

ET '96: Data and beyond

It's clear that data delivery to home computers could be a lucrative new revenue source for cable compa-

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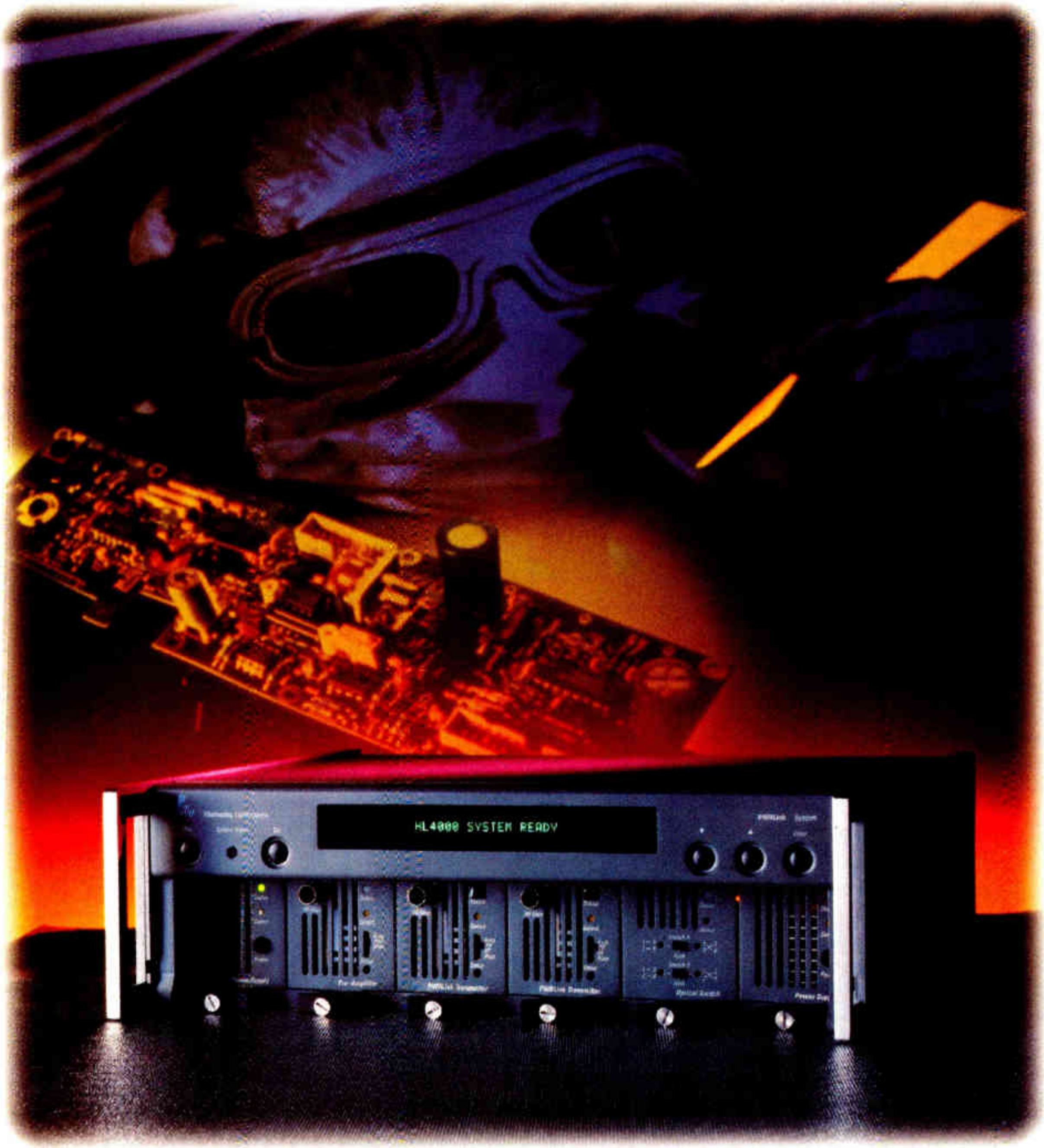

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nies with HFC networks. Engineers and operations managers must now make certain they transport the data efficiently.

That was the message delivered during the "Data Transmission" session of the SCTE's 1996 Conference on Emerging Technologies. Opening remarks for the day's sessions by Paul Baran of Com21, who cautioned that digital transmission's primary advantages — flexibility and power — have a downside in some system designs and become "awful" in their complexity.

Gaylord Hart of XEL Communications then explained why packet-switched data services on broadband hybrid fiber/coax (HFC) networks may be preferable to switched-circuit networks. For data transport, said Hart, switched-circuit networks are inefficient, because they tie up dedicated channels that idle while waiting for data. On the other hand, packet-switched networks statistically multiplex data in packets from several users onto a single channel. Ilja Bedner of Hewlett-Packard explained some of the technical requirements cable operators need to be aware of if they decide to exploit the revenue potential of delivering on-line services over HFC networks. A successful service requires more than just cable modem technology, said Bedner; decisions also must be made about data networking, remote content access, local content provision and service operation.

From there, the emphasis of the session shifted to identifying problems with the return path, such as ingress, and how to improve this perceived Achilles' heel for some HFC cable networks. Brian Johanson of Philips Broadband Networks looked at upstream spectrum control mechanisms for management of subscriber-induced noise on the HFC return system. There are a variety of methods for controlling noise, he said, such as high pass/bandstop filtering, frequency hopping, discrete multitone modulation, spread spectrum and downconversion.

For Richard Prodan of CableLabs, much of a system's ingress can be traced to poor shield integrity. In a paper on a continuous wave tester developed for field evaluation of impairments to the reverse path, Prodan commented that "one open shield could cause problems for everyone on the node."

Rounding out the session's technical focus on the reverse path was General Instrument's Dean Stoneback, who discussed return system design for full digital services. To maintain correct channel variance at the lasers and demodulators, Stoneback recommended reducing gain variance by modifying the HFC network to ensure that the loss to any one household will be constant across all frequencies. — *Alex Zavistovich*

Return path: Ready or not?

"Be prepared." The sentiment of keynote speaker Claude Baggett of CableLabs turned out to be that of almost every presenter at SCTE's ET '96. With the boggling dollar potential of data delivery setting off the cable modem frenzy at the last Western Show, engineers started chewing on the reality of network reliability and availability at ET. However, on the first day of the conference, they

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weren't just thinking data, but telephony and other potential moneymakers as well.

TCI's Tony Werner focused on the fact that multimedia services over cable will require at least the perception of 100% availability.

"Can this be achieved with any network? We believe it can," he said in his reality check presentation describing where the industry is and where it wants to be.

Raja Natarajan of Motorola took Werner's positive attitude one step further. "HFC and advanced cable networks can provide telephony with quality and reliability meeting or exceeding that of today's public switched networks," he said. He also sent out a call for quality to cable vendors. The complex nature of today's networks, with increased dependence on protocols and network management software, demands that vendors produce "near zero defect" hardware and exceptional software quality, he said.

Nonintrusive maintenance (read, "no outages") was tackled by Integration Technologies' Andy Paff. Although this philosophy is typically not traditional in cable networks, Paff emphasized that multimedia services over hybrid fiber/coax (HFC) networks demand it. He added, "Drop systems should be rethought completely."

Dave Large of Media Connections Group took on the analysis of capital, operating cost and reliability effects of choices in network powering. He covered a system outage and reliability software package that boasted "a reduction of 55% in network unavailability and 84% in video-subscriber-perceived outage rate ... using techniques that add only about 1% to network upgrade costs."

The powering topic also was considered by SatCon Technology's Peter LeBlanc and Richard Hockney. Hockney demonstrated how flywheels can be used in standby power supplies to provide stable power, either when utility power lines are interrupted or when the output voltage level falls below acceptable levels.

"So you say you're going digital, huh?" said luncheon speaker Claude Baggett, and added that you had better or become as "extinct as a Neanderthal." He said there were three fundamental challenges for cable engineers in the migration from analog: 1) Convince management to buy digital equipment; 2) Learn to use it; 3) Train your people. In other words, start working today for the inevitability of a digital tomorrow. —*Laura Hamilton*

Lucent joins ISDN standards group

Is Lucent Technologies (formerly AT&T Network Systems) hedging its bets or spreading itself too thin? The company, already part of a cable group creating interoperability standards for data delivery over HFC networks, has announced that it will be doing much the same thing in a group trying to get commercial digital phone service into the hands of small businesses and individual users.

Integrated services digital network (ISDN) telco lines can offer users fast access to multiple digital telecommunications applications. The problem, however, is that ISDN lines

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have not been widely available for smaller businesses, and certainly not for the general consumer. Now Lucent, Ascend Communications Inc., 3Com Corp. and U.S. Robotics have formed the ISDN Forum, to get the technology into the hands of these lower-end users.

Late last year at the Western Cable Show in Anaheim, CA, Lucent (then still AT&T Network Systems) announced its partnership in the Broadband Link Team. That group, which also includes Hewlett-Packard, Intel and Hybrid Network Technologies, is looking to develop standards for equipment delivering data over cable. Preliminary specifications for an open standard were to be ready by the end of 1995; already late, the work is still in progress at press time. Do consumers — especially home users — need both ISDN access and HFC cable access to digital telecommunications applications?

Rob Mariani, strategic marketing director with Lucent, said there is no conflict in his company's participation in two groups, each working on competing technology to bring valuable services into the home and small business. In a teleconference announcing the ISDN Forum, Mariani said, "Philosophically and practically, Lucent supports a number of network services to deliver solutions to end customers — whether that be narrowband with ISDN or broadband with HFC or SDV. We feel that ISDN is a very viable technology; the demand that the Internet is driving is ample proof of that. What we're doing addresses a viable technology. We don't see any conflict whatsoever." — *Alex Zavistovich*

Telecom Act is law

The following was reported in sister publication "CableFAX Daily."

"With one stroke of the pen, telecommunications laws catch up with the future," President Bill Clinton said while signing the Telecom Bill into law, ending a 20-year era of unprecedented Congressional lobbying, and commencing a new era of fierce Federal Communications Commission arm-twisting. Amid the festival of mutual self-congratulation, though, ominous signs of future battles appeared. While Vice President Al Gore invoked the Fed's role in supervising "public interest values" (translation: heavy FCC rule), Speaker Newt Gingrich won outgoing House Telecom Subcommittee Chairman Jack Fields' promise "to reform the FCC before he leaves."

Time Warner Cable head Joe Collins said he believed the most immediate beneficiaries of the new law will be equipment manufacturers. What's the first TW Cable effort? "Expect to see us in the long-distance business in the next year. AT&T Chairman Bob Allen promised local service via cable telephony but did not cite any partners. — *Marc Osgoode Smith*

NOTES

• **Bob Luff** was appointed president and CEO of **TV/COM**. He previously was with **Scientific-Atlanta.**

• **Bell Atlantic** launched the first U.S. commercial video dialtone service in Dover Township, NJ, in late January. It provides voice, data and video services over the same network.

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ET '96 draws 1,300

Over 1,300 attendees participated in the Society of Cable Telecommunications Engineers' 1996 Conference on Emerging Technologies held Jan. 8-10 at the San Francisco Hilton and Towers in San Francisco.

Despite snow storms affecting the Eastern states that resulted in airport closings and prevented some attendees from traveling, most registrants were able to attend the conference.

Preconference tutorials educated attendees on consumer interface issues and technical standards development. The conference itself offered four panel discussions among industry leaders on network availability, cable telecommunications networks and services implementation, data transmission and digital TV transmission.

The four sessions were enhanced by seven video screens that displayed computer-generated graphics to attendees. Those in the back of the auditorium were not only able to view the speakers projected on the screens, but also were able to view visual aids the speakers presented. (For more details on the sessions, see "News," which starts on page 10.)

Claude Baggett of CableLabs and Dan Brenner of the National Cable Television Association served as keynote speakers at the two conference luncheons.

SCTE member and cable veteran Archer Taylor was elevated to Fellow Member status in the Society at ET '96. He was the third person to be honored with this designation. Jones Intercable Director of Network Development John Brouse, Jr., was named recipient of the 1996 Polaris Award, which is co-sponsored by SCTE, Corning and *CED* magazine.

Proceedings manuals offering technical papers for all conference presentations were distributed to all attendees and are now available from SCTE headquarters at the special show prices of $30 for SCTE members and $36 for nonmembers. For further information, contact SCTE at (610) 363-6888.

Ted Woo named director of standards

The Society announced the addition of Ted Woo, Ph.D., to the SCTE staff in the newly created position of director of standards. In this capacity, he will advance the Society's efforts to present SCTE-developed standards to the American National Standards Institute for approval now that SCTE has been recognized by ANSI as a standards developing organization.

Woo comes to the Society from C-COR Electronics, where he was manager of mechanical engineering. Previously, he has worked at Mars Electronics, Northern Telecom, Kohler Co. and General Electric.

Woo is no stranger to ANSI, having served on a 1992 ANSI/IPC (Interconnect Packaging and Circuitry) Standards Approval Committee in the creation of standard guidelines for circuit board assembly. He also served as a speaker at the 1989 ANSI/IPC conference and presented an ANSI/IPC paper at the 1986 NEPCON conference.

Throughout his career he also has been involved in recommending proposed standards for the cable industry. He has recently been concentrating on a variety of areas of industry technical operations, including torque, corrosion resistance and thermal management.

"There hasn't been much telecommunication standards talk between the cable and telco industries," Woo states. "In the future, focusing on the interchangeability between telephones, computers and cable lines would greatly benefit not

only these industries, but the public as well."

Deadline approaches for Society election

Election packages containing voting information on candidates for the eight open positions on the Society's national board of directors have been mailed to all active national SCTE members.

National members will have the opportunity to elect one at-large director to the board, while members in seven SCTE regions also will be voting for directors to represent their areas. The election package includes biographies of all candidates to assist members in the voting process.

The nominations subcommittee submitted the following names to be placed on the 1996 ballot: At-Large — Alan Babcock, Ron Hranac and Bruce Weintraub; Region 3 — Pat Bacon, Norrie Bush and Ted Chesley; Region 4 — John Green and M.J. Jackson; Region 5 — Dick Beard and Larry Stiffelman; Region 7 — J. David Giesy, Bob Jackson and Jim Kuhns; Region 8 — Steve Christopher and Ken Wright; Region 10 — Bruce Carlson and Maggie Fitzgerald; Region 12 — William R. Grant and John Vartanian.

In addition to these candidates, members can vote for a person of their own choice in space provided on the ballot for "write-in" votes for each open position.

Be sure to read the voting instructions and biographies carefully before making final selections. Election packages should arrive to members by mid-February, and all completed ballots must be postmarked no later than March 15. Please exercise your ability to direct the future of your Society and vote.

On the reverse side of the ballot is a referendum vote being conducted with this election. The vote concerns changes to the national bylaws relating to the election of members to the board. The proposed changes are designed to ensure that regional directors remain in the region they were elected to represent and that board nominees have had sufficient tenure as SCTE members in order to experience first-hand the goals and mission of the organization. The changes also are set up to ensure a broad representation of the industry will exist on the SCTE board so as not to be dominated by a single corporation.

Enclosed in this year's election package is a survey developed by the SCTE national headquarters staff. Please take the time to respond and mail it in with your election ballot.

Also enclosed is an entry form for the Society's Field Operations Award and information on SCTE's "Basic Broadband Technology Course" and other technical training resources.

If you are an active member and do not receive a package by mid-February, please contact SCTE national headquarters at (610) 363-6888.

Fiber Optic CATV Drop Cables

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

Reader Service Number 231

Cost-Effective Systems Transmit Baseband Video/Audio Over Fiber

Several cost-efficient systems that transmit Baseband video/audio over fiber are now available from Radiant Communications. Whether your requirements call for one-way transmission with broadcast quality (RS250), or bi-directional (two-way) transmission using one fiber, Radiant has the solution. In addition, data or stereo audio are available options. These systems are now in use by all major MSO's nationwide in applications including college seminars, town meetings, direct feeds from broadcast studios or remote antenna sites, video conferences and CCTV.

Reader Service Number 233

New Unique Fiber Optic Ethernet System Eliminates Data Collisions

Radiant introduces the most cost effective and technologically advanced method of connecting remote ethernet hubs together. The series DL200 allows transmission distances up to 100Km and data throughputs of 100Mbs. It can be used for any size system — large or small. Typical applications include interconnecting large metropolitan school districts or remote college or industry locations. Budgetary cost is less than $3000 per location.

Reader Service Number 235

By Ron Hranac

Improving system reliability: Getting back to the basics

I recently completed a project that involved reviewing outage data from several major MSOs' systems. While I can't give you details such as company names and locations (you know the line ... if I told you I'd have to shoot you, or something like that), I can provide some generalities.

Surprisingly, most of the systems evaluated still have a lot of plant outages. Even more surprising: Most of those outages are what I would classify as controllable. (A brief side note: Even systems with fiber had a lot of outages. The node-based architectures have resulted in fewer subscribers being affected by a given outage, and outage duration is generally less because of a smaller physical area to troubleshoot.)

With few exceptions, the majority of the outages fall into two groups: third-party damage such as cut cables, and commerical power — disruptions due to commercial power outages, sheath current problems, surge and transient damage, and nuisance fuse blowing.

There is not much that we can do about third-party damage, except to make sure we perform accurate locates and charge repair costs to contractors who regularly cause backhoe outages. But power-related problems are another matter.

Back in August 1992 CableLabs published a document called *Outage Reduction*. If you're a CableLabs member, it's likely that you or someone in your company received a two-inch thick grey binder sometime in September of that year. It contained the document's first four chapters: Customer Expectations, Detection and Tracking; Reliability Modeling of Cable TV Systems; Plant Powering in Cable TV Systems; and Outside Plant and Headend Protection. (Chapters five through seven were sent out later: Service Restoration, Cable TV System Power Supplies, and Power Grid Interconnection Optimization.)

"These kinds of investments may not be revenue-producing, but they sure are revenue-protecting!"

Even if you aren't a CableLabs member, or you aren't your company's official CableLabs document recipient, the main parts of the first four chapters also appeared consecutively in *Communications Technology* December 1992 through March 1993.

Evaluating the various MSOs' outage data, it became clear that most of those systems have never implemented CableLabs' outage reduction guidelines. Indeed, one major MSO's head of engineering told me that despite his company's policy requiring all systems to follow CableLabs' outage reduction guidelines, he found to his surprise that most of them don't!

If your system is among what I suspect is the majority of cable systems that have not implemented those guidelines, my first recommendation is that you get from your bookshelf either the big grey *Outage Reduction* binder or the four back issues of *CT*, and read through the material, especially chapters three and four. There you'll find the bulk of the recommendations that will yield the biggest bang for the buck. In any event, I'm going to provide a synopsis of the most important and easier to implement outside plant improvements.

The first recommendations have to do with the way you power your system. It's important to realize that in addition to amplifier cascades between the headend and subscribers, every system also has power supply cascades. I'll use a tree-and-branch example. Let's say the worst-case end-of-line subscribers are fed by a 20-amplifier cascade. That same amplifier cascade is probably powered by about nine power supplies. Thus, there exists in addition to the 20-amplifier cascade a power supply cascade of nine. If any of the 20 amps should fail, end-of-line subs will experience an outage. Likewise, if any of the nine power supplies goes

Ron Hranac is senior vice president, engineering, for Denver-based consulting firm Coaxial International. He also is senior technical editor for "Communications Technology."

down, those subs will experience an outage. Reliability will improve in either case if we can reduce the cascades.

To reduce power supply cascades, you can do several things. One is to repower the system to achieve higher actual loading per power supply. If you're careful, it may be possible to reduce power supply cascades by almost 50%. Strive to get actual loading to 75% of the power supply nameplate current rating or more. Another is to use higher supply voltages than the 60 volts now used, say 75 or 90 volts (most amplifier manufacturers' switching power packs will have no problem with these higher voltages; linear regulated power packs could be a problem, though).

Next, work closely with your local power company to identify the most reliable parts of their electrical distribution grid, based on their outage data. That's where you want to connect your power supplies. Ideally, keep your power supplies close to substations, but on short side spurs to avoid the high fault and switching currents that can exist on main feeders close to substations. Try to avoid these locations: areas downstream of reclosers; areas fed by sectionalizers; areas between load break switch points; distribution lines protected by fuses (if you find you have limited choices, fused distribution lines are preferable to reclosers, sectionalizers and load break switches); and street light circuits (when the power goes down, these will be the last to be restored). If possible, try to connect to high-reliability phases and/or circuits. Often, power companies provide extra-reliable circuits to hospitals, police and fire stations, etc.

Now for an obvious recommendation: Deploy standby power supplies. To get the maximum benefit out of standby powering you also need to do the following: Use the right batteries for the environment in which the supplies will operate; Use limited status monitoring of the standby supplies to keep you aware of the power supply and battery condition, and to alert you when the standby operation time may exceed battery capacity;

Implement a good power supply preventive maintenance program. This means at least quarterly visits to each standby supply.

By far the easiest and cheapest of CableLabs' outage reduction guidelines that you should implement are surge suppression, fusing and proper grounding/bonding.

With regard to surge suppression, you should install solid-state surge suppression devices (generally a type of crowbar circuit) that meet ANSI/IEEE C62.41-1991, categories B3 or C1 (formerly C62.41-1980, category B2). These are available from several manufacturers as retrofit circuit boards for line power inserters, as stand-alone suppression devices, and as manufacturer-provided options for amplifiers. Where they are used, I highly recommend that a separate low-impedance, low-resistance ground be connected to the device housing. (Remember, don't connect copper ground wire directly to aluminum or galvanized steel — use an appropriate mating clamp to avoid a dissimilar metals interface.)

"Considering the low to moderate investment required, the payback in improved reliability and customer goodwill is priceless."

The next thing to do — and this must be done in conjunction with the surge suppression — is to properly fuse the network. Fuses are supposed to be overcurrent protection devices, but all too often they function as a form of unintentional and undesirable surge protection. When the network is overfused or not properly fused, and when you don't have adequate surge suppression, you'll experience an abundance of nuisance fuse blowing. Sound familiar? That's why surge suppression and fusing must be done together.

Here are CableLabs' fusing guidelines. All fuses, or circuit breakers, must be time-delay (slow blow) types. 1) Line power supply output protected at 150 to 200% of the power supply output current rating; 2) trunk amp power pack input protected at just under the current carrying capacity of the amplifier; 3) feeder protected at 150% of normal operation; 4) line extender power supply protected at just under the current carrying capacity of the amplifier; and 5) fuses that are used for power routing (splitters, couplers, etc.) should be replaced with buss bars, except for feeder port power routing in trunk amps (a dead short in the feeder should not take the trunk amp down). Some manufacturers have eliminated amplifier power pack fuses in conjunction with beefing up the power supply circuits. Hopefully this trend will continue.

The final thing to do is properly bond and ground your network. It must at the very least meet the latest NESC requirements. Besides improved safety, this will help mitigate sheath current problems. I talked to one system engineer who experiences a significant amount of sheath current induced amplifier outages. Where he grounded the amplifiers, the problem disappeared. Unfortunately, his system has several thousand ungrounded actives, and the company is reluctant to spend the money necessary to ground them. Too bad, because that would have a big impact on reliability.

There you have it. Several easy but effective ways to reduce outages in your system have been provided. Considering the low to moderate investment required, the payback in improved reliability and customer goodwill is priceless. As Todd Acker, a former colleague of mine once said, "These kinds of investments may not be revenue-producing, but they sure are revenue-protecting!" **CT**


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Figure 3: Choosing return path frequencies

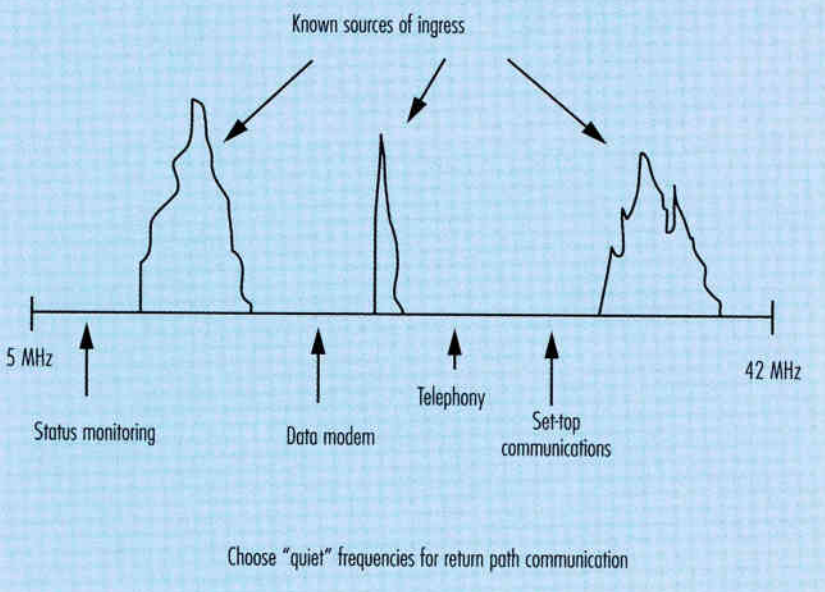
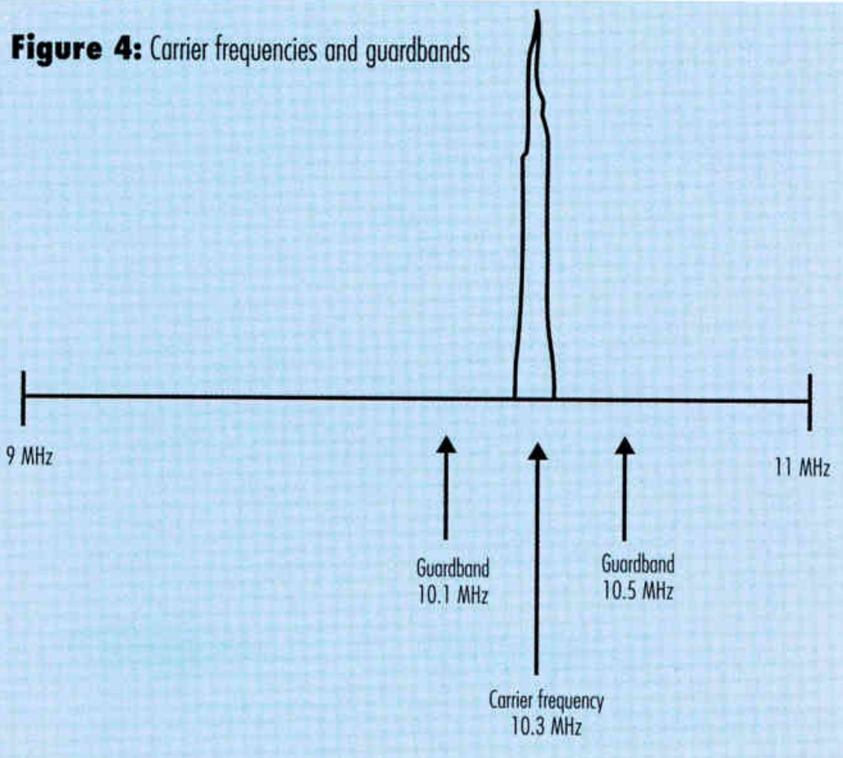


Figure 4: Carrier frequencies and guardbands



Active frequencies and guardbands

Activity	Active frequency	Guardband low	Guardband high
Status monitoring	10.3 MHz	10.1 MHz	10.5 MHz
Set-top communication	25.5 MHz	25.3 MHz	25.7 MHz
Modems	31.1 MHz	30.9 MHz	31.3 MHz

port A of the return path switch.

Output B carries the return signal from one node to a headend signal analyzer. Analysis is performed on one return path at a time, providing the operator with more useful information from each node rather than a composite noise reading. A headend signal analyzer controls port B of the return path switch.

The two outputs of the return path switch, A and B, must be independently controlled to allow signal analysis to take place on one node without disrupting the polling cycle in the system.

Using this method, cable operators can isolate persistent noise or ingress in the return path. The first step is to detect the noise or ingress, and the second step is to identify which fiber nodes may be noisy. Finally, a spectral plot of the return path will be made available to the operator allowing study of the entire frequency range on the return path of the offending node or nodes.

While this analysis is being performed, polling of nodes, power supplies and amplifiers in the HFC plant will continue uninterrupted.

Return path monitoring

The 5-42 MHz region of the broadband spectrum is particularly susceptible to noise from other activities including ham radio operators, broadcast radio channels and common household electrical activity. When the return path is activated within this spectrum, operators choose frequency blocks that will be "quiet" relative to the rest of the band, as shown in Figure 3.

Because "quiet" frequencies are chosen, it can be assumed that the immediately surrounding frequencies—or guardband frequencies above and below the carrier—also are quiet. Therefore, other than activity at the exact carrier frequency there should be no activity in the guardband frequencies. If the headend signal analyzer detects signal in the guardband frequencies, it assumes this is noise. It is further assumed that if there is noise at the

By Justin J. Junkus

Everything you needed to know about telephone signals

Everyone knows the two-way nature of telecommunications makes it different from traditional cable TV. Cable TV is introducing interactivity between subscribers and services, but interactivity has been built into telephone conversations from day one. What's really different, however, is that not only do people need to talk to each other, but so do the machines in the telephone network.

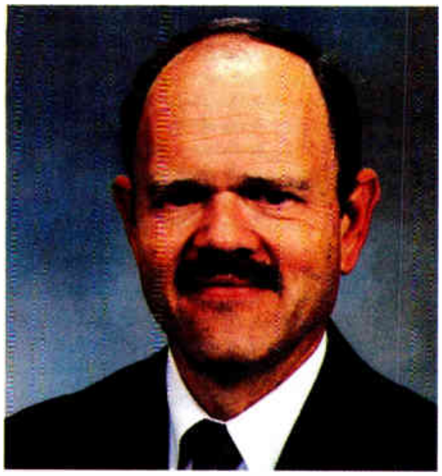
Telephone switches in a headend or telephone company central office can provide several examples of machines signaling other machines or human beings involved in a telephone call. As TV engineers become telecommunications engineers, they need to become aware of the types of telephony signaling that their networks will be processing, along with traditional TV signals.

As the telephone switch example shows, telephony signals can be grouped into two categories. Some signals provide an interface with human beings, and others are used by the machines that complete a connection. During any given call, signals of both types will usually be involved. Communication is typically bidirectional, either between humans, between machines or between a human and a machine.

Consider the process of call setup. Telecommunications call setup depends on two-way signaling. The simplest signaling between the caller and the telecommunications switching machine occurs when a caller picks up the receiver (goes off-hook, in the language of the telephone industry). That action causes an electrical circuit to be closed between the two wires connected to the caller's telephone line (the loop), much like turning on a light switch. The resulting current flow operates a detection device in the service provider's switching equipment, telling it that a caller has requested service. The switch's response is to send audible dial tone back to the calling end. Even at this early stage of call setup, we have transmitted two forms of signal — a DC current toward the service provider, and an AC tone back to the subscriber.

The caller responds to this auditory signal from the switching equipment by dialing a phone number telling the switch where to direct this call. In the "olden days," the usual type of dial was a mechanical rotary device with built-in contacts that do the same thing as picking up the receiver. It opens and closes the electrical circuit to the service provider's switching equipment, only faster and very carefully timed so that the closures can be recognized as digits. In between the digits, the electrical circuit to the service provider continues to appear as a closed connection, which is recognized as the separation between dialed digits. If the timing of any of the open intervals was too long, the switching equipment could mistake a dial pulse or an interdigit interval as a subscriber hanging up the phone.

The switch contains equipment that counts and stores the number of circuit closures as they are received, and sets up a connection through the network as directed by the calling party. Of course, if the called party's line is busy, the switch must send another AC tone back to the caller. This busy signal is a different frequency than the dial tone. It could be interrupted 60 times per minute or 120 times per minute, depending on whether the called party's line is busy, or if a path through the network is unavailable.



In modern telecommunications, dial pulses have been mostly replaced by tone signals, but the concept is similar. Rather than opening the circuit between the service provider's switch and the subscriber, audible tones corresponding to each digit are generated at the telephone set as the caller inputs the digits, and are sent over the closed loop to the switch where they are decoded and stored.

Other types of signals are used internally by telecommunications network equipment to continue the call connection. Although callers are usually not aware of these signals, they are necessary to complete the call. For example, when a call is completed from one switch to another, trunk

Justin Junkus has over 25 years experience in the telecommunications industry. Previously the AT&T cable TV market manager for the 5ESS switch, he is currently president of KnowledgeLink Inc., a telecommunications training and consulting firm.

circuits on each switch need to signal each other that a connection is being established, call information is being forwarded (such as the calling party's telephone number), or that the call connection is being torn down. In an analog network, these signals can be simple loop closures (the same idea as a caller going off-hook to initiate a call) or combinations of battery or ground applied to one or more of the talking path leads. In a digital network, the signaling is part of a set of digital pulses, which are decoded by the network equipment.

Certain analog trunks signal each other with a continuous tone in the voice frequency range to indicate to the opposite side that the connection is on-hook. When that trunk circuit goes off-hook, it removes the tone. The disadvantage here is that the signals are on the same path as voice or data, so voice or data signals at the same frequency could cause the trunk to incorrectly disconnect the line. Also, if the tone source fails for some reason, entire networks of trunks could become busy, significantly degrading network performance.

All of these methods of analog signaling between trunk circuits are susceptible to failures or fraud. In addition, signaling on the talk path requires call setup signaling circuitry to be built into each trunk circuit, adding to its cost. To avoid these negatives, a digital signaling system entirely separate from the talking path was created, called common channel signaling, or CCS.

CCS uses the same concepts as packet switching in the data world to forward call status and caller or called party identification between switch locations. Computers called signal transfer points (STPs) and signal control points (SCPs) are part of the CCS network. Signal transfer points provide the routing information for the call to the trunks in the switches, and signal control points contain data bases with network status or information on the calling or called numbers. While CCS was begun as a better method of call setup, its data base capability has evolved it into a feature-rich intelligent network that makes possible capabilities like nationwide personal telephone numbers.

So the cable telecommunications engineer needs to know not only cable TV, but also analog telephony and digital data communications. Everything you need to know will never be in one place. Telecommunications education is a continuous process, because the technology is continually changing. The only way to keep current is to draw from as many resources as possible, including this column, courses offered by the Society of Cable Telecommunications Engineers, your employer, educational institutions and outside reading.

For comments, suggestions or more information on this subject, Jay Junkus can be contacted at JJunkus@aol.com. **CT**

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Reader Service Number 78

By Britton Manasco

Videoconferencing promises over digital networks

As the number of individuals linked to networks continues to expand, the desktop computer's importance increasingly will revolve around its communications-related capabilities. Indeed, desktop videoconferencing appears poised to become one of the leading applications on tomorrow's broadband nets.

In a recent keynote speech at the Telecon XV conference in Anaheim, CA, Norman Gaut, chairman, CEO and president of PictureTel Corp. argued that the videoconferencing industry will go through the following "four waves of development": 1) group videoconferencing; 2) desktop videoconferencing; 3) local area network (LAN) videoconferencing; and 4) multicast videoconferencing on the Internet.

Most of the revenue generated from videoconferencing today comes from the first stage of industry development: dial-up group videoconferencing. It is a shared resource that depends on careful scheduling. And it is typically telephony-based, operating on ISDN (integrated services digital network) and switched 56 kbps lines.

However, it's a relatively mature market segment because of its restrictions and costs. Systems have a price spread today of $10,000-$50,000. While the segment has grown roughly 40% per year in recent years, the rate is falling, according to Robert Mirani, senior analyst for Boston-based Yankee Group: "Growth is slowing overall, but there's still growth." He predicted that price per videoconferencing room installation will dip below

$20,000 in 1997-1998 and annual unit sales will slow to 20,000.

That explains the rising interest in ISDN-based desktop videoconferencing. Multimedia Research Group, which is based in Sunnyvale, CA, predicts that the overall desktop videoconferencing market (including both desktop systems and upgrade kits) will rise dramatically from $148 million in 1995 to more than $14 billion in 2000.

Among the key service providers that are focusing in on the market's

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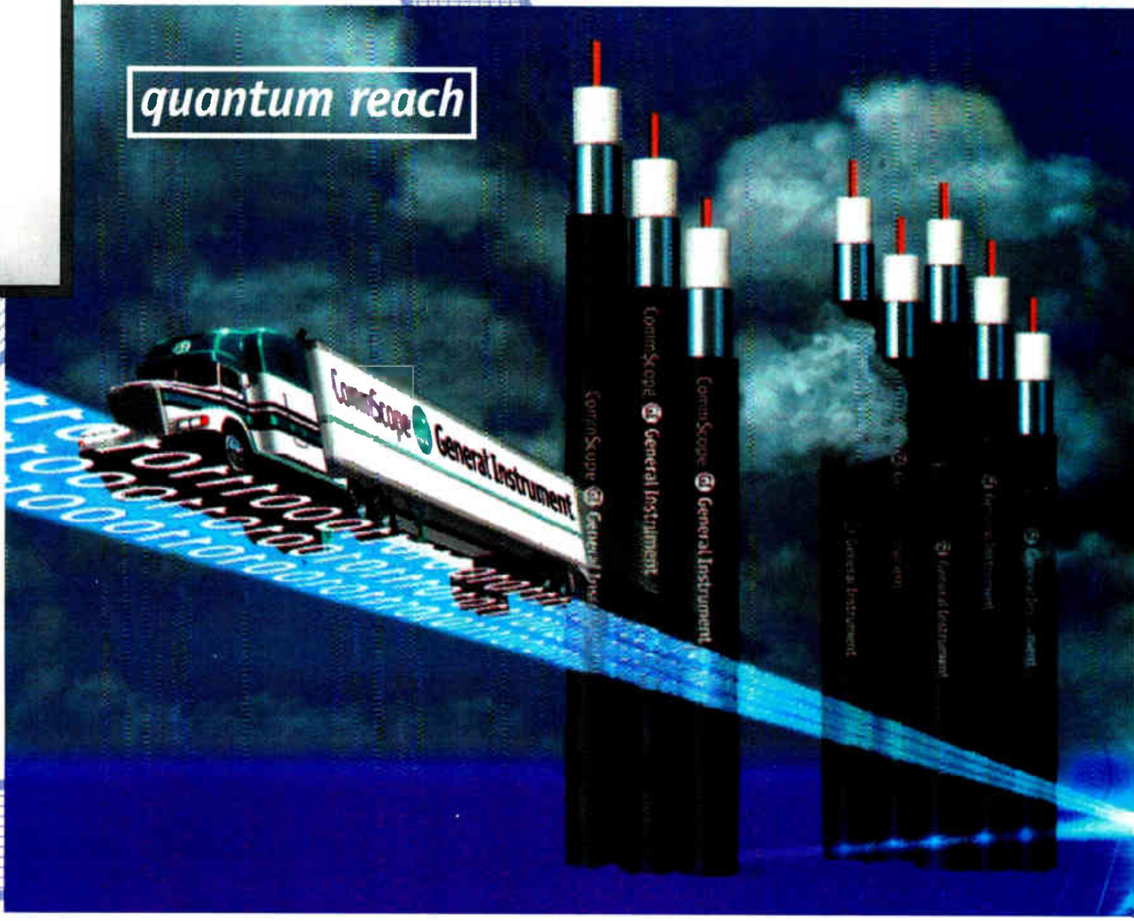


Reader Service Number 41

potential are telco carriers such as AT&T, MCI and Sprint. Meanwhile, important videoconferencing software and hardware offerings are being promised by such companies as Intel, AT&T, British Telecom, Compaq, Lotus, Vivo and Microsoft.

New markets, new alliances

As a result, traditional videoconferencing equipment players such as PictureTel, Compression Labs Inc. and VTEL, who still generate most of their revenues through group systems, are searching for alliance partners.

Gaut, whose company recently signed a PC bundling agreement with Compaq Computer, contended that industry standards will emerge in 1996 and that it will become a common feature on the PC in 1997: "This will be an explosive part of the overall mix."

Unlike group videoconferencing, the desktop alternative is a personal resource. It is spontaneous, not scheduled. There also is a significant opportunity to incorporate collaborative software tools, permitting the users to share information and applications. Moreover, it's less expensive than the group systems. Mainstream products run between $1,000 and $5,000.

Gaut explained that the desktop systems are attracting corporate buyers that previously did not purchase the group systems. What is grabbing their attention is the power of desktop videoconferencing as a collaborative tool. Among the applications: access to remote experts, sales-related communications, training and education. Indeed, some corporations are employing it for mission-critical management applications.

What's driving the rapid adoption of desktop videoconferencing? Recent advances in microprocessor power are a primary enabling factor. But there also are a series of new, board-level, video signal processors coming to market that are enhancing the PC as a platform for visual communications tools.

At the same time, standards are evolving. The industry is converging around the H.320 standard for ISDN videoconferencing as well as the H.26X standard for video compression on LANs and public networks. In fact, ISDN finally appears to be taking off. Bellcore estimates that 88% of regional Bell operating company (RBOC) territory will be ISDN-capable by end of 1997 and forecasts 90% metropolitan penetration by end of 1996.

Other factors: the enormous growth in the PC installed base. Gaut noted that while business markets still account for a majority of units sold, the majority of multimedia PCs sold are going to the home. That trend is colliding with communications trends. "ISDN will begin to penetrate the home market in 1996 to fulfill user demand for fast access to on-line multimedia services via the Internet," said Sarah Dickinson, an analyst with Personal Technology Research in Waltham, MA.

Gaut's third wave of development, LAN-based videoconferencing, revolves around communications within a company. While some analysts note that LAN managers now are having difficulty managing the existing data communications applications, Gaut is convinced LAN video is coming to the fore.

He notes that a series of collaborative and multimedia tools will reside on the LAN server, permitting constant and spontaneous information sharing. Importantly, he argued that LAN videoconferencing will be inexpensive because most of the costs are sunk in the network infrastructure.

Gaut, however, reserved most of his enthusiasm for Internet-based videoconferencing — something he expects to see become increasingly common within the decade. Like LAN-based videoconferencing, the Internet mode will be multiparty by design, as he sees it. It also will permit efficient and spontaneous network links that cut communication costs dramatically. "This is a very interesting and inevitable evolution," Gaut said.

For more information, you can contact the following: PictureTel Corp., (508) 762-5000; Compression Labs Inc., (408) 922-4610; VTEL Corp., (512) 314-2594; Personal Technology Research, (617) 893-2600; Multimedia Research Group, (408) 524-9767. **CT**

By Michael L. Smith

Monitoring strategies

As new services are provided, the need to monitor the operational health of equipment and the overall network will increase. Subscribers of telephony and data services have higher satisfaction and reliability expectations than video-only subscribers, according to published polls.

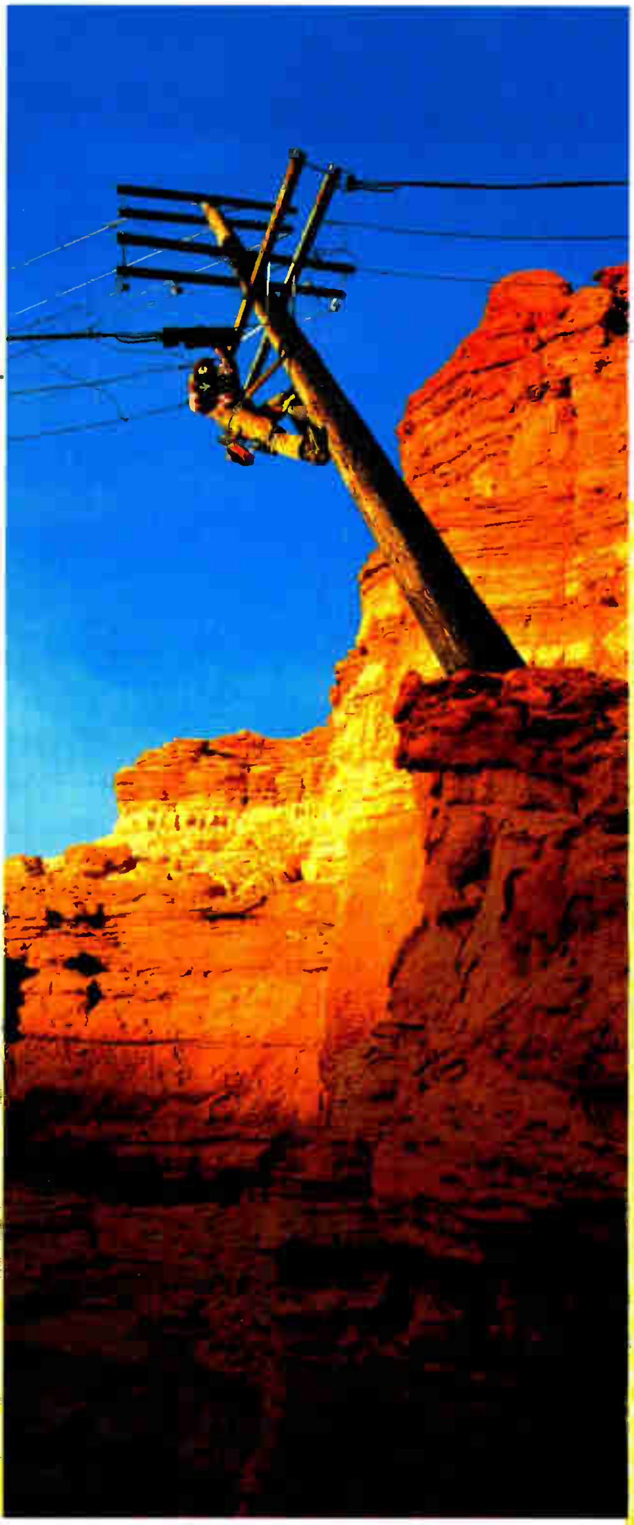
Several factors will influence the decision to utilize a remote monitoring system. These include: system architecture, equipment make(s) and model(s), services provided and company philosophy. Some broadband service providers are actively deploying monitoring systems as part of their rebuild/upgrade plans. Scheduled delivery of some new service offerings are anticipated to demand ongoing monitoring of the network. Some equipment being utilized may not have monitoring capability, which may require modification in order to achieve desired results.

Michael Smith is the director of engineering for Adelphia Cable in Staunton, VA. He can be reached at (540) 886-3419.

"The expertise and experience of technical staffs must be used wisely. They are a limited resource."

The older tree-and-branch architectures required fewer end-of-line locations to be monitored in order to determine overall network status, however, performance and reliability were less than desired due to the number of cascaded devices. The newer HFC architectures have reduced performance and reliability concerns, but have greatly increased the number of locations which must be monitored in order to evaluate the health of the complete network. Isolated faults could easily affect a small segment of the network, which could go undetected until a customer complaint is received, unless sufficient monitoring is in place.

This change in architecture requires that maintenance departments reconsider staff and resource allocations in order to meet this challenge. The approach must be to "work smarter, not harder." The expertise and experience of technical staffs must be used wisely. They are a limited resource. Even with comprehensive training programs in place and achieving positive results, mainte-



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nance personnel will be pressed to keep pace with all the issues and new technologies.

Remote network monitoring may be one way to address this concern. In general, monitoring is divided into status monitoring and performance monitoring. Performance monitoring is best described as the monitoring of selected locations in order to determine the operational integrity of the network to that point. Status monitoring concerns the "health" of selected equipment (i.e., power supplies, amplifiers, fiber-optic nodes, etc.) within the network.

Utilizing both types of monitoring allows parameters to be established throughout the network. Anytime a parameter (high or low) is violated, an alarm is generated for immediate identification and resolution.

Control centers would have the needed information to ensure assignment of appropriate maintenance personnel. Personnel could be dispatched to the precise location of the failure, reducing troubleshooting time and outage duration. Minor alarms would flag areas for assignment of maintenance crews to perform routine activities not requiring immediate action.

Performance monitoring would also allow remote testing to meet reporting requirements imposed by the company, franchise authority and FCC regulations, as well as identify areas requiring corrective action. Maintenance personnel would be assigned to known problem areas, again resulting in efficient use of resources.

Other benefits of remote testing include reduced subscriber complaints by minimizing the number of channel interruptions and duration. Staff overtime is controlled since testing is scheduled and accomplished unattended at the least objectionable time.

Most monitoring systems are scalable, which will allow you to address areas of need more specifically. End-of-line monitoring might be implemented first, which would allow analysis of the overall network and provide remote testing to meet the reporting requirements imposed. The monitoring of power supplies might be selected as the next step to allow monitoring of a vital network element, and could play a significant role in the utilization of staff resources involved with their maintenance. Battery voltages can be individually monitored and the unit tested remotely for proper operation. This would reduce unnecessary visits and allow personnel to focus on corrective action where needed or be utilized for other maintenance issues. The monitoring of fiber-optic nodes, OTNs, amplifiers or other devices could be implemented as the need is realized and funding is made available.

Communication between the control center, the headend controller and the field devices must be robust and reliable. There are several methods that might be utilized and include RS-485, phone modem, direct, RF two-way modem, etc. The options selected will be dependent upon your network architecture and the equipment chosen.

The ability of the monitoring system to be integrated into a composite network management system, which might include interfacing with billing, pay-per-view, fleet, etc., could prove invaluable.

In summary, the use of remote monitoring systems will aid in better utilization of limited maintenance staffs and resources to meet the challenges of new technologies, subscriber expectations and the delivery of enhanced services. The monitoring system selected should offer both performance and/or status monitoring. The system should be scalable to allow implementation to meet network requirements within company budget guidelines and offer open network interfaces to meet future network management plans.

The choice is simple ... "Do you work smarter, or harder?"

Until next time — read on! **CT**

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By Alex Zavistovich

Cable modems — Part 2: The race for your PC gains speed

This is the final installment of a two-part series on data delivery services using cable modem technology. In this installment, "Communications Technology" looks at how the services will be provided, who's joined the race, and why some cable operators are talking about "overbuilding the Internet."

Microwave ovens. Instant coffee. ATM machines. Prescription glasses in about an hour. Consumers have come to expect nearly instant gratification in every aspect of their lives — whether it's getting cash with a card a thousand miles from home or using a personal computer to pull work-related information off the Internet at one in the morning before tomorrow's big presentation.

On-line services are a prime example of our thirst for knowledge in the Information Age. For those spoiled by lightning-quick T-1 and ISDN access to the Internet while on the job, however, these services have a flaw at home: They're not fast enough.

Not any more. A growing number of cable system operators have decided that their networks can allow fast access to the Internet and on-line services, with the help of cable modem technology. TCI, Time Warner and Comcast Cable are launching data services delivered over hybrid fiber/coax (HFC) lines. These MSOs have placed substantial orders with cable modem manufacturers including Motorola, Hewlett-Packard, Zenith, Com 21, LANcity, Toshiba and others for the devices. Other operators as well, here and in Canada, are jumping

on the bandwagon and conducting tests of the service in select areas.

Data delivery may become a legitimate revenue generator for cable operators as early as this year. Cable engineers agree that their networks are basically robust enough to carry on-line traffic. Some industry spokespersons even maintain that the increased demand for on-line access and faster speeds will require the cable community to "overbuild the Internet," adding backbone to accommodate the added load.

Making the connection

The first three data services out of the gate are Time Warner's Linerunner, TCI's @Home and Comcast Online from Comcast Cable. Not surprisingly, in each case connection of the cable modem to the subscriber's computer requires an Ethernet port.

"Ethernet is the lowest cost high-speed serial connection we can establish with today's PCs," explained Jim Chiddix, vice president of engineering and technology at Time Warner Cable.

Time Warner has entered into an agreement with a local computer store to provide the connection to subscribers whose computers are not outfitted with an Ethernet port, although he added that "none of this installation work could not also be done by our own people." Comcast and TCI are still considering whether to create such a partnership for Ethernet installation. "We're [illegible]ghing the extent to which w[illegible]e to be in the business of [illegible]ng on computers or [illegible] this is best-f[illegible] area vendors," said Joe Waz, Comcast's vice president of external affairs.

Time Warner's Linerunner offering connects via high-speed lines to an Internet provider in the service area. At the subscriber end, a 10BaseT connection is used. Data from the subscriber's PC travels back to the headend via the standard CATV complement of line extenders, bridgers and amplifiers. Chiddix conceded that "going through amplifiers always adds noise to signals, but we're using QPSK modulation, which is quite robust. It's not affected by the low levels of noise on the cable system."

Waz said Comcast anticipates initial deployment of Comcast On-line (its provisional title) to employ asynchronous transmission, with a considerably larger downstream pipe than upstream, but added that "the upstream pipe will probably be faster than ISDN. It makes the most sense for what we anticipate the mass usage to be."

It isn't as if all you need do to get into data services is buy a

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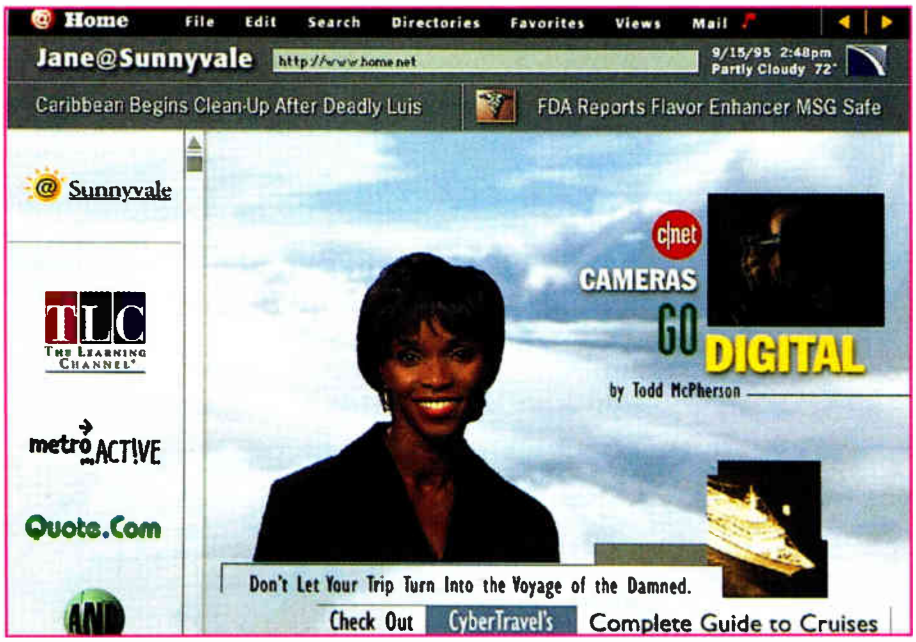
modem, of course. Besides the modem at the customers' premises, there is the other half of the modem set at the headend or distribution hub. Routers deliver packets to appropriate places. Even further behind the scenes at the headend is a complex system of gateways to off-site services, servers for local services, network management architecture, and subscriber management and billing systems. In Time Warner's Linerunner trial in Elmira, NY, Chiddix explained, Hewlett-Packard provided all the support architecture, including the GlobeView system for network management.

Is the current HFC network architecture for cable reliable enough for this kind of two-way data communications? MSO spokespersons agree that it is with some tweaking. Particular consideration is given to the return path, which has developed a reputation for being the least reliable portion of the network.

According to Michelle Kuska, director of network technology for TCI Technology Ventures, some upgrades may be required to ensure that on-line services like @Home operate optimally. Many of these upgrades, she added, are done as a matter of course. "Once a plant is return-path activated, there are maintenance methods and procedures for keeping the return path 'clean.' Upgrade and rebuild programs are occurring for TCI systems to reduce the number of homes passed on a node and to activate the return path."

At the subscriber drop, some additional inspection will be required, Kuska said. "Current drop cable can be used. However, it will have to be inspected to determine if it is capable of supporting two-way transmission and is tightened up against noise ingress." In many cases, according to Kuska, the location of the computer in the household will require that a new drop be installed to provide service. An F-connector will be used to terminate the cable drop into the cable modem, Kuska added. The cable modem will have a home run connection either directly to the tap or to a splitter that hangs off the tap.

In Comcast's current technical trials, Waz said, engineers are still "working the bugs out of two-way."



"We're conducting a technical trial to figure out where the problems lie in the upstream path," Waz explained. "Our technical people feel we've learned an immense amount about network engineering, and what our vendors need to know. We believe we're really cracking the nut on making two-way work effectively."

Time Warner's experience in its trials indicated that the company's HFC network has held up reasonably well to the demands of data communication, said Chiddix. Still, he added, "that's not to say we haven't had to do some things to tighten up the system. We've had to fix some RF leaks, and we've learned quite a lot about operating levels to run on the return." Chiddix also noted some experience with corrosion points that have created common path distortion interference in the upstream path from signals coming on the downstream path. These occasional problems have led Time Warner to replace some system components, "but it hasn't required anything drastic," Chiddix said. He anticipates the same minor tweaks in the other locations. "It's nothing extensive or surprising."

The Internet and beyond

By industry standards, the trials and initial deployments of on-line access via cable are ambitious. Spokespersons at all three MSOs concur that potential demand for high-speed computer access over HFC networks is great. It's not surprising, then, that some of these companies are already thinking beyond simple gateway services, and are looking at ways to enable the cable industry to expand the actual Internet infrastructure. That includes not only dedicated local networks, but even talk of added backbones for the Internet.

"Will Comcast be an Internet service provider? Probably yes," said Waz. "We will provide the gateway to get people onto the Internet. We also, however, anticipate having our own server farms, either on a local or regional basis, to facilitate Internet usage by caching certain frequently accessed information at those farms." Comcast now has a name before the Trademark Office to describe the localized version of the Internet being developed by the company; at press time, Waz was unwilling to reveal the name.

"We expect a substantial increase in the modem user market," said Waz. "We're confident we can push modem use well into the double digits in the local markets. It makes sense to have localized content."

It also makes sense to have a means of handling this projected additional capacity, whether local or national. Waz commented on talk within the industry of "overbuilding the Internet" by building additional backbones to overcome the inherent and growing delays in Internet traffic. "It wouldn't surprise me if you see some development along these lines," he commented. For its part, Comcast is taking nothing for granted. The company is also trialing complete broadband management systems, talking with ADC and other vendors. "Should we go that route, systems would be installed for managing bandwidth for video, data and telephony. We're looking at all our opportunities at once and figuring out the best network deployment."

At TCI, however, the catchphrase "overbuilding the Internet" is used routinely to describe the company's on-line offering, @Home. According to TCI Technology Ventures' Kuska: "The current public Internet is incapable of handling the amount of traffic that will be generated by widely available high-speed Internet access. As a result, TCI is going to use @Home as a backbone network provider."

"@Home is essentially overbuilding the Internet and, at the same time, maintaining full Internet connectivity," said Kuska. Servers will be connected directly to the @Home backbone, mirroring web sites at the @Home regional data centers and caching data at headends or local distribution hubs. Users will still be able to access all Internet data, Kuska explained, because the @Home backbone network will be connected to the Internet at three or four locations throughout the country.

Time Warner's Chiddix sees the value in having cable operators develop and manage their own localized networks, if only to ensure reliability of service. "In Elmira, we are tied directly through our own network, using leased facilities, to the Time Inc. publishing content servers in New York City. We could have done that connection through the Internet, but we needed guaranteed quality of service and a managed network; that was critical to our service."

"Our customers are going to have access to service providers who are a key part of our package, and we will have to have our own network to tie to those providers," explained Chiddix. "Customers will also have access to the Internet, which is chaotic and not very secure, but filled with all kinds of important information. There's a place for both."

Working together

Of course, the success of this new revenue source for cable depends on interoperability of equipment. Cable operators don't want to worry about proprietary technology, and neither do consumers. For data delivery to work over cable, one computer has to be able to talk with another, regardless of who makes the modem or the net-

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work hardware. That means having an open standard around which manufacturers can design their own equipment.

CableLabs has been working on an interoperability standard with General Instrument, Hewlett-Packard, Intel, LANcity, Motorola, Nortel, Scientific-Atlanta, Toshiba and Zenith. Richard Green, president of CableLabs, maintained at press time that preliminary specifications for a standard would be in place by mid-March.

CableLabs is not the only group working toward a standard, however. Hewlett-Packard and Lucent Technologies (formerly AT&T Network Systems) have formed a working partnership with Intel and Hybrid Network Technologies in the so-called "Broadband Link Team," announced at the Western Cable Show.

Spokespersons for the companies at that time indicated that a preliminary set of specifications for an open standard would be available by the end of 1995. They were a bit off the mark in their estimates. At press time, the specifications were incomplete, and Lucent Technologies spokesperson Jeanne Snell would not speculate as to when a standard might be released to the industry.

No one denies the need for a standard, although there is some reason to wonder whether the Broadband Link Team's efforts are truly helping CableLabs. Regardless, for Time Warner's Chiddix, standardization is important to the continued development of delivery of on-line services by cable. "In 1996 the industry is going to deploy a lot of hardware — there's a huge market just waiting for this service," said Chiddix. "What we will converge on as a standard is going to be what works best, although it has to be open." Chiddix conceded that proprietary equipment may work as part of an industry standard, "but only if vendors are willing to license the products at reasonable fees."

"I wouldn't see this as a rivalry," said Chiddix of the work by CableLabs and the Broadband Link Team. "The whole point of having a standard ultimately is so that not only we the industry but consumers directly can buy interoperable equipment from a variety of sources. That will ensure there is a competitive market, where quality is up and costs are kept down."

New in town

Standard or no standard, more and more cable operators are joining in the game, testing Internet access and on-line service delivery.

In February, Continental Cablevision began a trial of Internet service to some 200 homes in the Boston area. The operator teamed up with Internet provider BBN Planet to bring the service to consumers, who are connected to the Internet with cable modems supplied by Andover, MA-based LANcity. The trial is expected to last six months. In addition to Internet access, the test includes computer software to browse the World Wide Web, e-mail, customer support services and product marketing. "High-speed Internet access will be a major feature of the new services we'll offer in the future," predicted Continental President Bill Schleyer.

> **"In 1996 the industry is going to deploy a lot of hardware — there's a huge market just waiting for this service."**
>
> *– Jim Chiddix, Time Warner Cable*

On the other side of the country, Brad Anderson, president of Cable Co-op, a Palo Alto, CA-based cable operator, is using his system to test data delivery to 20 homes and elementary schools, using a variety of modems, including some from Com21. The tests have been both one-way cable modem downstream with a telco return and two-way through the trunk, Anderson said. Cable Co-op, which runs an all-coax network (no fiber), is conducting an engineering test to determine what must be done to the network to support multiple uses. The company will be conducting marketing and operational tests later this year.

Meanwhile, to the Great White North, Shaw Communications in Canada is starting its own data delivery trials. Jim Shaw, the company's president, had tests of different interactive services on the network scheduled for February, using Motorola CyberSURFR cable modems. Some 300 homes are to take part in the market trial. Shaw said his company hasn't "locked in on a name for the service," because a commercial launch is not scheduled until September at the earliest. He expects, however, that the price will be in the area of $40 (Canadian).

These new players are still uncertain as to what the target market should be. "There's a big difference between commercial and residential products," said Shaw. "I don't know if they really mix that well. The only function they have in common is the Internet access."

Anderson agreed. "I'm beginning to think that to be successful (in delivery of data services), you have to take advantage of the unique benefits of symmetrical high-speed data transfer both downstream and up. I'm not convinced this is a casual product to use at home." Anderson conceded, however, that "there are clear benefits to telecommuters and small businesses using high speeds (in excess of 1 Mbps) in both directions."

"In general, the missing element seems to be the content end," Anderson commented. "High speeds afforded by cable modems will support a variety of new types of content. The question is, how will it be developed — and who will develop it?" **CT**

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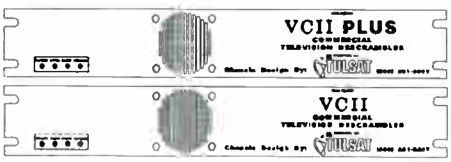

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By Henry Kallina

Reverse path design/construction

The following is adapted from the "Society of Cable Telecommunications Engineers 1996 Conference on Emerging Technologies Proceedings Manual."

Traditional cable systems of just a few years ago contained cascades of 30 trunks, one bridger and two line extenders. The use of fiber optics reduces these cascades to eight amplifiers or less. For carrier-to-noise ratio (C/N) purposes, the forward path is a series of amplifiers in cascade.

The reverse path is a series/parallel connection of amplifiers, all of which contribute noise back to the headend. The most difficult part of operating a reverse path with long cascades is isolating the path where signal ingress is occurring. In systems using fiber nodes, it is relatively easy to isolate the offending node and isolate the source of ingress.

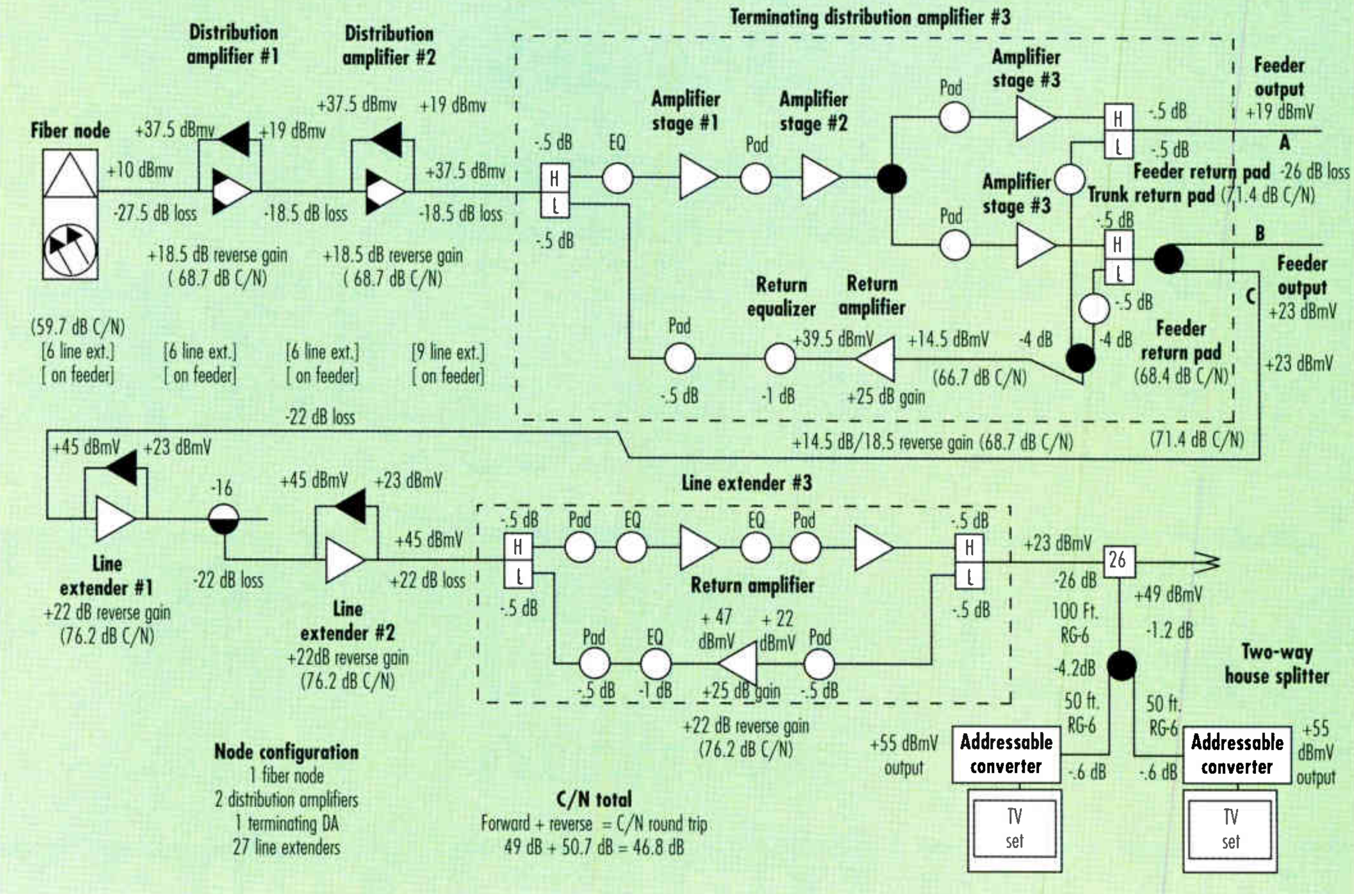
Long amplifier cascades cause the system's bandwidth to narrow and increases peak-to-valley. Maintaining long amplifier cascades is achievable, but requires a large and dedicated maintenance staff. Short cascades are easier to maintain and result in fewer subscribers without service should an amplifier fail.

The 5-30 MHz or 5-40 MHz bandwidths are currently in use. Since Ch. 2 in the forward path starts at 54 MHz, the maximum RF spectrum available is 5-40 MHz until all consumers have converters allowing the frequency spectrum to be reallocated. As in the forward path, shorter cascades are easier to maintain, and improve reliability.

In the forward path the concept of unity gain applies. Amplifier gain is offset by cable loss plus insertion losses of splitters, directional couplers and taps. The design of the reverse path should be calculated for the desired C/N at the headend or hub. The C/N for every amplifier module in the reverse path needs to be calculated and summed. Levels for the amplifier inputs and outputs on the reverse path need to have some basis of assumption. This article assumes that an addressable converter is the signal source with a specified output level. Amplifier input/output calculations are then made back to the headend. Then C/N calculations are made on

Henry Kallina is the owner of Broadband Engineering Solutions and Technology in Parker, CO. He can be reached at (303) 841-6522.

Figure 1: Node schematic



guardband frequencies, there also is noise at the carrier frequency.

As an example, Figure 4 on page 48 assumes the operator has chosen to run status monitoring communication at a frequency of 10.3 MHz. The headend signal analyzer is then programmed to perform a level detect measurement at the guardband frequencies of 10.1 MHz and 10.5 MHz. Under normal operation, these guardband frequencies should be "quiet." If a signal is detected (above a user-defined threshold), the headend signal analyzer triggers an alarm condition.

Let us further assume that this cable system has two return services activated in addition to active status monitoring.

In the example in the accompanying table on page 48, the headend signal analyzer would be programmed with the guardband frequencies, and would continually cycle the return path switch to perform level measurements at these frequencies on each of the individual return paths. When an alarm condition is encountered, an alarm is generated and a spectral plot is prepared on the return spectrum for that particular return path. While this activity is taking place, polling continues uninterrupted through the A port to the status monitoring headend controller.

Summary

Effective maintenance of the return path requires analysis of individual return paths. This analysis cannot interfere with status monitoring and polling of transponders, otherwise the reliability of the network would be degraded. In addition, the analysis must be automated and must operate unattended around the clock.

A return path switch isolates individual node return paths. Independent dual outputs on the return path switch enable analysis without interfering with polling for status monitoring, and a headend signal analyzer under the control of the management software and the headend controller allow signal analysis of individual return paths in an automated, unattended fashion. **CT** each amplifier module in the reverse path and summed.

Having the forward design not limited by the return amplifiers gain is more important than maintaining unity gain in the return path. (See Figure 1 on page 46.) Even though the gain of the feeder portion of Terminating Distribution Amplifier 3 is only 14.5 or 18.5 dB (depending on which port), the return input level is the same as that for the 22 dB reverse gain line extender feeding it. As a result the same amount of passive loss can be accommodated in both forward and return paths between the line extender and the distribution amplifier. The forward design is no longer return-limited. True, the return output level and spacing of the distribution amplifiers is now less than that of the line extenders, but there are no taps between the trunk portion of the distribution amplifiers and little requirement for a higher loss return budget.

A good procedure for setting up the amplifiers on the test bench prior to field installation will keep setup and alignment time to a minimum.

A C/N of 48 to 49 dB with a 4 MHz video bandwidth, is generally accepted as providing a noise-free picture with today's large-screen TV sets.

If a system uses a video quality return laser at a node, a 46 dB C/N ratio is about the best that could be expected for an NTSC video carrier. This assumes that the video carrier is starting at the farthest point from a node in the reverse path returning to the headend and then sent back on the forward path.

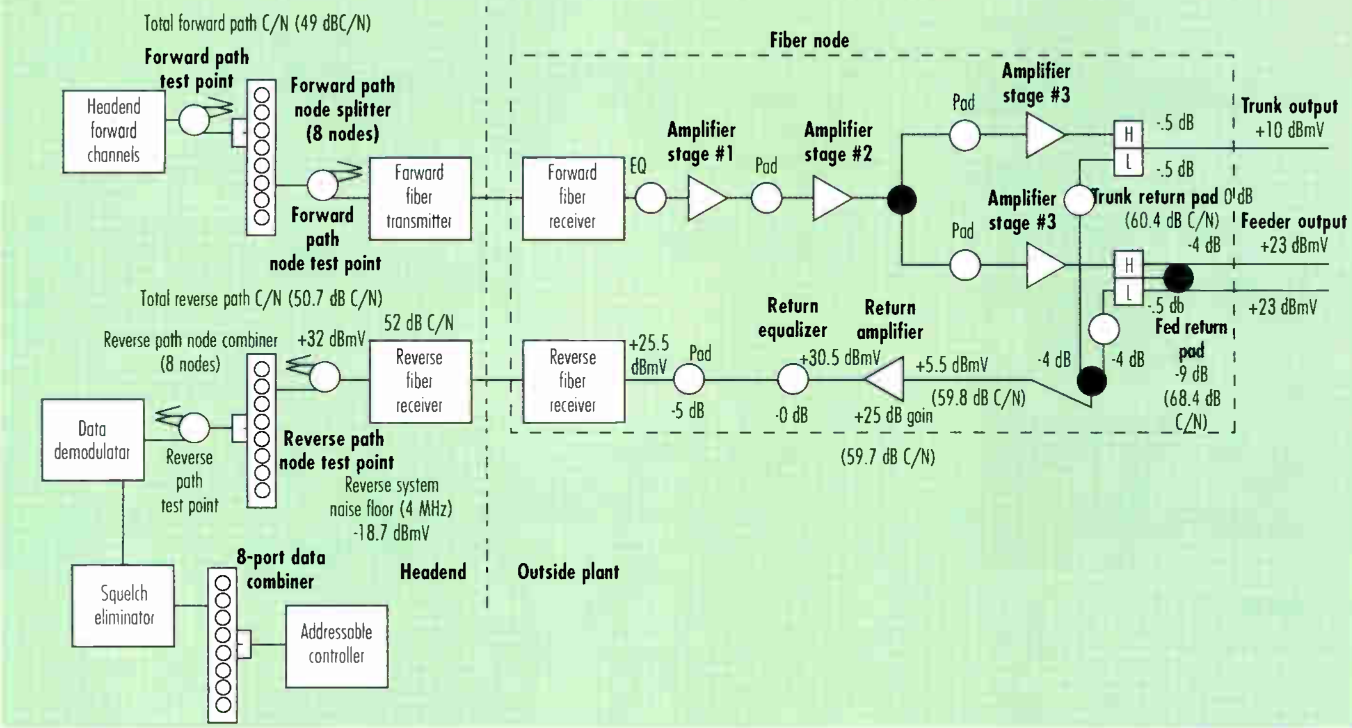
Fortunately, most return signals occupy bandwidths substantially less than 4 MHz and are digital in nature, making an equivalent 4 MHz C/N ratio of 25 dB or less acceptable. This low C/N requirement is why there haven't been many technical problems in carrying digital signals from addressable converters. It might be prudent to use video signal transportation standards for reverse system design.

Distortion analysis must be calculated for the forward path to ensure picture quality at the headend is identical to that at the consumer's TV set. This must occur regardless of outside temperature change.

Also importantant is that adding fiber and keeping amplifier cascades short does not ensure better picture quality than a conventional long cascade of amplifiers. Why? How many times have you seen distortion in a TV picture connected to the second line extender of an eight-trunk amplifier cascade? The distortion usually showed up at the output of the line extenders fed off the 25th trunk amplifier on a very hot or cold day. In system design, distortions are calculated for the last amplifier in the cascade. Fiber architecture systems are typically less than eight amplifiers in cascade and the level of distortion is close to the design limit at nearly all points. This compares with the low level of distortion in conventional systems at the eighth amplifier.

System distortions are usually calculated in the trunk by setting the operating input level higher than the noise floor and the output less than composite triple beat (CTB)/composite second order (CSO)/cross modulation (XMOD) specifications. In other words, the level is set somewhere in between these two contributors. In the feeder,

Figure 2: Headend and first node schematic



the outputs of the amplifiers are increased to the design limit of CTB, CSO and XMOD. This is done to obtain the highest signal level in the feeder plant and provide for long feeder lines, the highest tap value with lowest insertion loss and short line extender cascades.

The calculation of distortion and

C/N in the reverse isn't as simple as in the forward path. In the forward design, the quantity and level of the RF carriers are constant. In the reverse path, a data carrier burst or occasional video carrier makes calculation of distortion of little value. It is important that the reverse carriers are not high enough in signal amplitude to cause amplifiers, fiber transmitters and receivers to overload and clip the RF signals.

Automatic gain control (AGC) and automatic sensitivity control (ASC) are very important in system operation. When system distortions are calculated, the effect of temperature and signal level change isn't usually considered, because it is assumed that the system AGC/ASC will compensate for changing levels on the amplifier inputs due to temperature effect on the coax. The AGC/ASC in the amplifiers should act on these input level changes and hold the amplifier outputs constant. Chamber testing is necessary to verify that the amplifiers operate over temperature with your selected system design. Without chamber testing, AGC/ASC operation cannot be adequately checked and monitored prior to equipment installation and system activation.

It is generally accepted practice to use AGC/ASC in every trunk amplifier. In the feeder, there are different engineering practices. Some use thermal amplifiers only, some a combination of thermal and AGC, and some use AGC only.

My preference is to use AGC line extenders at all locations. There has been chamber testing conducted on short cascades of taps and passives as they would appear in a feeder. These devices' insertion losses can change up to 3 dB in quantities normally found between line extenders. The additional effect of temperature on the coax then alters the insertion loss of the taps and passives. The use of AGC in every line extender location is the only effective method to counteract the changes of taps, passives and coax over temperature in the feeder system. The use of AGC line extenders underground is necessary to compensate for the insertion loss changes for taps and passives over temperature.

Since the amount of cable loss is less in the reverse path, the effect of temperature on cable is reduced, but its effect on the taps and passives is still a factor. Most manufacturers offer thermal control for reverse amplifiers and prudent use of this type of control is good engineering practice. The question is: Where should thermal control be used?

Thermals should be placed, starting at the first amplifier from the node, for the dB of cable they are designed to compensate for. This is not an easy task because the thermals introduce additional insertion loss, and this loss uses up the reverse gain. The use and placement of thermals in the reverse needs to be analyzed on a system-by-system basis. Thermal control adds insertion loss and temperature varies it. Thermal operation is crude by some standards, but will work if the manufacturer's recommendations are followed. The use of AGC in reverse is complicated by the requirement that AGC needs a pilot carrier to operate. It would require the installation of a pilot carrier generator at the end of every feeder line — making this impractical.

In the forward path, the pads and cable equalizers are located before and sometimes between the amplifier stages. Cable equalizers are selected for the previous cable in dB at the highest frequency. If there is 20 dB of cable at 750 MHz previous to the station, then a 20 dB cable equalizer is required. Pads are selected to attenuate the RF input signal so that the combination of cable, cable equalizer and pad is equal to the gain of the amplifier station. If a 26 dB station is located at the end of a span of 20 dB of cable, it would require the installation of a 20 dB cable equalizer and a 6 dB pad.

In the reverse, the opposite is true. Typically there exists a socket for a pad, the amplifier stage and then sockets for a cable equalizer and second pad. The equalizer is used to compensate for the cable between it and the next upstream station. The input pad should then be used to provide proper amplifier input. By padding return amplifier inputs rather than outputs, a better carrier-to-ingress ratio is achieved. The output pad should only be used to match levels where two (or more) amplifiers are combining to feed the next upstream station.

Testing the forward path has many established and proven proce-

(Continued on page 92)

By Lyle Haynes

Automating field operations

Over the past decade, computers have significantly altered construction automation. Until recently these changes were limited to office-related or desktop work processes. But now, the increasing availability of "mobile computing" solutions is offering an opportunity to use computers in field-related work processes.

So many cable TV field work processes are paper-dependent and use or capture data that is valuable back at the office. The problem, up until recently, was that the technology was not readily available to develop efficient field automation solutions. But that has changed.

The decision to automate can be a difficult one depending on the complexity and number of work processes. The first step is to identify a work process that can benefit from automation. For instance, an underground facilities locating business — a business with a variety of efficiency problems.

The work order

There is a great deal of paper associated with this work, making significant savings possible through even a relatively small (10%-20%) increase in efficiency. To better understand the reasons and results of automation, it is important to understand the current life cycle of a work order.

Office

1) Excavator notifies facilities owners of intent to dig.

2) A work order or ticket describing where the excavation will be performed, the type of excavation and any other relevant information is generated.

Lyle Haynes is manager of software development for Kelly Cable Corp. based in Denver, which provides construction, utility locate, installation and other services.

3) The work order is then transmitted via modem to a computer at the main office.

4) All of the work for a given day is sorted by location and routed to one of the lead technicians.

5) This work is then printed out and distributed to each lead.

6) The lead for each area determines if additional technicians are needed and distributes work orders.

7) The technicians route their work based on location, work type and appointments that need to be met.

Field

1) The technician travels to a site and locates the underground facilities as described on the work order.

2) Depending on the landscape and conditions, facility locations are marked with paint, flags, whiskers or a combination.

3) On the work order is a predefined space for a sketch.

4) A copy of this sketch is left for the excavator. Copies are brought back to the office for reference in the event of a damage at the site.

Even with a good understanding of the work process, it is important to dedicate personnel to study the process in detail. This person can ride along with different technicians and study their methods in order to identify areas that can be improved through automation.

Kelly Cable identified three major areas that could benefit from automation: distribution of work to technicians; routing of work after technicians receive it; and the redundancy of doing essentially the same sketch multiple times.

All of these are field-related work processes. Following are improvements to the above work order that can be made in a field software application.

Office

5) The work is placed in a predefined directory on a host computer. Each lead can then call in from home and download the work to a portable computer.

6) If additional technicians are required, the lead can select work orders to be passed on and upload them to a predefined directory on the host computer.

7) Once loaded into the computer, the work to be performed is automatically routed by placing the location of the work order on a digital map of the technician's area. Special circumstances such as appointments are indicated with a code in the work order list.

Field

3) The technician's sketch of the facilities is drawn on a pen computer and saved for future reference. This sketch can be quickly and easily retrieved and reused during future visits to the same site.

4) A digital copy of the site sketch is placed on the computer work order and printed out using a portable printer in the vehicle. A copy is left for the excavator. The digital copy of the work

order is downloaded to the host computer in the office for reference in the event of a damage at the site.

Software

The goal should be to come up with a design that mimics, as close as possible, the current process. Rather than change the way technicians do their job, the software should be a tool that makes their job easier.

Investigating available hardware and software solutions for our application, Kelly Cable selected pen computers as a hardware platform . (These are identical to a notebook PC except they use a pen-like device for data input.) Other considerations in selecting hardware included versatility and expandability through Personal Computer Memory Card International Association cards.

A computer that supports a variety of these cards can become a machine for many uses and easily be upgraded based on the needs of the application. The hardware also has to be rugged enough to survive in the work environment and be powerful enough to run the application efficiently. Also very important is the cost of the hardware that meets these requirements.

Choosing software can prove rather difficult. We wanted a PC-based software product that had some basic functionality such as a powerful graphics engine with connectivity to a data base. Essentially we sought a mobile geographic information system (GIS) that supported applications in AM/FM, GIS and GPS.

It should be designed for field workers to work with data downloaded from a central data base and support vector, raster and standard data base files in a variety of common formats. Users should be able to append, change or delete information in the field, while supervisors should control when and how the changes are made centrally. Extensive drawing tools, pen-specific support and user customization of the menus will prove useful.

Important to our software decision was the availability of an engine development kit, which was absolutely necessary for us to custom tailor a product to our specific needs. Other issues included the stability and potential endurance the company possessed. As a safeguard, it was important for the company to be willing to place their source code in escrow to ensure that we would have a core product to work with even if the company disappeared.

Return on investment

In deciding to automate, most important is estimating a return on investment (ROI), which is determined by development costs, cost to equip a technician and efficiency gained by using the application.

The one complication when pricing hardware is that the technology changes so fast that the cost could change significantly in as little as six months. Our approach to this problem was to base our ROI on current market prices. In regard to the software, we took the list price of the core software and added a value-added fee per unit to account for development costs.

To determine and quantify the efficiency gained by using the new system, we estimated the time that would be saved in each affected area. Feedback from the technician in the field to senior management is important to these estimates. →

In developing a prototype of the application, we created a timetable for completion, with benchmarks to help measure progress.

Our first step in proceeding was to take our application design, expand it into a detailed application design and develop the application. Our goal was to create a design that would be relatively static but flexible enough to accommodate any unexpected changes.

This application design should be centered on the data that technicians need or create, and provide tools to facilitate the interaction or creation of that data. A model for data flow and data management should serve as a framework for the design and development of the user interface.

The user interface

In developing the user interface, one unique problem is that some users will have no computer experience. The challenge is to design an interface that will serve a fairly complex data management model while being extremely easy to use. This can be accomplished through a control panel that provides work information and access to other application features. Having one window to control the application will simplify the interface and make it more user-friendly. Also helpful are Windows features such as pick lists and buttons, and the use of familiar terminology.

With a detailed design in place, you should be able to assess the programming resources required to develop a prototype. The development language should provide extremely powerful applications development and be easy to use. In developing the field portion of the application, the goal should be to create a prototype that performs the basic functions required by the design, understanding that in some cases these functions will not be performed as efficiently as possible.

It is extremely beneficial to demonstrate the application in its various stages of development to management as well as the end users. This provides real-time feedback. These demonstrations also can identify issues that alter the design. Training an end user before the application is fully developed also can identify further improvements.

Once the office training of our "beta" technician was complete and some additional modifications were made, we conducted a field training. A developer observed a technician performing a light work load.

We compared results of a time-motion study of work processes before and after automation. Considering this information and feedback from the technician, the following questions should be posed:

- Does the application save time and how much?
- Do these time savings justify implementation?
- If not, are there design changes or modifications that could be made to justify implementation?
- What is the ROI based on results of the pilot? **CT**

Some Leakage Problems Are Pretty Easy To Identify...

and some are not always so obvious.

Being a model is not as easy as it looks. At least that's what Ann Marie Liberty learned on her first big modeling job. And besides, no one told her about the stress other models put on a girl. Perfection is a demand that's not easy to achieve.

Unless you're looking for things that aren't always on the surface. Cable Leakage Technologies has been in business over 5 years and has found more than 4.8 million miles of cable leakage all over the world while boasting positive identification, 2-5 meter location and one step prioritization. Things that impact *your* bottom line. We did all of that because we invented the original Wavetracker...it's that simple.

Now the New Wavetracker makes it even more simple...and it thrives on perfection.

All New:

- *Trilithic Channel Tag Ready* • *2-5 Meter Positional Accuracy 100% of the Time* • *Windows Based* • *One Step Processing*
- *All New Hard/Software* • *Solid State Nonvolatile Data Storage*
- *Upgraded Digital Mapping*

Standard:

- *Work Order Creation* • *Quality Control* • *Proof*
- *Quarterly Monitoring/Comparison* • *Archiving*
- *Time Management* • *GPS Tracking*

To some people, accuracy and consistency are worth it...an original.

THE NEW WAVETRACKER

CLT CABLE LEAKAGE TECHNOLOGIES
1200 Executive Drive, Suite 136
Richardson, Texas 75081
800.783.8878 · 214.907.8100

Reader Service Number 40

By John Chamberlain

Fiber outside plant PM

Optical fiber has been installed in cable networks at an unparalleled rate over the past five years, resulting in a dramatic increase in network reliability and signal quality. Many cable engineers have had fiber installed in their systems with limited understanding of the media and its performance in the outside plant. This mass deployment of fiber also has resulted in a concentration of communications circuits into long lengths of increasingly smaller and more vulnerable packages in need of new maintenance methods.

Fiber outside plant records

The need for excellent outside plant records is especially important for fiber-optic cable. Typical fiber outside plant records should include the following:

• *Fiber routing information:* This includes headend routing from the transmitter through all patch panels to the OSP cable; outside plant cable ID, bundle color and fiber color; splice enclosure fiber routing; fiber node assignment; transmitter ID and rack location.

• *Cable routing information from design and construction as-build records:* This includes cable route, splice enclosure locations, cable excess slack locations, node locations, and footage marker recordings at the headend, splice points, excess cable slack points and terminations.

• *End-to-end individual fiber attenuation values:* This includes fiber, splice losses, connectorization losses, optical distances to splices, and attenuation measurements at 1,310 nm and 1,550 nm.

• *Cable sheath condition:* This includes resistance of the armor-to-ground and end-to-end armor to ground.

• *Power level (optical and electrical):* This includes headend equipment RF levels, laser transmitter output, received optical power at the node or other receiver, and RF output and distortion values at the receiver.

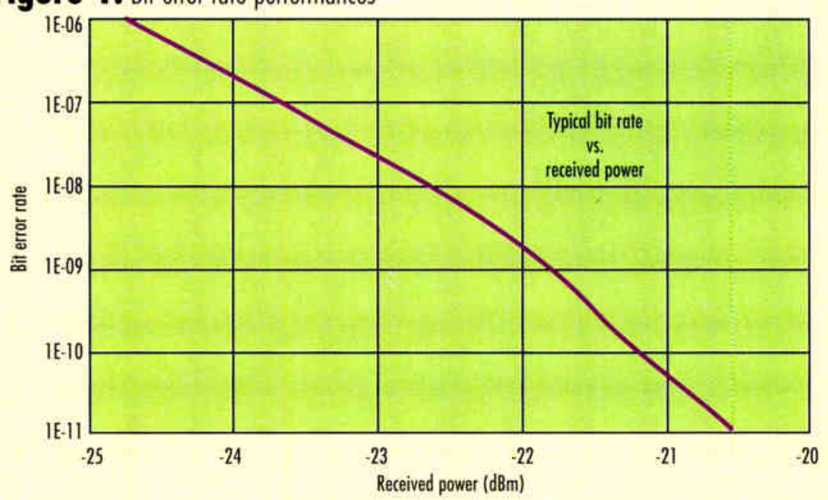
This data should be securely stored, easily accessible and updated on a regular basis. Although paperwork systems are completely acceptable, a computer data base is obviously well-suited for these requirements. Regardless of the type of system, one system administrator should be responsible for updating the data base due to planned changes or changes recorded in periodic system audits. System audits of all practically attainable data should be done at least every two years.

Optical fiber monitoring

Until recently the only practical way to monitor the fiber-optic transmission path was by monitoring the receive end of the network equipment. When the transmission signal is lost, something is definitely wrong with the transmission path. It only tells you the obvious when a failure occurs. A method that can give early warning of impending transmission problems is required for an effective "monitoring" system. Bit error rate (BER) monitoring for digital systems have been developed by the transmission industry in an attempt to meet this monitoring need. BER monitoring systems typically can be set to alarm at 10^{-3}, 10^{-6} or 10^{-8} BER, depending upon the system and the manufacturer. Systems typically run nominally at 10^{-11} BER or better. As can be seen in Figure 1, a change in BER from 10^{-11} to 10^{-6} corresponds to approximately a 4 dB increase in optical loss. A 4 dB increase in loss in an optical fiber path usually denotes a serious outside plant problem, yet BER measurements are relatively insensitive to this type of loss. A digital signal's insensitivity to noise is what makes it very robust, but also makes it a very poor way to measure degradation of the transmission media.

New systems have recently been developed that actually monitor the transmission path of each individual fiber. Optical time domain reflectometer-based monitoring systems make periodic measurements on each transmission path, keeping a historical record. Optical power throughput systems also are available that continuously monitor optical paths. In both systems baseline measurements are taken and maintenance alarms are sent when preset increases in transmission path attenuation are detected. As an additional benefit, many of

Figure 1: Bit error rate performances



Bit error rate increases rapidly with drop in Rx power beyond minimum threshold.

John Chamberlain is general manager of Norscan, a manufacturer of fiber-optic cable monitoring systems.

these systems also offer a computerized data base capable of keeping your entire fiber-optic data base as mentioned before.

Fiber sheath monitoring

New systems also are available for the continuous monitoring of the sheath of fiber. These systems are based on techniques used in the past for acceptance testing of twisted-pair cable. Although most recorded outages of fiber are caused by instantaneous cable cuts, many causes of fiber outages are due to a slow degradation of the cable. Cable sheath monitoring allows for the maintenance of the cable sheath and therefore of the fiber within. These systems are completely remote-controlled and alarm reports are automatically forwarded to preprogrammed alarm centers. This type of monitoring is truly an outside plant preventive maintenance monitoring system.

A Federal Communications Commission report published in 1993 evaluated 160 major fiber outages creating in excess of 650 hours of downtime for one year beginning in March 1992. (See Figure 2.) Of these outages, approximately 60% were caused by instantaneous failure resulting from backhoe dig-ups and vehicle collisions. The 40% of outages not causing instantaneous failure such as a variety of typical outside plant failures such as rodents, incorrect installation, water, power lines, firearms, etc. The study dealt mostly with how to eliminate the single largest cause of outages — dig-ups — by recommending rigorous "call-before-you-dig" programs, tone location and better record keeping.

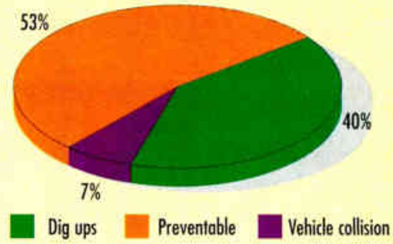
The sheath monitoring systems now available make these noninstantaneous failures preventable. These systems, like fiber monitoring systems, are available with a data base to keep not only the sheath monitoring records, but also all other outside plant records.

Tone location programs

Tone location has been used for years in locating coax. Fiber location is even more critical because of the high density of traffic and the relative difficulty in emergency restoration. Tone location equipment is commonly used as a means to locate underground cable. Tone location is accomplished by applying a low frequency tone (typically 512 Hz) to a longitudinal metallic member in the cable.

The most common application is on the corrugated steel armor. (Armor is traditionally applied to cables in order to protect the cable from the rigors of the outside plant.) Tone location signals are usually applied at splice points where the sheath is easily accessible. New long-range, automated tone location devices also are available. A long-range tone location transmitter is installed in a headend, central office or repeater hut. Special grounding devices are installed at

Figure 2: Reported outages from 3/92 to 2/93



splice locations in order to allow the long-range tone location signal to travel beyond the splice but still provide a ground for induced 60 Hz AC and high-voltage transients caused by lightning or power company surges. The centralized transmitter can be remotely switched on to "light up" the cable. Then hand-held field equipment is used to locate cable underground before a construction dig begins.

It should be noted that in order to monitor the sheath or tone locate fiber, an armor must be an integral component of the cable. An armor should be deployed, in any case, for an underground plant in order to better survive the rigors of the outside plant environment. In addition, for sheath monitoring and tone location, the outside plant should be constructed so that the armor is electrically accessible at splice locations. This is commonly accomplished by making electrical connections from the buried splice enclosures to an above-ground pedestal. **CT**

By G. Keith McDonald

Curing the shakes: Is your plant earthquake proof?

Cable service is rapidly moving from just entertainment to becoming a necessity for many subscribers. Many people rely on cable to provide information critical to their work and personal lives, and soon the service also may become the sole method of communication for those households choosing cable for local telephone access, as is already common overseas. It's important to note, however, that the increasingly important role of cable carries with it increased risk of severe repercussions should the service fail when it is needed most.

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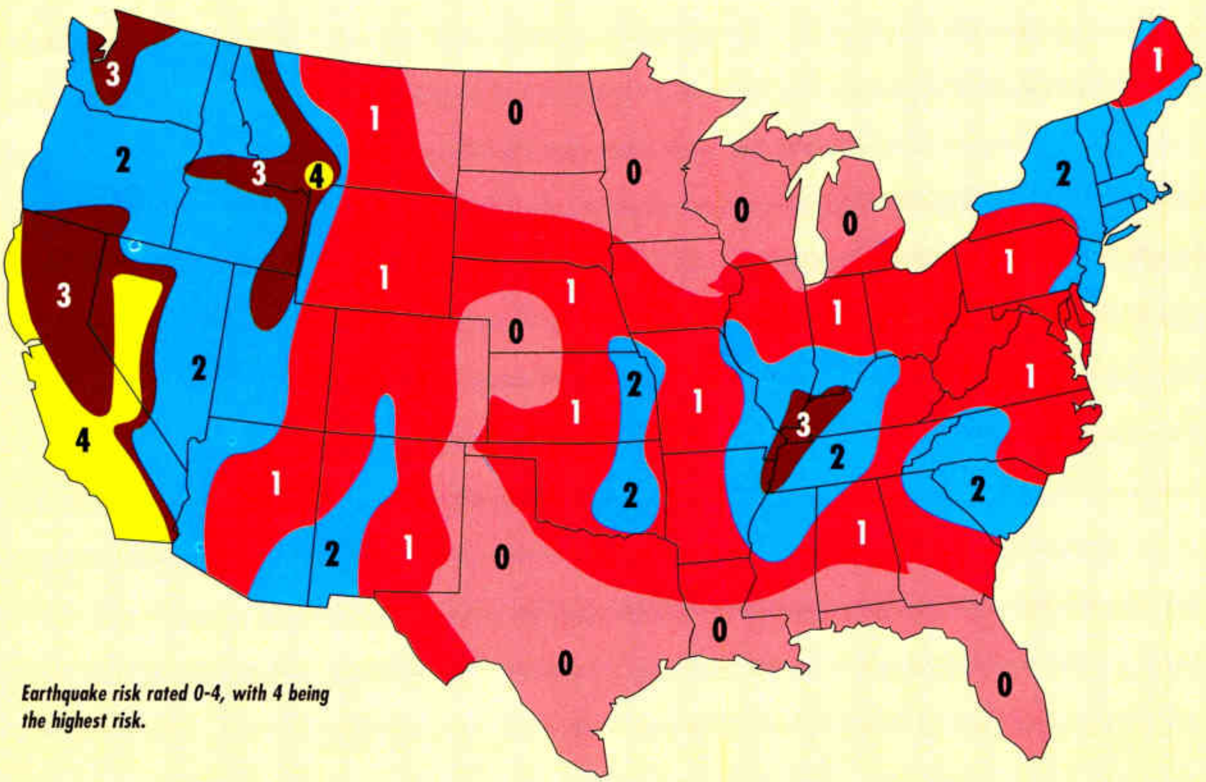
For example, imagine you are a customer in the Los Angeles area and have selected a cable provider for local telephone access. Chances are that you may one day experience an earthquake measuring 6.0 or more on the Richter scale. If you are injured or otherwise in need of assistance, you expect to be able to pick up the telephone and call for help. Unfortunately, you may not get a dial tone if the cable provider has not planned for just such an emergency. The same is true even when the stakes aren't as great: For example, consider on-line services, which some cable operators are offering over hybrid fiber/coax lines: If the network is down, so is your access to the Internet.

The problem is not isolated to the West Coast, either. Major telephone companies have known that there are fault lines in parts of the Midwest and on the East Coast that have the same risk of earthquake damage as some parts of California. How can you find out what the risk of seismic activity is for your headend, and how can you better plan for such an event? It may be easier than you think.

Risk assessment

First off, the effects of earthquakes and many other vibrations (say, as caused by a busy street or railroad track nearby) on electronic gear has been thoroughly studied by some test laboratories. One of the most well-known is run by Bell-

Bellcore earthquake zoning map



Earthquake risk rated 0-4, with 4 being the highest risk.

core. Bellcore publishes various technical references that are available to the industry for a small charge. The technical reference that applies to seismic activity and other vibration is TR-NWT 000063. This technical reference not only provides risk assessment for earthquake damage in the U.S. by geographic area, but also provides detailed setup inspections on how to test equipment for resistance to seismic activity.

be taken to brace taller structures and cable tray to the ceiling or walls using Z-bars or Warren trusses in both horizontal axes. Structures must be spaced away from walls or columns to prevent equipment from being crushed as the structure flexes. Cable (especially fiber, but also copper) must be laid with slack and protected cable rack turns to allow them to move and flex without pinching or snapping. Don't forget to examine the floors and walls of the

"The best anchors aren't much good on wood, unreinforced concrete or thin steel walls or flooring."

According to Richard Gemra at Bellcore, "Earthquakes usually last from 10 to 60 seconds, and have their major energy content in the mechanical frequency range of 1-20 Hz. Facilities and equipment structures that have similar natural frequencies will experience amplified motions that are often many times greater than the ground motions." The U.S. is broken up into "zones" rated zero through four, with four being the highest risk. (See accompanying figure.) Equipment installed in Zone 4 areas must pass the most stringent tests.

Supports, fasteners and structures

Equipment providers have learned to design supports, fasteners and structures to provide protection from seismic disturbances. In general, structures involve the racks or cabinets that house the electronic equipment and overhead or under floor racking for cable. Supports are the framing and brackets that attach the structures to the building and floor with fasteners. Fasteners may include a combination of grade five bolts and nuts, along with high-strength anchors for the floor.

While it is important to ask your headend or central office installer to use seismically rated equipment, it also is important to make sure the room layout is properly considered. It is possible to install the proper equipment in a way that will still cause problems in the event of an earthquake. Care must

room. The best anchors aren't much good on wood, unreinforced concrete or thin steel walls or flooring.

If you are having the equipment installed for you, select a vendor who understands and can evaluate seismic risk. If you are installing the equipment yourself, consider hiring an engineering firm to inspect the proposed site and help with the layout. Your equipment vendor also can help. Companies that provide seismically rated structures and supports can usually provide advice and layout drawings for their equipment at little or no charge.

Trouble also can come from unexpected sources after an earthquake. Power outages may be measured in days rather than hours and batteries can be drained before supervision can arrive through blocked roads. Automatically triggered generators help, but can run out of fuel and also need to withstand the vibration. The best prevention is to have at least one on-site maintenance person in major equipment installations, and emergency travel plans to those installations you can't staff around the clock. Such plans need to consider contingencies for closed bridges and overpasses.

With the proper advanced planning, even most earthquakes can be weathered with minimal losses in service, revenues and equipment. The peace of mind provided to your customers and company is worth the effort. **CT**

By Morris Engelson and Jerry Harris

Hybrid digital/analog signals: Dynamic range theory — Part 2

Recapping the introduction to Part 1 in the February issue, the cable TV signal is sometimes analog sinusoidal, sometimes noise-like due to digital modulation and sometimes mixed analog/digital as in digital audio combined with analog video. Whatever the combination, it is a high-density spectral environment that puts a strain on the dynamic range performance of test equipment. Dynamic range of the test equipment, such as the spectrum analyzer, is a critical factor because it affects the ability to make a large range of needed measurements, such as composite triple beat (CTB), second order intermodulation (CSO), adjacent channel power, etc. Indeed, the situation can be even worse when an apparently proper measurement is made but the result is wrong because of spurious response generation and signal gain compression due to inadequate measurement dynamic range of the spectrum analyzer.

"The key to obtaining the largest possible measurement dynamic range ... is to set the input signal at the largest optimum level where distortion products just become visible."

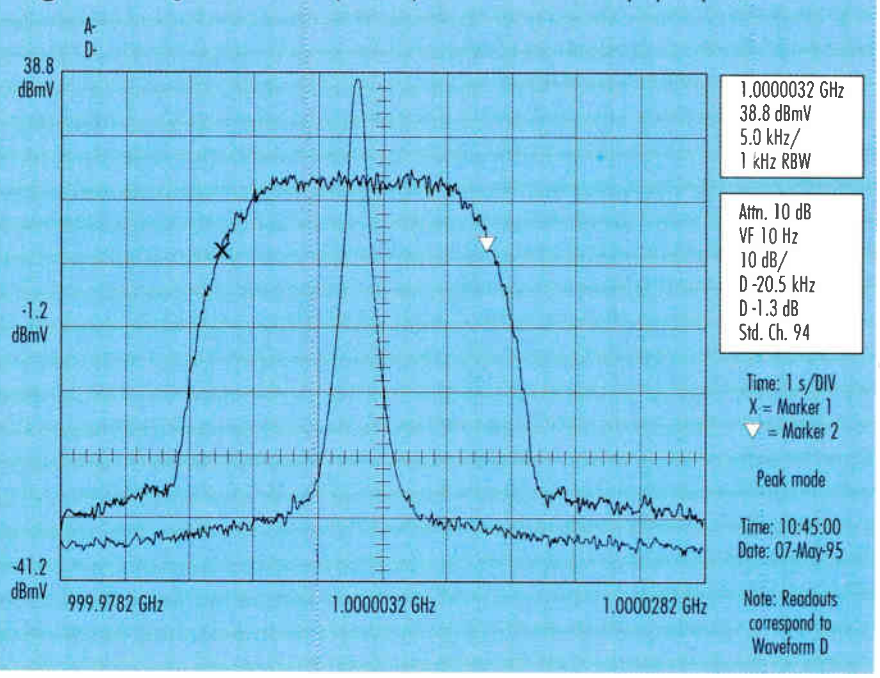
The user needs to be concerned with three issues. What dynamic range is needed? What optimum, or best, dynamic range can be obtained with a particular spectrum analyzer? And, how should one set the instrument in order to achieve the best possible dynamic range results? Part 1 provided a tutorial summary of the various dynamic range issues associated with analog, digital and digital/analog cable TV signals as discussed in the literature. References are provided for those who want to dig deeper. This part applies these factors to practical measurements.

Morris Engelson is consulting chief engineer and Jerry Harris is product marketing manager, both for Tektronix Inc. in Beaverton, OR.

Practical dynamic range

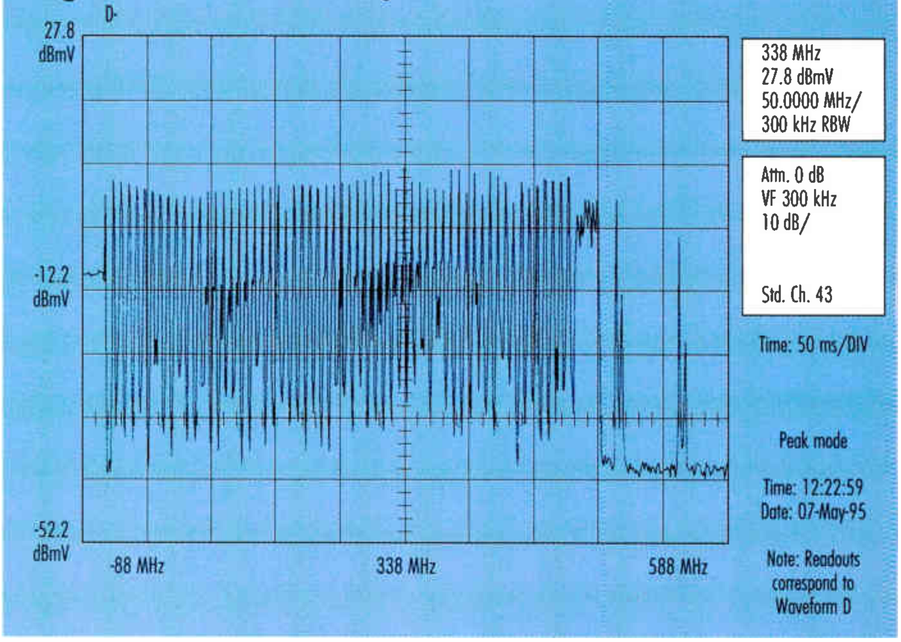
Part 1 of this article discussed how the multicarrier environment of a CATV signal puts a strain on the dynamic range of a spectrum analyzer. Digital modulation signals also reduce dynamic range performance becausethe indicated displayed amplitude is well below the true transmitted power due to spectrum spreading. These factors will reduce dynamic range by between 20 dB and 40 dB compared to a two-carrier signal, depending on various signal parameters. A good spectrum analyzer typically used by cable systems will exhibit a maximum dynamic range of about 90 dB before the impact of multiple carriers and digital signal spreading. Hence, we find that the theoretically comput-

Figure 1: Digital modulation spreads spectrum for reduced display amplitude



ed dynamic range for a dense CATV environment could be an inadequate 90-40 = 50 dB. Fortunately, multicarrier and spread spectrum theory is not fully applicable to the spectrum analyzer. The actual performance will be about 10 dB better than calculated, resulting in a barely acceptable 60 dB worst case dynamic range, and 75 dB at best. But this requires that the input signal level be just right, as discussed later in the article. At this time we will illustrate the reason for the 10 dB improvement compared to theoretical calculations.

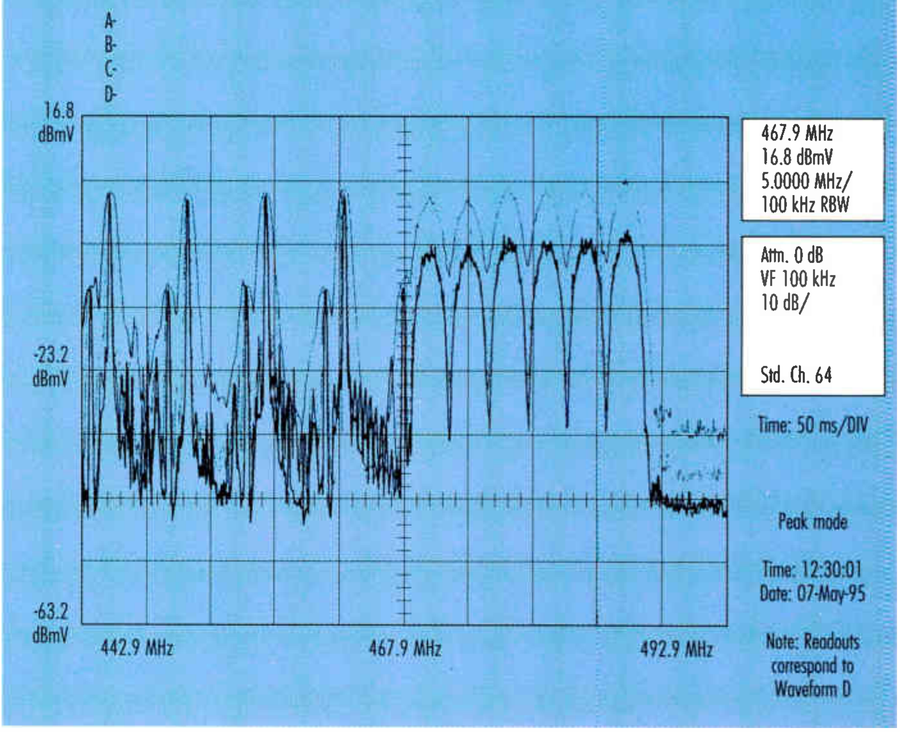
Figure 2: Multicarrier cable TV signal



Wide spectrum environment

All wide spectrum environment, theoretical dynamic range relationships start with a narrow signal environment 1 dB compression point, as discussed by Perlow.[1] This can be combined with two-tone intermodulation factors[2] and multisignal amplitude stacking[3] to establish a theoretical dense-spectrum dynamic range value. These calculations assume that all signal components are simultaneously present in all circuits. This is not the case for the spectrum analyzer. This instrument includes a cascade of three intermediate frequency (IF) amplifiers of progressively narrower bandwidth. Hence, just a few closely spaced carriers will be simultaneously present in all circuits. However, many carriers will only impinge together on the front-end IF circuits, not those on the far-end. Distortion from the far-end circuits will not increase as the number of signal carriers increases because the signals cannot interact unless these are simultaneously present in the circuit. Dynamic range performance for a spectrum analyzer is therefore about 10 dB better than it would be for one constant bandwidth wideband amplifier when subjected to a large number of cable TV carriers.

Figure 3: Zoom of Figure 2 showing analog channels and digital audio



You can easily test the overdrive capability of your spectrum analyzer as follows. Apply an unmodulated carrier with an amplitude at the maximum input level that the spectrum analyzer can handle. Now frequency modulate the signal to spread the spectrum over a relatively wide frequency bandwidth. You will find that the signal level can be increased by about 10 dB before the spectrum analyzer gets into difficulties. Thus for the 2715, starting with a full-screen spectrum of a 48.8 dBmV unmodulated carrier, the spectrum analyzer input attenuator is set at 20 dB, and the front-end circuit is subjected to 48.8-20 = 28.8 dBmV. Frequency modulation does not affect the amplitude of the signal, but the carrier power is moved into sidebands and spread in frequency. After frequency modulation the spectrum display is about 17 dB below that of the unmodulated carrier. This FM spectrum was increased in level by 15 dB before the 2715 went into gain compression. This illustrates that a wide spectrum signal can go at least 10 dB above the spectrum analyzer limit for a narrow spectrum width signal.

Digital modulation

Digital modulation spreads the carrier transmitted power across a frequency spectrum. The resulting display amplitude is less than for the unmodulated carrier and this reduces the dynamic range. The measuring bandwidth should not be made so wide that it distorts the resulting spectrum shape. Too narrow a bandwidth will not improve spectrum shape resolution and just increase the measurement time. The usual range of bandwidth to spectrum width is 1:3 to 1:30, with a 1:10 ratio about right. Under optimum bandwidth conditions the loss in display amplitude and dynamic range will be between 10 and 20 dB.

Figure 1 on page 60 shows the spectra of an unmodulated carrier and after the carrier is digitally modulated. The occupied-bandwidth function of the spectrum analyzer has been set to measure the 10 dB down spectrum bandwidth, which shows as 20.5 kHz. The spectrum bandwidth, spectrum shape, transmitted power and many other signal factors can be determined by the spectrum analyzer.[4,5,6] The resolution bandwidth is set at 1 kHz, resulting in a 15 dB display amplitude difference between the unmodulated 1 GHz carrier and the digital modulation spectrum. This is in the middle of the expected range of 10 to 20 dB.

The expected amplitude reduction can be calculated when the digital modulation signaling rate is known. The relationship is 10 Log(modulation rate/measuring BW). For a digital modulation signaling rate of 270 kbps, for example, we have an amplitude shift of 10 Log (270/10) = 14 dB when using a 10 kHz measuring bandwidth, and 10 Log (270/3) = 19.5 dB when using a 3 kHz measuring bandwidth.

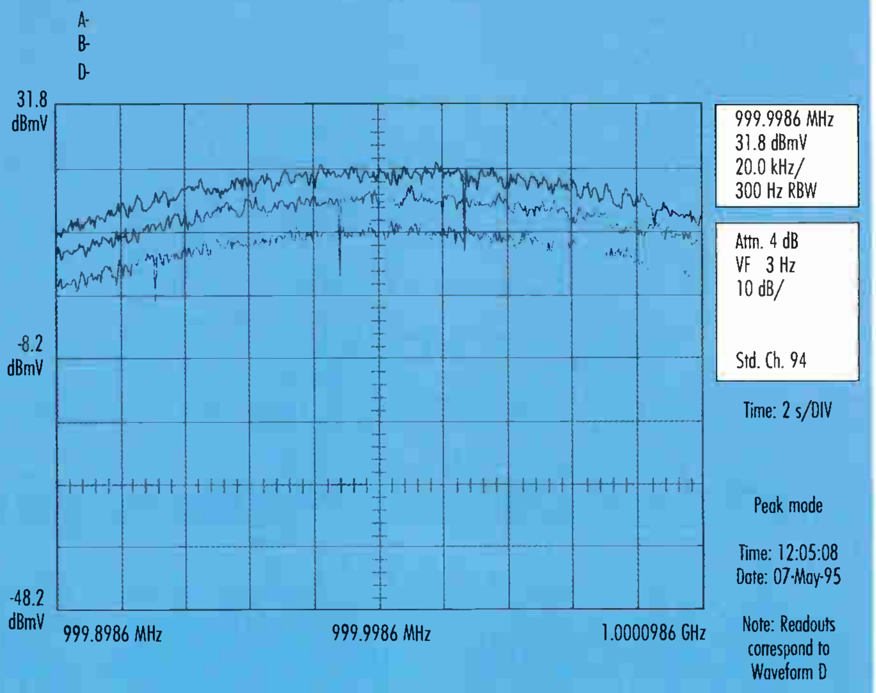
Combined spectra

Figure 2 on page 61 shows the many carriers of a fully operating CATV system. The spectrum on the right hand side, however, looks different from the rest. This portion is not occupied by sine wave carriers but rather by digital audio modulation. This area is expanded to show more detail in Figure 3 on page 61. The left four signals are analog modulated carriers while the six on the right are digital audio channels. There are several ways to determine which is which. One way is simply to recognize the spectrum shape. A more scientific procedure is to test for impact of measuring bandwidth change.

Figure 3 consists of three traces taken at three different measurement bandwidths. A change in bandwidth has no significant effect on the sine wave signal spectra peak levels on the left. (Analog modulated visual carriers will show an amplitude change when measured with a bandwidth more than 300 kHz.) The digital audio, however, appears as a noise-like signal measured on a per-Hz basis. The three measurement bandwidths each show a different display level on the right. Digital modulation appears as a random signal whose display level will change with bandwidth, while an unmodulated carrier or analog modulation will change very little with measuring bandwidth.

We previously noted that a change in measuring bandwidth has no effect on the displayed signal level of the analog signals on the left side of Figure 3. Only the noise-like digital modulation signals on the right are affected. But the signal-to-noise ratio, and hence dynamic range, is very much affected for the analog signals on the left. To a large degree the analog signal level does not change, but the noise level is proportional to bandwidth. The narrowest usable bandwidth for cable system measurements, such as CTB determination, is about 300 Hz as noted in Part 1. This will provide a more than adequate 90 dB of signal to spectrum analyzer noise ratio dynamic range. But the CTB or CSO terms generated by the spectrum analyzer will interfere, so that only about 60 dB of the available carrier-to-noise (C/N) range is practically usable. This is just good enough to make the needed measurements, but there is no margin to spare. The key to achieving best dynamic range results depends on setting the input signal to the optimum level of the spectrum analyzer. This is discussed next.

Figure 4: Gain compression test for digital modulated signal spectrum



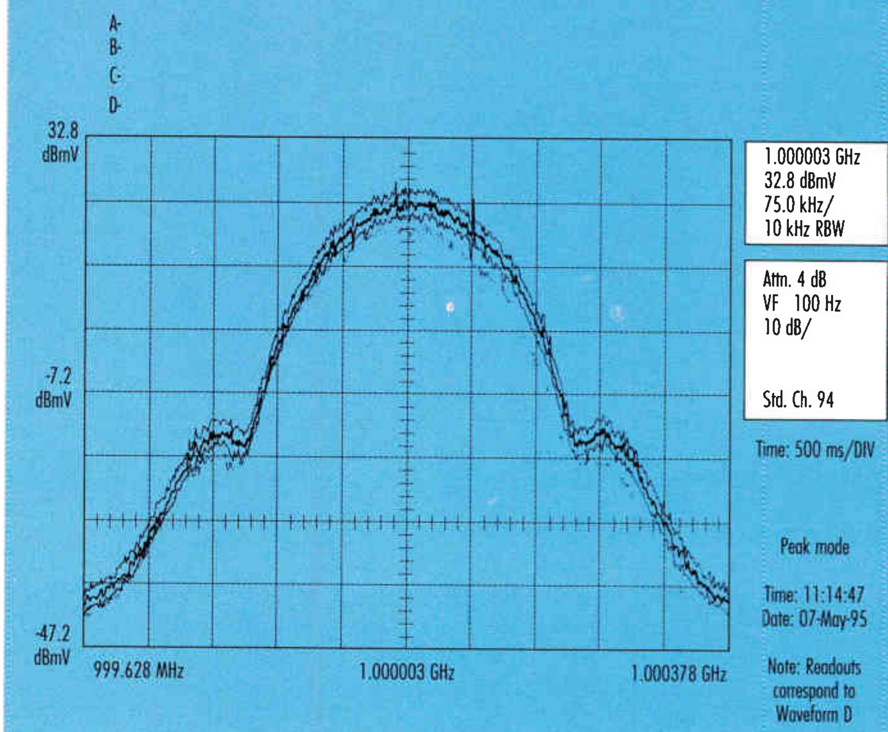
Input level and dynamic range

As introduced in Part 1, the operating dynamic range of a spectrum analyzer is critically dependent on a so-called optimum signal input level.[7] The reason is that distortion components increase in amplitude at a higher dB rate than the actual signal. Thus, for example, the CTB component will go up by three times the rate of the main signal input. Therefore, an increase in signal beyond the point where the CTB terms exceed the sensitivity noise, will result in a smaller CTB to signal ratio. Since the CTB result goes at three times and the signal goes at 1:1, an increase in input by Z dB above the optimum will lose (3-1)Z = 2Z dB in dynamic range.

These input level constraints apply to both analog and digital as well as hybrid analog/digital signals. In every case there is some particular input signal level that will yield best display measurement dynamic range. The finer the available attenuator steps, the closer it is possible to operate at the optimum signal level point. Here, we illustrate the procedure using a spectrum analyzer with 2 dB steps. This means that we can get to within 1 dB of the optimum level. A 10 dB step attenuator will permit signal level setting to within only 5 dB of optimum.

This difference of 5-1 = 4 dB, is worth 4x2 = 8 dB in CTB dynamic range. The optimum signal level can be calculated,[7] but this is only for theoretical analysis. There is no need for these calculations in actual measurements. Rather, what follows will illustrate how to set the spectrum analyzer correctly by spectrum observation.

Figure 5: Digital modulation fine attenuator change tests



Consider the three digital modulation spectrum traces shown in Figure 4 on page 63. The lower trace was obtained at a 20 dB attenuator setting. The attenuator was set at 14 dB for the middle trace. This is a 6 dB change, and in agreement with the measured results shown in Figure 4. Now we reduce the attenuation by a further 10 dB, from 14 dB to 4 dB. The result is the upper trace. Clearly, this does not show a 10 dB display level change. The upper trace is based on too large an input signal. A finer grain version of signal level adjustment is shown in Figure 5. Here the four traces involve 2 dB attenuation change per trace, and the display level change is clearly observable. The ability to distinguish a relatively small amplitude difference, such as 2 dB, is important for digital modulation signals because these frequently do not change shape with amplitude overdrive. Because of signal compression, the upper trace of Figure 4 is not usable but its shape is not much different from the other traces. Therefore, we can identify an incorrect setting from the less than expected display level change as the spectrum analyzer goes into signal compression. The ability to observe a 2 dB amplitude change is useful here, as previously noted. Other spectra can be easier to identify when in compression because the shape as well as amplitude may change.

Summary

The smallest measurement level for analog signals is determined by a combination of instrument distortion, such as CTB, and instrument sensitivity, determined by noise figure and measurement bandwidth. The smallest digital modulation level that can be observed is driven by instrument noise figure and is not dependent on the measurement bandwidth. In both cases, the largest display level depends on the distortion intercept point, typically 54 dBmV. When all the calculations and performance measures are taken into account, we find that the dynamic range for both analog and digital, or mixed hybrid, signals is about 60 to 70 dB, depending on the number of carriers involved. This can lead to marginal results, which may require the use of an external input preselector to reduce the input signal loading.

The key to obtaining the largest possible measurement dynamic range, so that the need for a preselector is avoided, is to set the input signal at the largest optimum level where distortion products just become visible. This is done by means of a small-step input attenuator in the spectrum analyzer front-end. The smaller the input attenuator steps the closer one can set the input signal to optimum and the greater the resulting measurement dynamic range. **CT**

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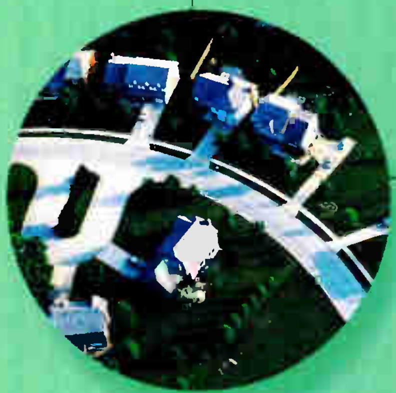

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Reader Service Number 146

By Caitlin Bestler

Conditional access — Part 2

This is second installment of a two-part article. Part 1 ran in the January issue on page 58.

A conditional access control system should provide the following services for all conditionally accessed material: Adding or deleting a decoder/ST from the list of those to be tracked by the system; Determining what authorizations are required to access specific services or programs; Editing authorizations that specific decoders have; Optionally enabled real-time transaction processing by the CACS itself, and collection of transaction logs afterwards.

The CACS will have to provide an external model of conditional access requirements and then translate those requirements into the actual conditional access protocols required to communicate with the STs. The subscriber management system should not have to understand the specific protocols used. The CACS will have to manage at least two conditional access protocols: one for analog scrambling /descrambling and at least one for encryption/decryption of digital MPEG programming. However, this number is likely to get larger, especially if you are considering all sites at which the CACS software would be installed.

At least one choice of analog conditional access protocols is likely to be dictated by an existing addressable analog decoder base. For digital conditional access protocols the cable system operator will have to weigh the benefits of higher security vs. the benefits of standardized protocols.

Whether or not more than two options are ever exercised, there is a distinct advantage to the subscriber management system of having a single conditional access model for all interfacing.

Caitlin Bestler is the manager of control systems design for Zenith Network Systems, based in Glenview, IL.

Conditional access model

Cable TV conditional access requirements naturally fall into the three following categories:

1) *Subscription services.* (They last indefinitely. They are relatively few in number. A given decoder can be authorized for any subset of them concurrently.)

2) *PPV events.* (They have a finite lifespan. There can be a large number of potential PPV events. A given decoder needs to be authorized for at most a handful of them at any given time.)

3) *PPV events that also are available as part of a subscription package.*

One solution for the control is offered in the following model:

- Subscription services are represented by an *authorization bitmap,* which should be at least 256 bits in size. A decoder can be authorized for 0 to all of these.
- PPV services are represented by *transient lists.* Each is represented by an integer value. A decoder can be authorized for 0 to N of these, where N is a relatively small value to match limited secure storage capacity in the ST. Conditional access protocols support a capacity of 10 for analog protocols and 64 for digital protocols.
- Specific programs can be enabled by 0 or more authorizations from the authorization bitmap and/or a value in the transient list. This allows a given service/program to be provided in the clear, solely as part of a subscription tier, solely on a PPV basis, or on both a subscription and PPV basis.

This model also supports a full NxM mapping between authorizations and programs as follows:

- Any authorization level can be used to enable any number of programs.
- Any program can be enabled by any number of authorization levels.

This flexibility allows applications such as the following:

- Limited free preview of other services, only available to those customers who subscribe to other tiers.
- Selling PPV movies within a subscription service to nonsubscribers.
- Selling sporting events as part of different packages. (For example, all U.S. medal-contention events, all ski events, all weekend events, etc.)

In the digital model any given service can be authorized any number of different ways. Distinct authorizations can be created for every way that a marketing department can sell the service. Further, once a single authorization has been sold it can be used to authorize any combination of services, no matter how many different channels they are presented on, over what period of time.

Translating the model

Ideally the digital model would be applied to both analog and digital services. Unfortunately that would require retroactive modifications to existing analog conditional access protocols.

Faced with a conflict between the model and an actual conditional access protocol there are two potential strategies that can be applied:

1) *Restrict* — While the same representation and syntax is used, certain options may not be allowed when the target conditional access protocol does not allow it. (For example, if the model did not limit the pay-per-segment capability for analog services, the fuller capability might have to be simulated.)

2) *Simulate* — Take the model as the requirement and implement as best as the target conditional access protocol allows. (For example, one method is to use a channel-specific output to create virtual authorization capacity by multiplying the fixed capacity in the decoders by additional channel-specific values.)

Key distribution

The analog and/or digital conditional access modules within the STs may contain private key data required to properly control them. This is naturally specific to the individual conditional access protocol, but is almost certain to be part of any digital encryption protocol.

Holding the private key data is what gives the control system the right and ability to control a decoder's digital conditional access module. That is why it is encrypted for use only by specific control systems. Because of the critical importance of this data the subscriber management system should be given the option of distributing it itself as part of the decoder attributes, or of being totally ignorant of this data and expecting the control system to obtain the data itself from the serialization site.

Program scheduling

Authorizing decoders is only half of a conditional access system. The control system also must know what authorizations should be required to view each service at any given time.

In deciding on the policy for a logical channel the cable system provider must specify the following:

- What, if any, subscription tiers will enable services provided through this channel.
- Whether PPV transient levels also should be available for PPV segments on this channel. If so, do these pre-empt the subscription access or are they just pay-per-segment offerings?
- How individual programs are to be identified:

1) Explicitly with times by the cable system provider.

2) By a specific EPG feed, and the designation of the channel on that feed.

3) By any change in MPEG program ID.

- What, if any IPPV buy/cancel windows should be created for PPV programs, and what their relative times are to the start/end of the movie.

Explicit scheduling can be used when policy rules have not provided enough data or for exceptions. An example exception would be free-preview weekends.

Real-time upstream

In a two-way plant the conditional access control system will typically control the real-time RF upstream system for decoders. Doing so has the following advantages:

- The real-time RF upstream capability exists primarily for the benefit of the conditional access system.
- Addressability of downstream messages is typically part of the specific conditional access protocols.
- A single message can both acknowledge the upstream and authorize the decoder. This efficiency is always important, but is an absolute requirement for workable real-time two-way analog systems.

IPPV ordering

Automated IPPV ordering of both analog and digital programs should be supported. Analog decoders should be able to order analog programs; hybrid decoders should be able to order either.

Automated real-time ordering systems can use the RF upstream in a two-way plant or could use the phone system via ANI (automatic

By Anthony J. Wasilewski

Public key cryptography in broadband nets: Part 2

Part 1 of this article ran in the December issue of "Communications Technology" on page 70. This is the final installment.

The broadband networks operated and deployed in the wake of the Tele-communications Act of 1996 need to offer both more expanded and more advanced services to their subscribers to compete with alternatives. Significant new revenue streams are possible with electronic commerce applications. However, consumer and merchant acceptance of these applications in broadband networks will be limited without suitable technologies to secure them.

Content providers, network operators and consumers alike are concerned with protecting messages, product orders, programming, software, databases and intellectual property from vandalism, theft or unauthorized access. Traditional conditional access and secure messaging systems make use of signal security measures, such as encryption, to prevent a signal or message from being received except by authorized users. Many aspects of the conventional approaches to conditional access are inadequate for the requirements of emerging digital networks. Due to the nature of the applications and services, an extremely robust public key cryptography system is necessary. Further, such a public key system also can provide the foundation for electronic commerce in broadband networks by enabling users and service providers to exchange secret, protected messages without first having to exchange a secret, such as an encryption key.

Anthony J. Wasilewski is principal engineer, digital video systems with Scientific-Atlanta.

Standards will be as important to electronic commerce applications as they are to the underlying communications networks over which they run. There are several fronts on which potential security standards are being pursued.

IETF

The Internet Engineering Task Force is the standards setting body for the Internet at large. There is currently much activity ongoing within the IETF to create Internet security standards. The debate is wide-ranging and includes which part of the network stack to provide the security services.

Figure 1 shows the approach that puts security at the *network layer.* The authentication header (AH) and the encapsulating security payload (ESP) are used to add security services at the IP layer.

Figure 2 shows the positioning of the secure sockets layer (SSL) protocol. It resides between the applications and the transport. SSL uses a combination of public key and symmetric algorithms to provide confidentiality, data integrity and authentication of the server and (optionally) the client.

Security also can be imposed at the application layer as shown in Figure 3 on page 54. In this approach security algorithms and protocols are added to specific application protocols such as those shown in the diagram. Secure hypertext transfer protocol (S-HTTP) is used in WWW-based applications while secure multipurpose Internet mail extensions (S-MIME) is used to make e-mail exchanges both more interoperable and secure. →

Figure 1: Security at network layer

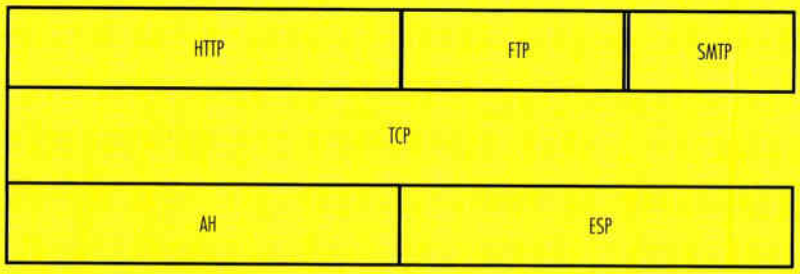
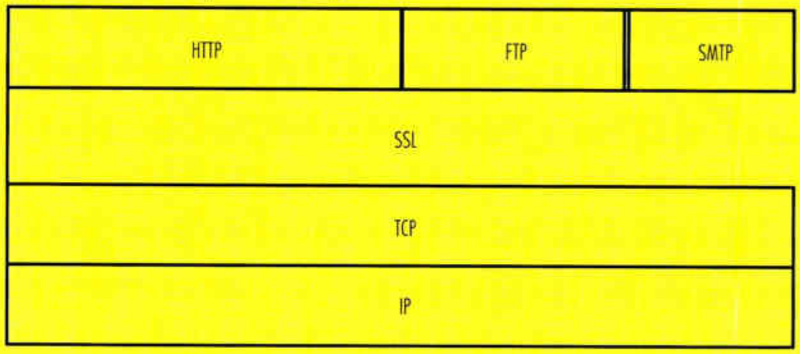


Figure 2: Security at session layer



number identification) or ARU (automatic response unit) technology. A phone return modem also can be used to collect after-the-fact authorization records on a store-and-forward basis from self-authorizing decoders. In the past, RF upstream modems also have been used to collect store-and-forward self-authorizations. These systems, however, were designed when the reliability of the upstream plant was questionable and headend real-time transaction processing capacity was expensive. Neither assumption still holds.

With data modem and telephony services being envisioned for the same HFC plants, the reliability of the upstream is no longer in doubt. The feasibility of real-time transaction processing in the headend has been demonstrated for over a decade. During that decade the cost of headend real-time transaction processing power has continuously fallen as processors got both more powerful and less expensive.

With two-way ordering the decoder places IPPV orders on its own. The hybrid decoder has to be able to send upstream messages to purchase either analog or digital authorizations. This has to be done with a single upstream RF modulator. Acknowledgment of two-way purchases must be carried in-band with the authorization to provide a truly reliable secure transaction closure.

ANI/ARU ordering can be done either by the consumer or the decoder. In either case, the procedure should be the same for analog and digital IPPV services. You wouldn't want to require customers with hybrid decoders to use a different call-in ritual depending on what channel the IPPV movie they were buying was on. It also would be undesirable to require separate incoming phone lines and numbers to take orders from analog and digital customers when they are buying the same PPV event. Lastly all IPPV transactions should be collected in a log for forwarding to the subscriber management system for billing.

Downloaded application support

The control system must provide support for downloaded applications in analog interactive and hybrid subscriber terminals. For digital/hybrid STs, downloaded application support includes the following:

- Allowing applications to access source transport streams based on compile-time designations, without having to have run-time knowledge of resource assignments. A barkering application must be able to select a movie by a permanent designation that is not affected by site-specific encoder allocations.
- Providing a messaging system.
- Upstream datagrams (from set-top decoder client applications to the server) must be routed by the control system onto a public network. Destinations can include other components or any interactive server connected to the network.
- Downstream datagrams can be imbedded in the source transport stream by the server. Datagrams can be broadcast and/or individually addressed.
- Downstream datagrams can be accepted over the network, and then translated for insertion in the downstream transport stream where the decoder will receive it.
- Random data access where applications such as electronic program guides may need random access to large amounts of data. Rather than storing all of this data in every set-top decoder, the control system should allow the decoder to access the data only as required.
- For two-way systems, decoders should be able to send a read for specific data. The control system should respond to this data on its own without invoking an external server.
- For one-way systems, this data can be repeated automatically. Obviously this is less efficient in a one-way system and therefore should be used only for critical data that there is a high probability of it being used shortly. EPG program descriptions are one of the few examples that might fit.
- Lastly the control system should allow certain operations to be performed without having to download an application. The most obvious of these is the ability to download an application itself. Other examples could include messaging, IPPV purchase prompting and prompting for opinion survey responses.

Downloadability to analog interactive decoders

Interactivity does not automatically require digital services or hybrid decoders. However, some analog interactive decoders are limited to a single downloaded application, and their onscreen displays are cell-based rather than fully bitmappable. They receive data out-of-band at UART data rates, rather than in-band at Mbit rates. But given these limitations they can still provide cost-effective support of the most desired interactive applications including the following: Electronic program guides, messaging, bulletin board pages, sports scores and other text information services.

Plant/ST monitoring

The conditional access control system needs to be in continual contact with subscriber terminals to refresh authorizations and distribute new encryption keys. Since it already has the ability to efficiently poll STs in a two-way plant, it can use them as a distributed set of plant measurement devices.

STs can measure many characteristics of the received signal such as required equalization taps, signal level and bit error rate. All subscriber terminals can be monitored on a "keep-alive" basis to determine when they are out of contact with the control system. **CT**

AD INDEX

By Keith Switzer

Reducing resistivity in an electrical grounding system

The goal of any grounding system is to provide a low-impedance path for fault currents until they reach the earth. But the effectiveness of any grounding system depends in large part on whether the soil that surrounds it can absorb and dissipate large electrical currents.

"Whatever the soil conditions — the sandy soil of Long Island, or on a Georgia mountaintop — ground enhancement material has been proven effective."

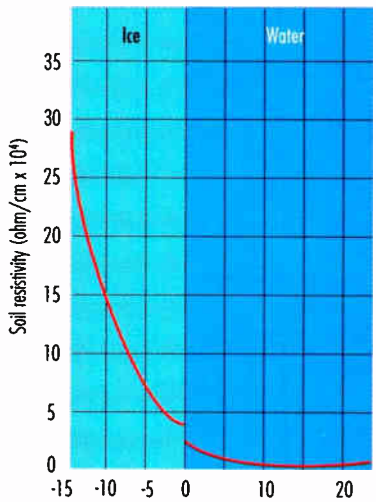
The conductivity of the earth varies with different types of soil, and can be dramatically influenced by moisture content and temperature levels. Moisture content is important because it helps the soil that surrounds ground conductors disperse the electrical current. When moisture content falls below 10%, resistivity can increase significantly.

Temperatures below freezing also increase soil resistivity. As soon as moisture turns to ice, resistivity increases sharply. (See Figure 1.) In areas subject to freezing winters, driving the ground rod below the frost line is required in order to maintain low resistivity.

When considering the grounding conditions at any site, it is essential to test soil resistivity. Test results must be examined carefully, since resistivity levels can vary widely, even in apparently similar soils. (See table on page 74.) In general, black dirt, or soils with high organic content, are usually very good conductors because they tend to retain higher moisture levels and have a higher salt level, leading to low resistivity. Sandy soils, which drain faster, tend to have a much lower moisture content and lower salt level, and therefore, tend to have higher levels of resistivity. Solid rock and volcanic ash, like the soils in Hawaii, have virtually no moisture or salt. These soils, therefore, have very high levels of resistivity and effective grounding is difficult to achieve.

Keith Switzer is an application engineer at The Electrical Products Group, Erico Inc.

Figure 1: Soil resistivity vs. temperature (sandy loam, 15% moisture)

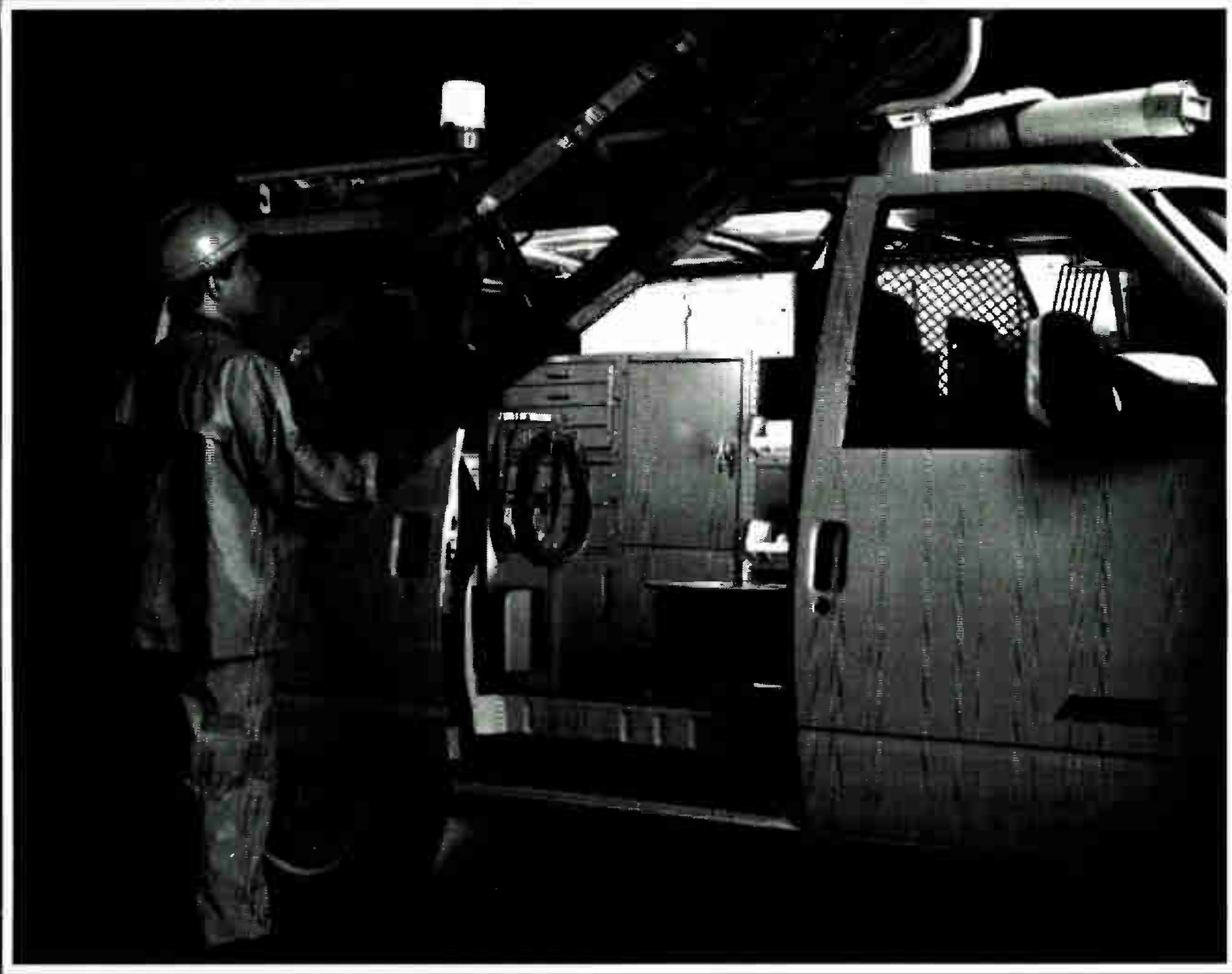


Reducing soil resistivity

If soil tests show a high level of resistivity, grounding system designers can choose from several options. Depending on the kind of soil, increasing moisture content may lower resistivity. In topsoil, soil resistivity may be reduced 80,000 ohm/cm by increasing moisture from 5% to 10%. (See Figure 2 on page 72.) An additional — although much smaller — reduction in resistivity can be obtained by increasing moisture from 10% to 20%. Further moisture additions only provide a small increase in resistivity.

In some places, ensuring low resistivity is as simple as driving a ground rod into a subsurface soil layer that has a relatively permanent and conductive moisture content. In the absence of such favorable conditions, though, there are other options for improving soil conductivity. These include filling the ground rod hole with bentonite, treating the soil with a salt (such as copper or magnesium sulfate, or rock salt), or using a ground enhancement material.

Bentonite is a clay substance that has been used in grounding systems in areas with high resistivity in the soil. However, conduction in bentonite only takes place via the movement of ions. Ionic conductivity can only occur in a solution, which means that bentonite must be wet in order to provide the required low resistivity levels. When bentonite loses moisture, its resistivity increases and its volume decreases, breaking contact with the surrounding soil. →



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Another way to improve soil conditions and lower earth resistivity is to treat the soil with a salt, such as copper or magnesium sulfate, or rock salt. Combined with moisture, the salts leach into the soil and reduce earth resistivity. However, this same process can also cause problems. First, as the salts are depleted, the soil reverts to its untreated condition, and the system needs to be recharged periodically. Second, the leachate may contaminate ground water. Local environmental regulations, then, may rule out this alternative.

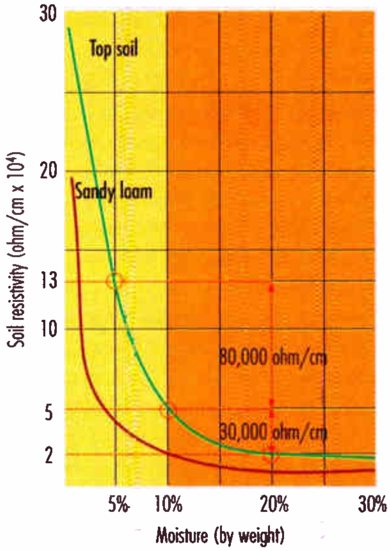
The third alternative is a low-resistance, noncorrosive, powdered ground enhancement material that offers a test-proven resistivity of 12 ohm/cm or lower in its set condition, compared with 250 ohm/cm for bentonite. It improves grounding effectiveness regardless of soil conditions, and is the ideal material to use in areas of high resistivity, such as rocky ground, mountaintops and sandy soil.

Ground enhancement material provides excellent conductivity, permanently, in even the most difficult conditions. For instance, the Home Box Office Communications Center in Hauppauge, NY, is located on a glacial moraine that was created after the ice age. This means that the soil on the HBO site consists mainly of sandy, low-conductive, quartz-type material — far less than ideal for a low resistance grounding system.

In addition, over the 13 years that the HBO Communications Center has been operating from this site, it has expanded and added a significant amount of new equipment, particularly sensitive, digital equipment. And, because it provides a satellite uplink for HBO cable affiliates, it is imperative that the Communications Center's equipment operate consistently and reliably.

Concerned that age, high-resistivity soils, and new digital electronic loads could compromise the performance of the facility's 13-year old grounding system, HBO contacted William Simmen of William Simmen Electrical Contracting Inc., St. James, NY, to conduct a system survey. First, Simmen evaluated the existing grounding system, which consisted of six 16-ft. copper-clad steel rod electrodes that had a bare 500 MCM cable exothermically welded to each electrode. The existing grounding electrode conductors were terminated in the building, deep in the main electrical service — making them inaccessible for testing. Also, since reaching the terminations was so difficult, upgrading for new requirements was almost impossible without interrupting service to various functions within the facility. Simmen concluded that any enhancement to the system should include a grounding point that was more readily accessible for inspection and maintenance.

Figure 2: Soil resistivity vs. moisture



Soil resistance tests, the final step in the grounding system survey, yielded a measurement of 82 ohms — completely unacceptable to properly run the sensitive electrical equipment at the communications center. Simmen determined that a 10 ohm resistance was required.

With the problems of the existing grounding system in mind, Simmen and his crew began evaluating a number of electrode assemblies consisting of large copper tubes with enhancement fillers and special back-fill compounds. These systems require well-drilling equipment, slurry mixers and a crew of five to install. They felt that these alternatives were too expensive and too messy. So, Simmen contacted a company that focuses on soil resistivity problems, which provided him with user-friendly software that assisted with the designing of the new system. The software also generated a comprehensive material list for the project, which included ground enhancement material to be used as the backfill.

Ground enhancement material can be installed wet or dry. It absorbs moisture from the surrounding soil and then hardens, retaining moisture within its structure. When it is used dry, no mixing is required and it will reach its maximum efficiency in a matter of days. To accelerate curing time, it can be premixed with water to a slurry form and then poured around the ground rods.

Ground enhancement material has many advantages over bentonite and rock salt. Unlike rock salt, it does not require periodic charging treatments or replacement. And, because it is a chemically stable substance that is extremely low in sulfate and chloride, it actually protects ground conductors from corrosion rather than attacking them the way salt treatments can.

Ground enhancement material sets up hard like cement, and fills any voids that may exist between the cable and the earth — it actually becomes the earth around a conductor. Once set, it maintains its high conductivity, whether in wet or dry conditions. Unlike bentonite, it does not depend on the continuous presence of water, so it performs even during prolonged dry spells that render other grounding treatments ineffective.

In situations where ground rods can't be driven, or where limited land area makes adequate grounding difficult with conventional methods, ground enhancement material may be the best solution. Although it costs more initially than standard fill materials such as bentonite, only a small amount of it is required to surround the conductor, so the size of the grounding array can be reduced dramatically.

With all these benefits, it's no wonder William Simmen decided to use ground enhancement material at the HBO Communications Center. The crew began by installing eight 3/4-inch electrodes in eight 6-

inch diameter x 7-foot deep holes that were dug with post-hole diggers and spoon shovels. These electrodes were connected by a bare 500 MCM conductor installed in a 4-inch wide x 18-inch deep trench. The conductors were connected to the ground rods with a Cadweld connection and terminated on a copper bus assembly within the building. The Cadweld process is a controlled exothermic reaction involving the reduction of copper oxide by aluminum to produce molten, superheated copper, which is formed in a graphite mold. The resulting weld is permanent and corrosion resistant, and provides current-carrying capacity equivalent to the grounding conductors.

The entire installation was then backfilled with ground enhancement material, including the electrode holes and conductor trench. "The thing I would stress is the low labor requirement and the lack of heavy equipment," Simmen says. "From the point that the first shovel hit the ground to the time the last tool was put away, the installation only took two men two-and-a-half days."

Simmen's original goal for the grounding system was to achieve a resistivity of under 10 ohms. In this case, post-installation test readings of the soil resistivity levels averaged 0.8 ohms. "It was excellent," Simmen adds.

Reducing high resistivity

By reducing resistivity levels at the HBO Communications Center, ground enhancement material made an electrical grounding system possible in one of the toughest grounding conditions — sandy soil. Solid rock was the challenge at the Oglethorpe Power Corp., near Rome, GA. There, the task was grounding an electric utility building at Oglethorpe's Rocky Mountain pumped-storage hydroelectric plant. The plant was to be constructed on solid rock, where conductivity needed for grounding is virtually nonexistent. So the designers of the grounding system had to look into all the options available to lower resistivity.

Terry Unger, then construction superintendent for National Steel Erectors Inc., the firm that designed the Rocky Mountain plant grounding system for Oglethorpe Power, considered all the alternatives. The original specifications called for copper ground plates to be placed in holes dug out of the rock and surrounded with coke powder as the conductive material. Unger recalls, "Our estimates showed that the cost of drilling out enough rock to bury 18 x 24-inch plates and then hauling in coke and fill dirt was just prohibitive. So we agreed to go with rods, which needed just 3-inch diameter holes drilled straight down."

Because ground water can wash coke powder away, and grounding should be permanent, Unger decided to use a ground enhancement material. He started the process by using a trencher with bullet teeth to cut narrow slots in the rock for laying the conductor cable, and drilled holes for 30 ground rods.

After placing the cables and rods, Unger filled the slots and holes with ground enhancement material, working it under and around the cables. The amount of the material used for the cables varied with their length. As an example of the amounts needed for such work, however, each ground rod took two 25-pound bags of ground enhancement material.

Post-installation test readings of the soil resistivity levels were "some of the best I've ever gotten — less than 1 ohm," according to Unger.

Ideal grounding conditions

Only rarely do grounding system designers and contractors get to work on a site with good grounding conditions. Even under ideal circumstances, soil structure can vary and make it difficult to achieve uniform, low levels of resistivity across a wide area. Ground enhancement material, however, can offer a lot more predictable results:

- A reduction in resistance to earth that remains for the life of the system
- Wet or dry installation
- Test-proven resistivity of 12 ohm/cm or less
- Permanent reduction in resistivity, even during dry spells
- Maintenance-free grounding

Whatever the soil conditions — the sandy soil of Long Island, or on a Georgia mountaintop — ground enhancement material has been proven effective at overcoming high soil resistivity and improving grounding system performance. **CT**

Resistivities of different soils

Soil	Resistivity ohm/cm Average	Minimum	Maximum
Fills: Ashes, cinders, brine wastes	2,370	590	7,000
Clay, shale, gumbo, loam	4,060	340	16,300
Same as line above, with varying proportions of sand and gravel	15,800	1,020	135,000
Gravel, sand, stones, with little clay or loam	94,000	59,000	458,000

Source: U.S. Bureau of Standards Technical Report 108

By Kathryn Lynch

Basic telephony overview — Part 3

This is the third in a three-part series on basic telephony. The first two installments (Part 1 in November and Part 2 in December) discussed the individual phone circuit and the switching required to place a call between two users. This third installment will address the concepts of digital multiplexing, the synchronous optical network (SONET) and asynchronous transfer mode (ATM) technologies utilized for more efficient transmission and switching between multiple users.

Digital transmission, while relatively new to cable operators, is virtually standard procedure in telephony networks. Because digital transmission can carry signals over much longer distances with much less signal degradation, digital transmission has replaced analog signal transport in most of today's telephone networks. This is true both in the multiplexing of individual voice circuits in telephony's asynchronous transport environment, and in the packaging and transport of much larger amounts of information via more robust digital platforms, such as the SONET networks in wide use today. Also of note is ATM, a relatively new technology that "packetizes" digital traffic — whether voice, video or data — for transport via the SONET platform.

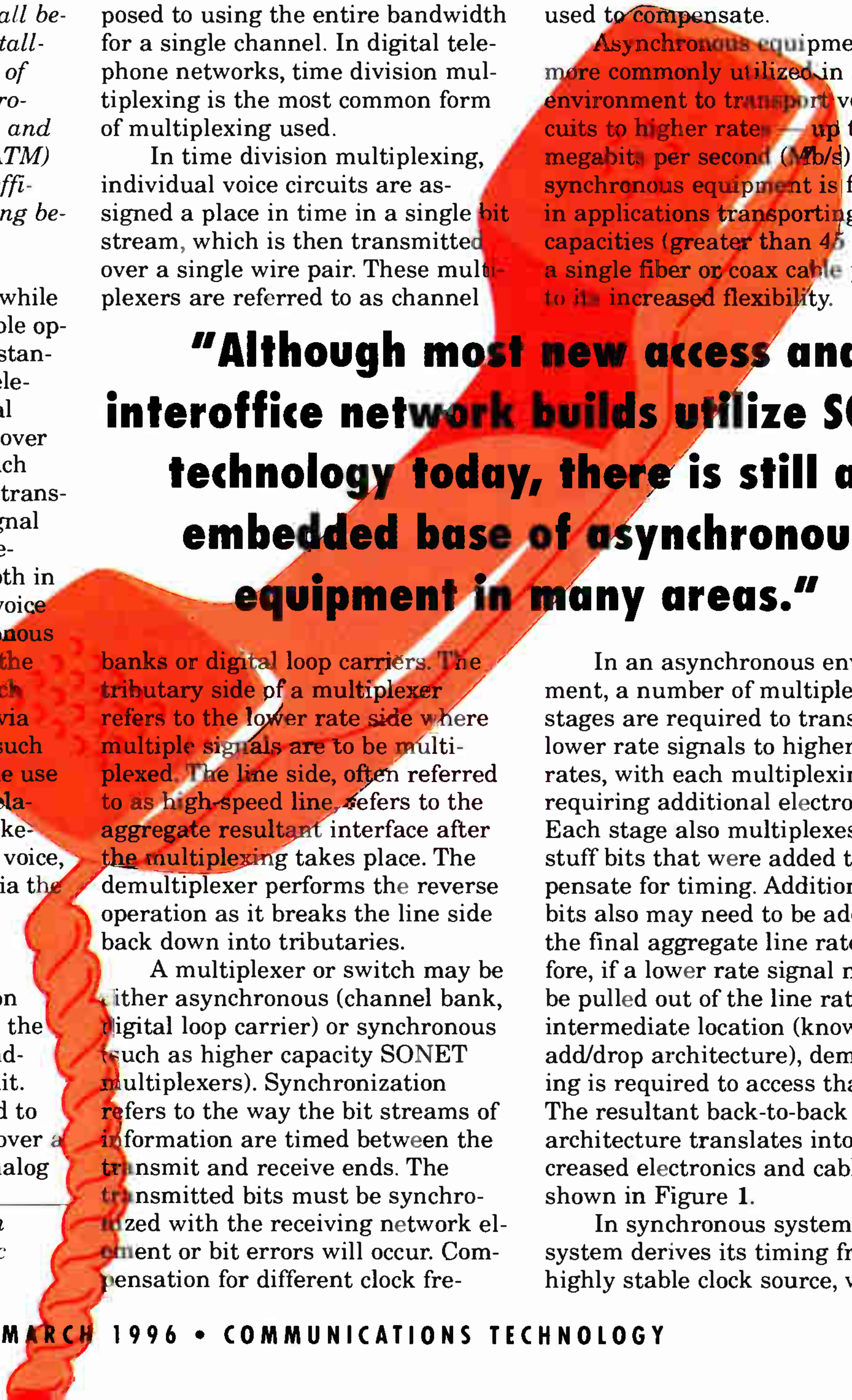
Multiplexing

Telephony networks rely on twisted-pair wiring, which has the capacity for a much larger bandwidth than a single voice circuit. Therefore, multiplexing is used to combine signals for transport over a single pair of wires. Today's analog transmission uses frequency division multiplexing to allow multiple phone conversations to be placed on individual frequencies within the same channel bandwidth, as opposed to using the entire bandwidth for a single channel. In digital telephone networks, time division multiplexing is the most common form of multiplexing used.

In time division multiplexing, individual voice circuits are assigned a place in time in a single bit stream, which is then transmitted over a single wire pair. These multiplexers are referred to as channel banks or digital loop carriers. The tributary side of a multiplexer refers to the lower rate side where multiple signals are to be multiplexed. The line side, often referred to as high-speed line, refers to the aggregate resultant interface after the multiplexing takes place. The demultiplexer performs the reverse operation as it breaks the line side back down into tributaries.

A multiplexer or switch may be either asynchronous (channel bank, digital loop carrier) or synchronous (such as higher capacity SONET multiplexers). Synchronization refers to the way the bit streams of information are timed between the transmit and receive ends. The transmitted bits must be synchronized with the receiving network element or bit errors will occur. Compensation for different clock frequencies between transmitting and receiving equipment is done through a technique called bit stuffing in an asynchronous environment. In a synchronous system, pointers are used to compensate.

Asynchronous equipment is more commonly utilized in an access environment to transport voice circuits to higher rates — up to 45 megabits per second (Mb/s) — while synchronous equipment is favored in applications transporting larger capacities (greater than 45 Mb/s) via a single fiber or coax cable pair due to its increased flexibility.



> **"Although most new access and interoffice network builds utilize SONET technology today, there is still an embedded base of asynchronous equipment in many areas."**

In an asynchronous environment, a number of multiplexing stages are required to transform lower rate signals to higher line rates, with each multiplexing stage requiring additional electronics. Each stage also multiplexes any stuff bits that were added to compensate for timing. Additional stuff bits also may need to be added at the final aggregate line rate. Therefore, if a lower rate signal needs to be pulled out of the line rate at an intermediate location (known as an add/drop architecture), demultiplexing is required to access that signal. The resultant back-to-back terminal architecture translates into increased electronics and cabling, as shown in Figure 1.

In synchronous systems, each system derives its timing from a highly stable clock source, with the

Kathryn Lynch is transmission product line manager for Antec Corp., in Norcross, GA.

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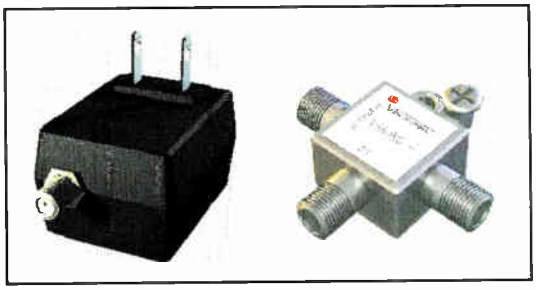

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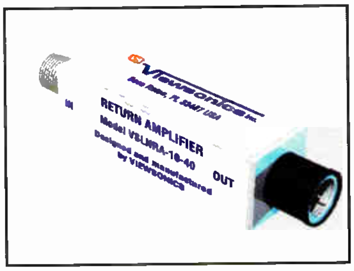

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2-Way Interactive Spectrum Expander

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Figure 1: Asynchronous/synchronous environments

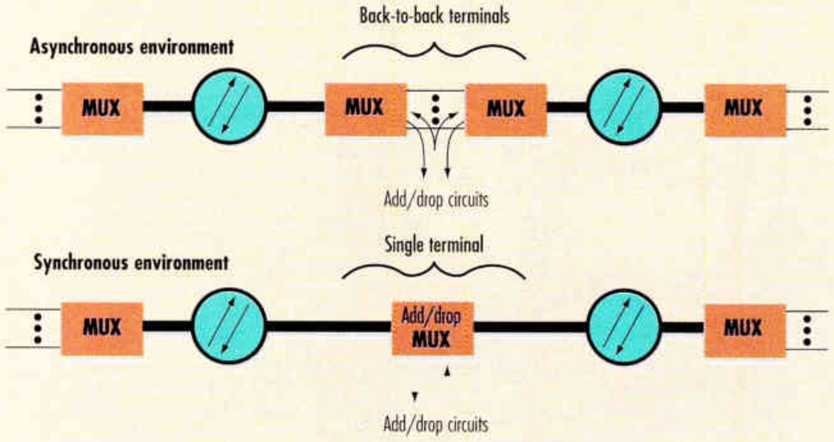


Table 1: Asynchronous digital signals (North American hierarchy)

Digital signal	Number of voice circuits	Bit rate
DS0*	1	64 kb/s
DS1*	24	1.544 Mb/s
DS1C	48	3.152 Mb/s
DS2	96	6.312 Mb/s
DS3*	672	44.74 Mb/s
DS4	4,032	274.18 Mb/s

* *Most commonly used today*

Table 2: SONET transmission

Electrical signal	Optical signal	Bit rate
STS-1	OC-1	51.84 Mb/s
STS-3	OC-3	155.52 Mb/s
STS-12	OC-12	622.08 Mb/s
STS-24	OC-24	1,244.16 Mb/s
STS-48	OC-48	2,488.32 Mb/s
STS-192	OC-192	9,953.28 Mb/s

average frequency of all clocks being the same or nearly the same. Bit stuffing is not required to compensate for timing, so individual signals are easy to access in multiplexed bit streams and higher bit rate aggregates can be achieved. Back-to-back equipment is eliminated in add/drop architectures, thereby saving on costs.

Traditionally, asynchronous fiber-optic systems operating at capacities greater than 45 Mb/s (a DS3) have been proprietary in nature. Equipment, operations and maintenance, line rates, and multiplexing techniques in the asynchronous environment are all specific to each vendor's product line. Synchronous standards were developed to alleviate this problem and allow for multivendor interworking.

SONET standards

The SONET standards were initially developed by the regional Bell operating companies (RBOCs) and interexchange carriers (IXCs) as a way to allow multiple vendors' equipment to work together. The RBOCs viewed this standardization as a way to drive toward a commodity market among vendors, thereby driving equipment prices down. The IXCs wanted to interface via fiber to multiple RBOCs that may have different vendors' equipment at the other end of the fiber span. The intent of the standards was to allow one vendor's multiplexer to operate with another's multiplexer over fiber.

SONET also defines sophisticated operations, administration, maintenance and provisioning (OAM&P) capabilities like performance monitoring and single-ended maintenance. Performance monitoring allows a technician to detect a signal degradation before it affects service. Single-ended operations allow a technician physically located at an office housing one network element to provision and maintain other network elements at remote sites as long as they are connected via the fiber optic line. Single-ended operations are available through a part of the SONET overhead known as the data communications channel, as shown in Figure 2. The standards are still in progress on the definition of all the SONET overhead; however, basic transmission can be achieved between different vendors today.

STS-1 (synchronous transport signal level 1) is the first logical building block for SONET. It is similar to the DS3 (44.7 Mb/s) signal; however, SONET adds overhead used for OAM&P that brings the bit rate up to 51 Mb/s. "OC" represents optical carrier, which designates an STS signal in optical format.

Although most new access and interoffice network builds utilize SONET technology today, there is still an embedded base of asynchronous equipment in many areas. For this reason, SONET is designed to accept DS3 and DS1 interfaces as well. Multimedia traffic may take the form of ATM cells, which are carried within the SONET architecture.

Asynchronous transfer mode

ATM is a fast packet-based standard supporting the transport and switching of multimedia services. Traffic is packaged into 53-byte fixed-length packets called cells. ATM equipment is designed to handle "bursty" traffic, such as data

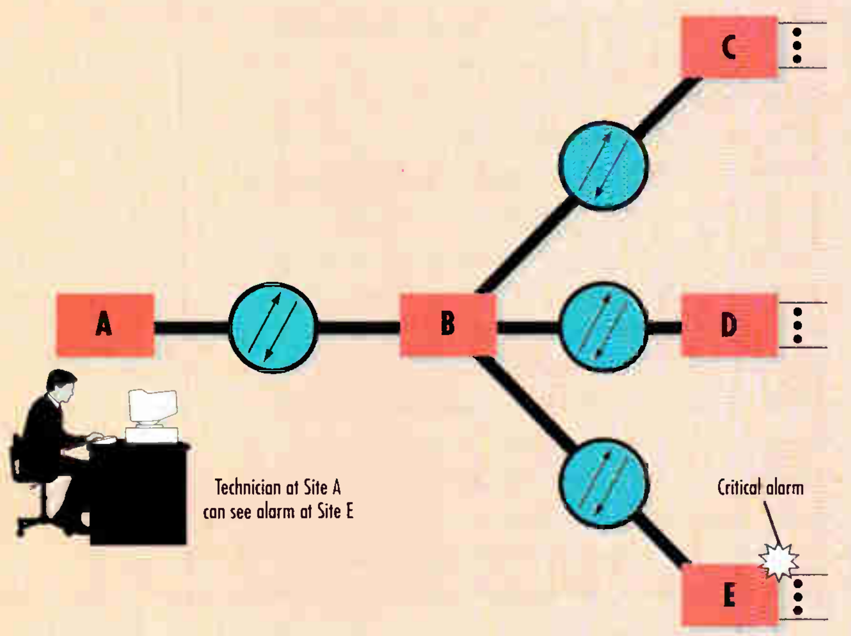
The humble precursors to modern technologies like SONET and ATM included this telephonic "news teller" from Budapest Telefon-Hirmondo in 1901.

files and video, along with delay sensitive traffic such as voice, allowing planners to design the most economical network. ATM equipment has buffering capabilities, allowing capacities higher than the transport bit rate to pass. Therefore, in the event bursty traffic is sent, the network does not have lines dedicated to the maximum traffic rate, which may be unused much of the time.

SONET and ATM networks are already in place and will continue to be the technologies of choice as telephony networks continue to grow.

As an increasing number of business and home users require a variety of voice, data and video services, SONET provides the bandwidth and the open architecture necessary for economical transport of current and future services. As users increase their demand for services such as Internet access, interactive distance learning, work-at-home capabilities, videoconferencing and video-on-demand, SONET and ATM are likely to become even more prevalent, not only for the telcos but for cable systems as well. **CT**

Figure 2: Single-ended operations



Test set

Progressive Electronics Inc. introduced the Model 401K CATV cable tone test set. Specifically designed for the CATV, MATV and SMATV industries, the unit provides a quick and affordable means of identifying coaxial drop cables at their distribution points. Proprietary circuit design allows the transmitter unit to send tone through any passive device including splitters, traps, taps and directional couplers.

The transmitter can be set to produce one of four distinct tones, allowing technicians to use up to four transmitters for tracing multiple cable runs. Additionally, the high output transmitter will support tone signal on a cable with up to 60 dB loss. Both the transmitter and receiver units are equipped with female F-connectors and the addition of adapter leads allow the unit to be used on larger distribution cables as well as single conductors or wire pairs.

As a continuity tester, the device provides both audible tone and LED display to indicate resistance levels. The unit also identifies the presence of low level AC or DC voltage on the cable under test.

Reader service #311

Switch control

CableCom specialists Inc. launched its PSC1900 rack-mountable headend switching controller. This

fully programmable digital controller automatically activates virtually any pay-per-view promo or video event, RF/IF modulator, satellite receiver, VTR and any other externally switched device in the headend.

The unit switches up to 255 different channels separately and/or simultaneously through one real-time clock. It also is designed to control character-generated graphics, pay-per-view promotional overlays and crawl messages.

Reader service #312

Signal test set

The new CR-1151 QPR monitor/test set from Hukk Engineering enables users to monitor and test QPR-modulated signals such as those used for the Scientific-Atlanta implementation of DMX digital audio and the Sega Channel. Measurements include error count, bit error rate, errored seconds, severely errored seconds and level. Testing can be performed anywhere from the headend to the subscriber's residence.

The unit is portable, battery operated, rugged and weatherized. The instrument eliminates the need for a TV monitor, Sega game adapter, Sega console, DMX set-top, 115 VAC source and lengthy cable currently required for testing these digital services outside the subscriber's residence.

Reader service #308

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

☛ *EBS and the Cable Industry* — This features Frank Lucia, Helena Mitchell and Kenneth Wright. It provides an understanding of the current and future demands upon the Emergency Broadcast System, and why cable TV will become such a critical part of EBS. As you will see, EBS has numerous state and local applications. The type of hardware that will become necessary also is discussed. This is an important topic, since the time to voice our operational and hardware recommendations to the EBS is now. (60 min.) Order #T-1117, $35.

☛ *How Will the New NEC, NESC and OSHA Regulations Impact Your System?* — Featuring James Kearney and Roger Keith, this covers NESC requirements such as clearances both on the pole and midspan. Recommendations also are provided for meeting the new grounding requirements of the NEC. If your system has not established an employee safety program, or if your program is not current, you should start by viewing this program. (75 min.) Order #T-1118, $45.

Note: The videotapes are in color and available in the NTSC 1/2-inch VHS format only. They are available in stock and will be delivered approximately three weeks after receipt of order with full payment.

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March

4-5: SCTE regional training seminar, *Introduction to Telephony*, SCTE national headquarters, Exton, PA. Contact SCTE national headquarters, (610) 363-6888.
6-8: SCTE regional training seminar, *Introduction to Fiber Optics*, SCTE national headquarters, Exton, PA. Contact SCTE national headquarters, (610) 363-6888.
7: ADC Telecommunications T1 Technology Seminar, Minneapolis. Contact Katie Eastman, (800) 366-3891, ext. 2040.
8: SCTE North Country Chapter meeting, BCT/E and Installer exams to be administered, Columbia Heights, MN. Contact Bill Davis, (612) 646-8755.
12-13: Bellcore Wireless Interconnection Seminar, Sheraton Plaza at Florida Mall, Orlando, FL. Contact (908) 699-5800.
12-14: SCTE Wheat State Chapter meeting, BCT/E exams to be administered, Wichita, KS. Contact Joe Cvetnich, (316) 262-4270.
13: SCTE Southern California Chapter seminar, high-speed cable modems, Time Warner Cable office, Garden Grove, CA. Contact Tom Colegrove, (805) 252-5280.
14: SCTE Satellite Tele-Seminar Program, *NEC, NESC and OSHA Regulations (Part I),* to be shown on Galaxy 1R, Transponder 14, 2:30-3:30 p.m. ET. Contact SCTE national headquarters, (610) 363-6888.
14: SCTE Great Plains Chapter annual vendor show with technical workshops, Holiday Inn, Omaha, NE. Contact Randy Parker, (402) 292-4049.
14: SCTE Magnolia Chapter seminar, BCT/E and Installer exams to be administered, Ramada Inn Coliseum, Jackson, MS. Contact Robert Marsh, (601) 939-6240.
14: SCTE Michiana Chapter Installer certification tutorial, Comfort Inn, New Buffalo, MI. Contact Russ Stickney, (219) 259-8015.
14: SCTE Penn-Ohio Chapter meeting, Installer exams to be administered, Virginia. Contact Marianne McClain, (412) 531-5710.
14: SCTE Rocky Mountain Chapter meeting, NCTI, Littleton, CO. Contact Mike Phebus, (303) 795-1699.
15: SCTE Central Indiana Chapter Installer certification tutorial, Holiday Inn-Pyramids, Indianapolis, IN. Contact Kris Meyer, (317) 473-6633.
16: SCTE Gold Coast Meeting Group seminar, BCT/E Category IV Tutorial—Distribution Systems. Contact Dave Schroeder, (805) 375-0463.
19: SCTE North Country Chapter technical program, in conjunction with the North-Central Cable Show, BCT/E and Installer exams to be administered, Hyatt Hotel, Minneapolis. Contact Bill Davis, (612) 646-8755.
20: SCTE Dakota Territory Chapter seminar, digital transmission schemes, Guest House Motor Inn, Watertown, SD. Contact Tony Gauer, (605) 426-6140.
20: SCTE Golden Gate Chapter meeting. Contact Mark Harrigan, (510) 927-7060.

Planning Ahead

April 28-May 1: Cable '96, Los Angeles Convention Center, Los Angeles. Contact NCTA, (202) 775-3629.
June 10-13: SCTE Cable-Tec Expo, Nashville, TN. Contact SCTE national headquarters, (610) 363-6888.
June 26-28: Global DBS Summit, Denver. Contact Global Exposition Holdings, (713) 342-9826.
July 10-12: WCA '96, Colorado Convention Center, Denver. Contact Wireless Cable Association, (202) 452-7823.

20: SCTE Inland Empire Chapter telephony, Telect offices, Liberty Lake, WA. Contact Roger Paul, (509) 484-4931, ext. 230.
20: SCTE Oklahoma Chapter seminar, fiber-optic applications, BCT/E exams to be administered, Moore Norman Vo-Tech Center, Norman, OK. Contact Oak Bandy, (405) 364-5763, ext. 249.
20: SCTE Piedmont Chapter seminar, FCC system proof testing and cable fault location, BCT/E exams to be administered, Statesville, NC. Contact Mark Eagle, (919) 220-3889.
21: ADC Telecommunications T1 Technology Seminar, Minneapolis. Contact Katie Eastman, (800) 366-3891, ext. 2040.
21: SCTE Dakota Territory Chapter seminar, digital transmission schemes, Cablecom Office, Fargo, ND. Contact Tony Gauer, (605) 426-6140.
21: SCTE Penn-Ohio Chapter seminar, Sheraton Inn North, Pittsburgh. Contact Marianne McClain, (412) 531-5710.
22: SCTE Chaparral Chapter seminar, telephone service of cable, TVI, Albuquerque, NM. Contact Rick Padilla, (505) 761-6290.
24: SCTE Old Dominion Chapter BCT/E Category V—Data Networks and Architectures tutorial, Continental Regional Training Center, Richmond, VA. Contact Margaret Fitzgerald, (800) 231-0237.
25: SCTE Old Dominion Chapter annual vendor show, Holiday Inn, Richmond, VA. Contact Margaret Fitzgerald, (800) 231-0237.
28-29: Institute for International Research Intelligent Set-Top Box conference, Hyatt Regency, San Francisco. Contact (212) 661-3500.
29: SCTE Wheat State Chapter meeting, BCT/E exams to be administered. Contact Joe Cvetnich, (316) 262-4270.

April

1-3: Philips Broadband Networks Mobile Training Course, broadband technology, Toronto, Ontario, Canada. Contact Cathy Manion, (800) 448-5171.
2: SCTE Southeast Texas Chapter meeting, BCT/E and Installer Certification exams to be administered, Houston. Contact Jimmy Smith, (409) 646-5227.
4: SCTE Gateway Chapter meeting, Overland Community Center, Overland, MO. Contact Chris Kramer, (341) 579-4627
4: SCTE Great Plains Chapter meeting, BCT/E and Installer exams to be administered, Bellevue, NE. Contact Randy Parker, (402) 292-4049.
8: General Instrument Broadband Network Overview seminar, term definition and component functionality, Hatboro, PA. Contact Lisa Nagel, (215) 830-5678.
8-12: General Instrument Broadband Communications Network Design seminar, operational theory and network design, Hatboro, PA. Contact Lisa Nagel, (215) 830-5678.
8-12, 15-19: General Instrument Headend Maintenance and Performance Testing seminar, Hatboro, PA. Contact Lisa Nagel, (215) 830-5678.
9: SCTE Desert Chapter seminar, Telephony 101, El Rancho, Beaumont, CA. Contact Bruce Wedeking, (909) 677-2147.
9-11: SCTE Wheat State Chapter meeting, BCT/E exams to be administered, Wichita, KS. Contact Joe Cvetnich, (316) 262-4270.
10: SCTE Bluegrass Chapter seminar, surge protection and grounding, BCT/E exams to be administered, Holiday Inn, Elizabethtown, KY. Contact Max Henry, (502) 753-6521.
10-12: Philips Broadband Networks Mobile Training Course, broadband technology, Truro, Nova Scotia, Canada. Contact Cathy Manion, (800) 448-5171.
11: SCTE Satellite Tele-Seminar Programs, *NEC, NESC and OSHA Regulations (Part II)* and *Interdiction and Other Signal Security Techniques (Part I),* to be shown on Galaxy 1R, Transponder 14, 2:30-3:30 p.m. ET. Contact SCTE national headquarters, (610) 363-6888.
11: SCTE Music City Chapter meeting, BCT/E exams to be administered, Nashville, TN. Contact Rodney Lanham, (615) 645-8296.

CABLE TRIVIA

By Rex Porter

CT's historical guru has provided the following trivia questions on the cable industry. Answers to the last set of questions appear first. (The last "Cable Trivia" ran on page 98 of the December issue.) Look for answers to this month's questions in a future issue (along with a new set of 10 questions). The person supplying the most correct answers (see additional requirements below) will be awarded a special Cable Trivia T-shirt.

Your answers need to be sent to: The Trivia Judge, *Communications Technology*, 1900 Grant St., Suite 720, Denver, CO 80203; fax: (303) 839-1564; e-mail: CTmagazine@aol.com. To be in the running for a prize, your answers need to be postmarked, faxed or e-mailed to us by the 20th of the month of the issue date that the specific trivia test appears in. The first person who sends in the most correct answers will be the winner. Good luck!

Trivia test #5 answers

1) $165
2) Stan Searle
3) $5 million
4) Showtime
5) Frank Thompson
6) 1984
7) Doug Dittrick
8) John Malone
9) Mini-Hub
10) Westinghouse

Western show trivia answers

At the last Western Show, *CT* ran some trivia questions in the *CT/IC Daily*. The answers were as follows: 1) Valtec; 2) Dolly Parton; 3) 1981; 4) Sid Topol; and 5) The Weather Channel. Congratulations to David Van Valkenburg of US West for turning in the most correct answers.

Trivia #6

1) In the 1970s and early 1980s, Times Fiber Communications offered the first fiber-optic system for a CATV system into the home. It was called ___________.
A) Vikoa
B) Cerro
C) Theta Comm
D) Vitek

2) The originator of the *Cable and Broadcast Atlas*, ___________ supplied us with information vital to franchise acquisition from his *Television Digest* offices in Washington, DC.
A) Bill Wagner
B) Bill Daniels
C) Al Warren
D) Stan Searle

3) The first saleswoman to represent products of a major CATV company, she started with Ameco, joined CCS Hatfield and then helped start a cable manufacturing venture named Systems Wire. Her name is ___________.
A) Carolyn Thompson
B) Mary White
C) Gail Sermersheim
D) Polly Dunn

4) In 1969, Times Wire introduced a radical concept by using polystyrene in its aluminum cables. Within a year, every other cable manufacturer also was making "styrene" cables but no matter which company supplied it, everyone generally called the cable by Times' name___________.
A) Dynafoam
B) Cellularfoam
C) Xelofoam
D) Sealamatic

5) Some called it "microwave through a wire." This transmission line probably continues to hang on poles in Yucca Valley. Patented and sold by Surface Conduction Inc., in New York, this single conductor line is known as___________.
A) Micro-cable
B) StripBraid
C) G-Line
D) Ladderline

6) Owner of the Forum, the Lakers, the Redskins and other holdings, he owned one of the largest MSOs in the early days of cable. He is ___________.
A) Bill Bresnan
B) Bill Daniels
C) Jack Kent Cooke
D) Irvin Kahn

7) Named chief engineer of Teleprompter in 1965, after 11 years at Jerrold, ___________ was responsible for the industry's acceptance of copper-clad aluminum center conductors for trunk and feeder, copper-clad steel conductors for drop cables, super-low loss dielectrics, fiber-optic application and many other money-saving ideas. "If he will use it at Teleprompter, then I will too."
A) Roger Wilson
B) Jim Stillwell
C) Ron Cotton
D) Bob Bilodeau

8) Launched in 1980, this news service outshines the network news teams with feeds from worldwide locations.
A) ESPN
B) BET
C) CNN
D) CNBC

9) Starting in cable TV in 1972, its president, Arthur Fink, its executive vice president, Don Edelman, its national sales manager, Ray Perez, Bronx, NY-based ___________ became a leading supplier by 1980.
A) Craftsman
B) RMS
C) ACMS
D) Broadband Industries

10) When I first met her in 1969, she was marketing director for Telesis Corp., in Evansville, IN. A graduate of Indiana University, she is presently a vice president of Home Box Office. A past president of Woman in Cable and CTAM, winner of numerous National Cable Television Association awards, she is ___________.
A) Carolyn Chambers
B) Gail Sermersheim
C) Polly Dunn
D) Mary White

And the winner is ...

Congratulation to Bob Greiner of Pico Products for winning "Cable Trivia" #5.

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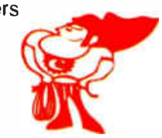

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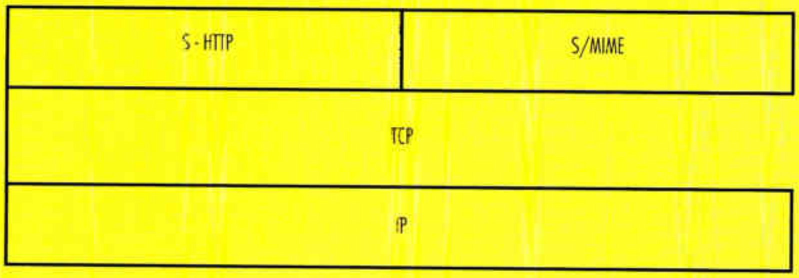
Figure 3: Security at application layer



All the approaches to Internet security have both pros and cons. Let's take a look at some of these approaches.

- *AH:*AH is the IP authentication header and is specified in standards track RFC 1826. It provides strong message authentication based on the keyed-MD5 secure, one-way message digest (RFC 1828).
- *ESP:* This is the encapsulating security payload as defined in RFC 1827. This proposed standard for IP data security uses the DES algorithm for message confidentiality.
- *SSL:* The secure sockets layer specification is published in the form of an Internet draft (draft-freier-ssl-version3-00.txt). It is by far the most prevalent session-layer protocol and was introduced by Netscape Communications in 1994. It uses a combination of public key and secret key cryptosystems to provide privacy, data integrity and authentication of the server and client in TCP/IP networks. In can be used in the Netscape Navigator Web browser to authenticate servers (Internet merchants, correspondents and organizations) and, when a public key certificate is available, the browser user as well.
- *S-HTTP:* Secure hypertext transfer protocol was proposed by CommerceNet in 1994 and was later put under consideration by the IETF's Web security group. It also is specified as an Internet draft (draft-ietf—wts—shttp—01.txt) and like SSL provides privacy, data integrity and authentication. It defines an extension to the Internet standard HTTP, which is now found universally in all Web browsers and many servers.
- *GSS-API:* The generic security service application program interface is specified in RFC 1508 and provides a high-level abstraction of security services for callers. These services may be supported with a wide range of underlying mechanisms using public key and secret key techniques. The GSS-API defines contexts, services and primitives in a programming language independent way.
- *S/MIME:* Secure multipurpose Internet mail extensions is one of several proposed security enhancements to e-mail services. Proposed in 1995 by RSA Data Security Inc., it is currently receiving scrutiny from the Internet Mail Consortium.
- *SKIP:* The simple key exchange for Internet protocols

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(Continued from page 50)

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Testing, setup and alignment are more difficult in the reverse. In the forward system there are video/audio carriers, FM carriers, unmodulated carriers, sweep signals and other RF carriers used to set up and maintain the forward path. In the reverse path, none of these signals exist on a permanent basis for the technician to use. A burst of a data from an addressable converter is too short and random. Equipment exists that generates signals sent back on the reverse path and then returned down the forward path for setup and alignment.

Presently, to test and maintain the reverse path requires specialized test equipment and is more time-consuming when compared to test and alignment of the forward path.

Calculating the C/N and distortions for the forward path is relatively straightforward. The inputs to amplifiers are used to calculate the C/N of the system and amplifier output levels are used to calculate the distortion at the last amplifier station.

The C/N calculation for the reverse is very important. I suggest adding the individual C/N ratios of each amplifier module in calculating the overall ratio. Using this method, the station gains do not necessarily match losses between stations. By matching the C/N ratios of each amplifier, the highest ratio will be obtained. In the feeder system, establish a constant loss between line extenders. Do the same for the trunk amplifiers.

The two schematics for this article show the calculations for C/N, path loss and gain. The node schematic (Figure 1) illustrates connection from the TV set back to the node. The headend and first node schematic (Figure 2 on page 49) shows the path to the headend.

The output of an addressable converter is +55 dBmV. The reverse signal travels through 50 feet of RG-6, the house splitter and 100 feet of RG-6 to the tap. The 26 dB tap is close to the output of Line Extender 3. The input is +23 dBmV and with 22 dB of gain. Its output is +45 dBmV. The input to the next line extender is +23 dBmV for 22 dB between line extenders. This 22 dB of loss is maintained to Feeder Outputs B and C of Terminating Distribution Amplifier 3. The loss for Feeder Output A is 26 dB. The signal is amplified by the Terminating Distribution Amplifier 3 to a trunk level of +37.5 dBmV through 18.5 dB of loss to Distribution Amplifier 2. The signal continues through Distribution Amplifier 1 to the fiber node. The loss between the last distribution amplifier and the node is set to 27.5 dB allowing for many trunk splits. At the fiber node, the signal is amplified and sent to the reverse fiber transmitter, through the fiber and to the reverse fiber receiver at the headend. The output then passes through a test point to the reverse path node combiner.

The test point is used for testing the reverse path signals. The noise returning from the node and its amplifiers can be checked and should typically be -18.8 dBmV at 4 MHz BW or about -30 dBmV at 300 kHz. This is a good method for checking the static operation of the reverse without a reverse signal.

The output of the node combiner feeds equipment for addressable converter operation. The method of combining needs to be altered if telephony or other reverse signals are to be sent over the reverse path. **CT**

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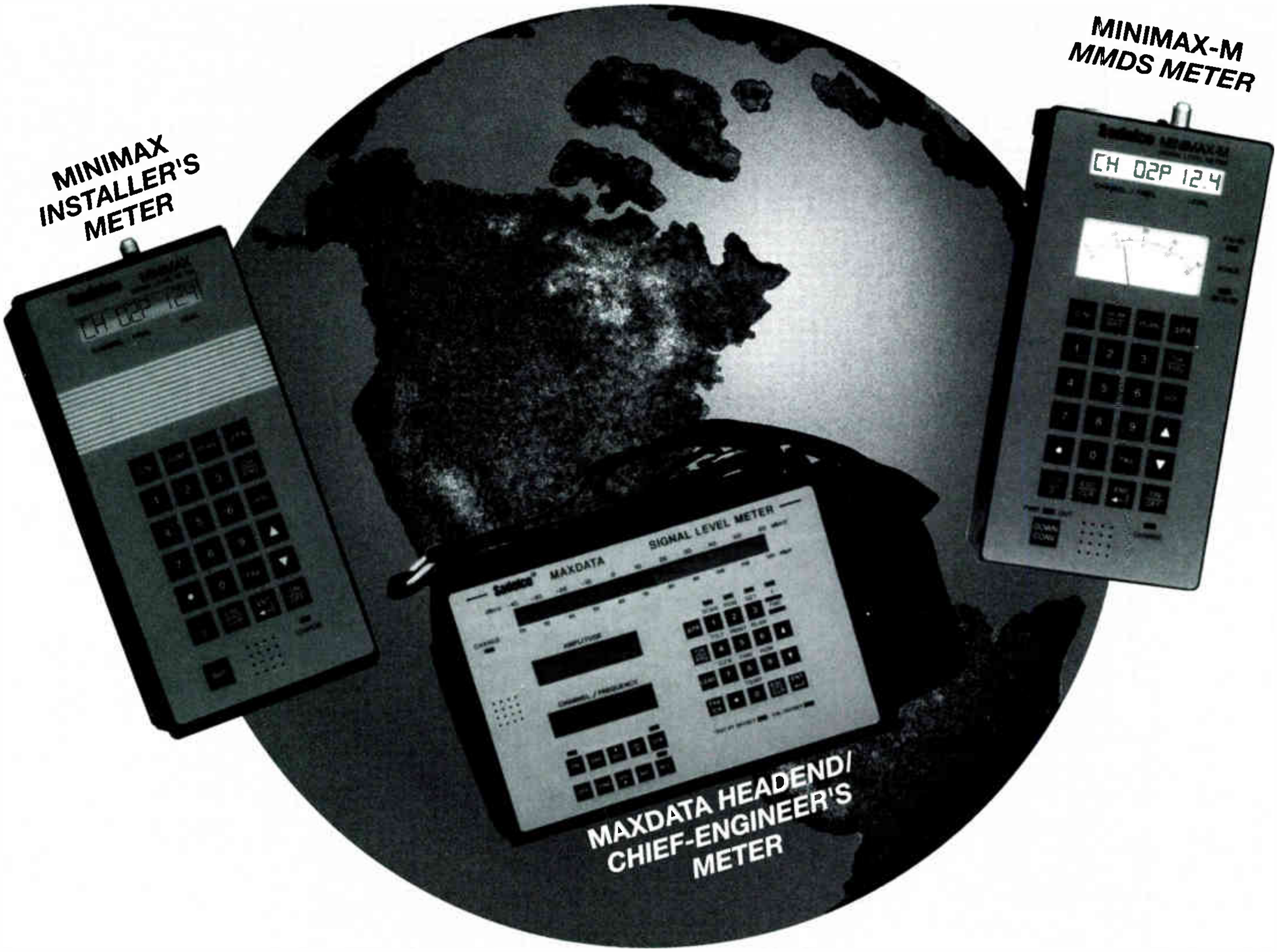

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By Bill Riker

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SCTE has a new home! At long last the national headquarters staff is settled into the new location. This momentous event caps off a year-long period of tremendous movement for the Society that included our name change, record-breaking attendance at Cable-Tec Expo '95, numerous additions to the staff, the planning of an in-house SCTE museum and finally, the construction of and relocation to a larger, more efficient national headquarters facility.

As the dust settles, I'd like to examine what the next few months hold for the Society. To begin with, I want you to have our new address: 140 Philips Road, Exton, PA 19341-1318. As we have remained in Exton, the (610) 363-6888 telephone number remains the same.

I'd also like to call attention to the February 29 official grand opening of SCTE's new headquarters. This will be followed by subsequent open houses over the course of 1996, intended to introduce the new facility and the benefits it offers. As members gradually become familiar with the building, my hope is that they will utilize what it has to offer, such as the cable museum, meeting rooms and training facility. A great deal of planning and effort has gone into this project, and the time has come to enjoy the fruits of this endeavor.

In addition to these opportunities for members to see our new home, the Society will be opening its training room with the first of its regional seminars to be offered in the facility. "Introduction to Telephony" will be presented on March 4-5 and "Introduction to Fiber Optics" will be given March 6-8. Both will be led by our Director of Training Ralph Haimowitz. Anyone interested in attending should call our special projects department at the number listed before.

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

Of the many changes that have been implemented in our new home, one is our new telephone system, which has voice mail capabilities. This will allow members to leave messages for staff members without necessitating a lengthy explanation to a third party.

Another change is that national headquarters will now have two incoming fax lines intended for different departments. The (610) 363-5898 line is for all faxes regarding membership and administration. This would include membership applications, address changes, requests for information, editorial and promotion matters and merchandise orders. The new (610) 363-7133 fax line is for all faxes regarding the training and conference departments. This includes certification program requests, chapter premeeting notices and agendas, conference and seminar registration and housing. National headquarters will soon offer fax-on-demand capabilities, which will allow callers to access key brochures 24 hours a day.

The new facility affords the Society the storage space it has so strongly needed for the past few years. The warehouse offers not only ample room to accommodate materials that must be handled daily, such as publications, videotapes and other merchandise, but also has an area allotted to archive materials that the Society preserves for either historical reasons or business purposes.

Our on-site museum is a welcome addition to national headquarters. Visitors can view classic cable equipment that has been integral in the evolution of the telecommunications industry. The museum also will contain archives from the Society's history dating back to its inception in 1969. Items such as early SCTE promotional pieces and publications will be displayed along with the names of the Society's Charter Members and photos of SCTE milestones.

The Society's computer system also has undergone significant changes since we have upgraded to a Windows NT server and are moving toward using Windows '95. To ensure the safety of all computer data, a Compaq server with mirrored disk drives has been put in place.

As the Society's membership continues to grow, accordingly, so does the staff to support it. I am pleased to announce the recent addition of Ted Woo, Ph.D., to the SCTE staff in the newly created position of director of standards. In this capacity, he will advance the Society's efforts to bring SCTE-approved standards through the process of American National Standards Institute approval now that SCTE is an ANSI-recognized standards developing organization. He comes to the Society from C-COR Electronics, where he was manager of mechanical engineering.

Expo alert

In other news, registration packages have been mailed to all SCTE members for Cable-Tec Expo '96, to be held June 10-13 at the Opryland Hotel in Nashville, TN. I recommend that you return your registration forms promptly to take advantage of the best housing options.

I am delighted to bring you this good news and report on all the latest developments at SCTE national headquarters. 1996 is already a milestone year for the Society, and I look forward to experiencing even more progress throughout the rest of this year. **CT**


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