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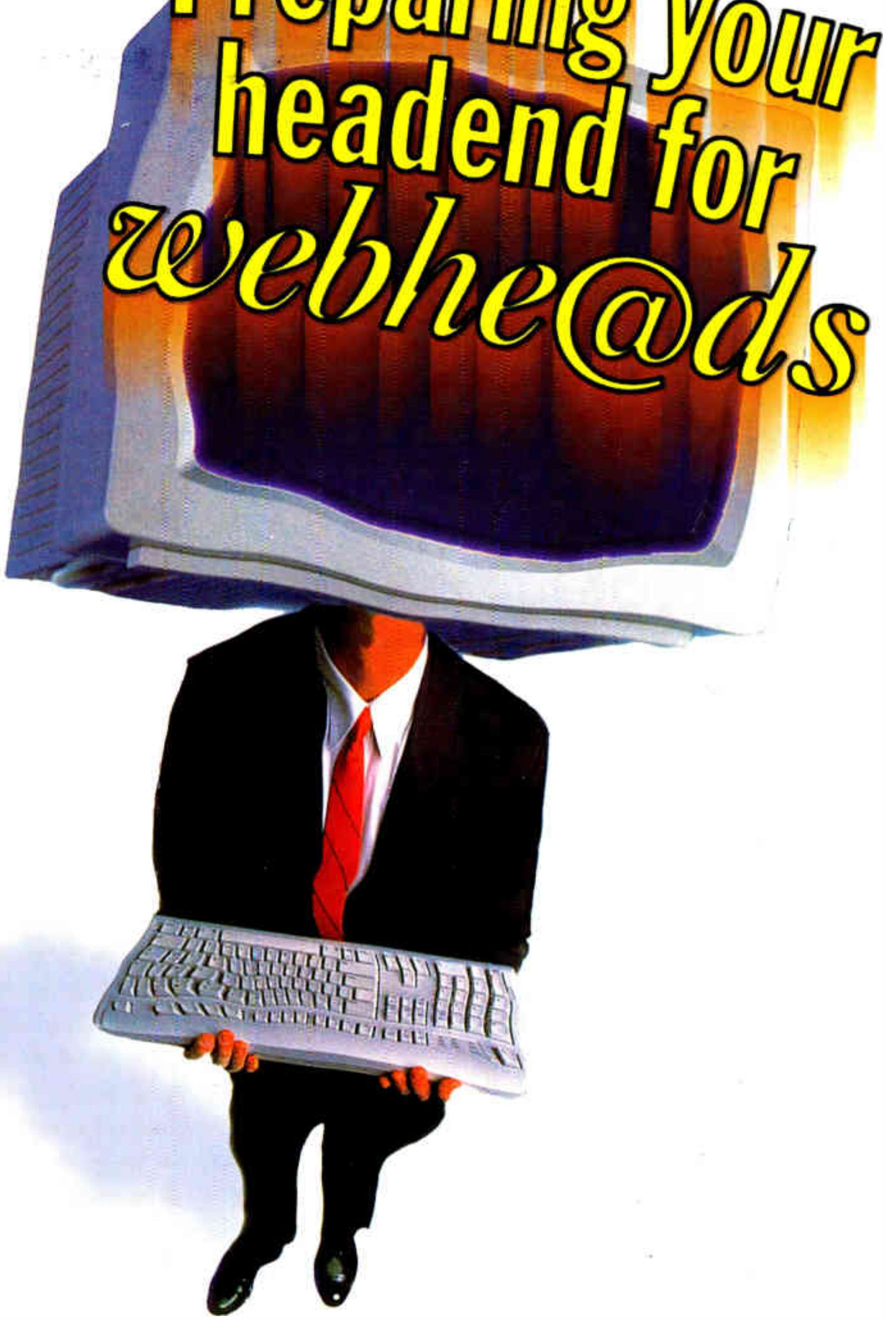

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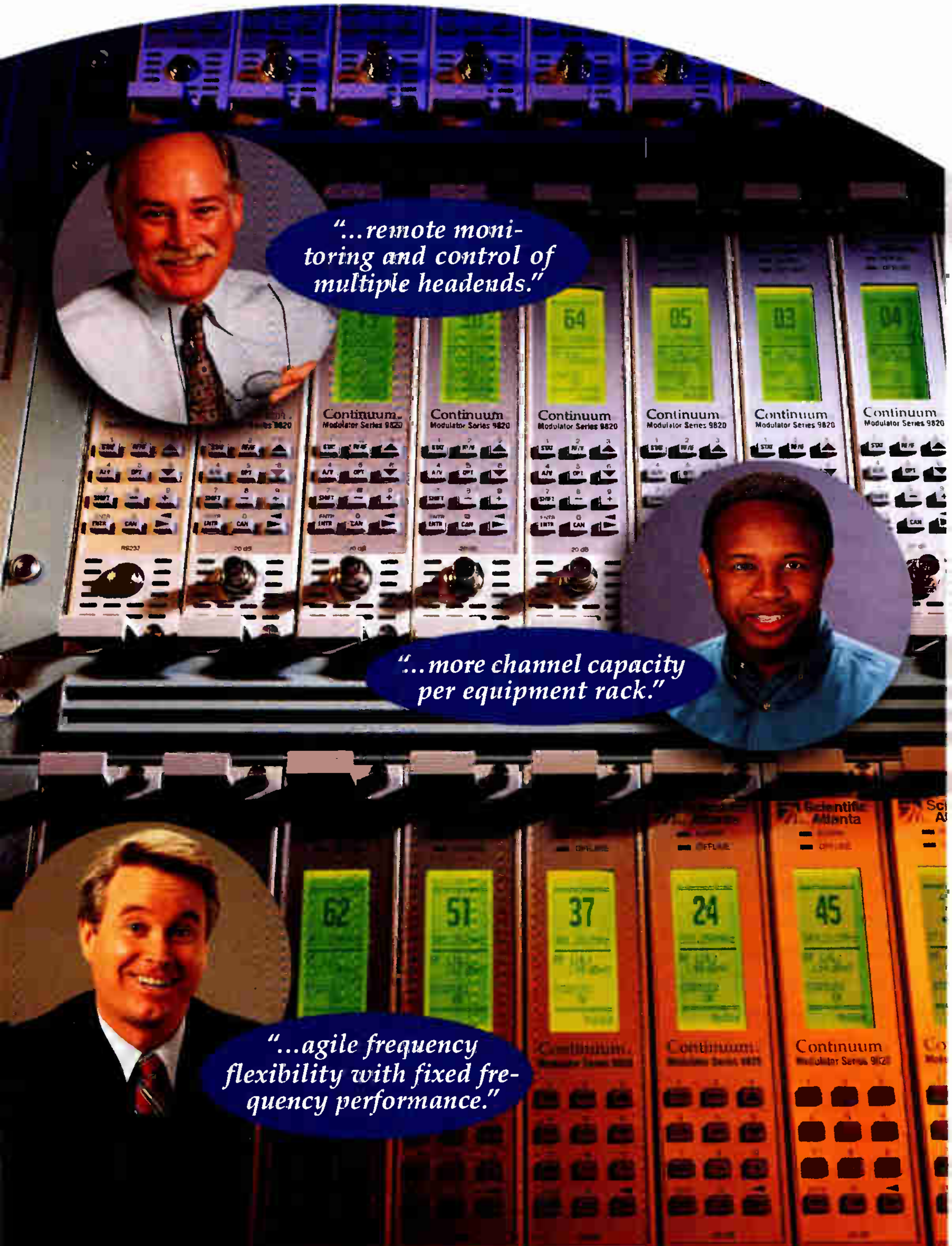

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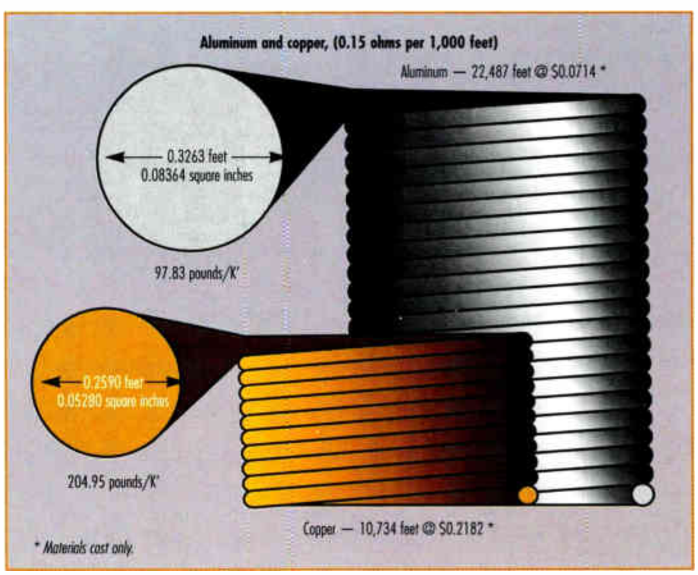

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EDITOR'S LETTER

Back to the future

No question about it. I have now seen too many changes taking us back to where we used to be. I had plenty of time to roam the National Show '97 convention floor in New Orleans back in March. And what I saw was equipment and ideas from the old days. Here are a few examples.

Addressable taps

I remember Ameco and a number of other companies introducing addressable taps almost 20 years ago. Now, with engineering strenthening their return paths for data and telephony, addressable taps begins to make sense. One of the big reasons addressability wouldn't work back then was downstream and upstream egress/ingress. Cumulative leakage index (CLI) programs began the improvement in system leakage and then added attention needed for networking completed the improvement. There will probably be a lot of addressable taps sold over the next few years.

Interdiction

Even heavier emphasis seems to be on interdiction equipment. Since full-service networks may require switching and filtering at the side of the residences or businesses, addition of interdiction is a natural. I found the addressable tap suppliers to also be marketing interdiction and it will be interesting to see which method of service will take the lead.

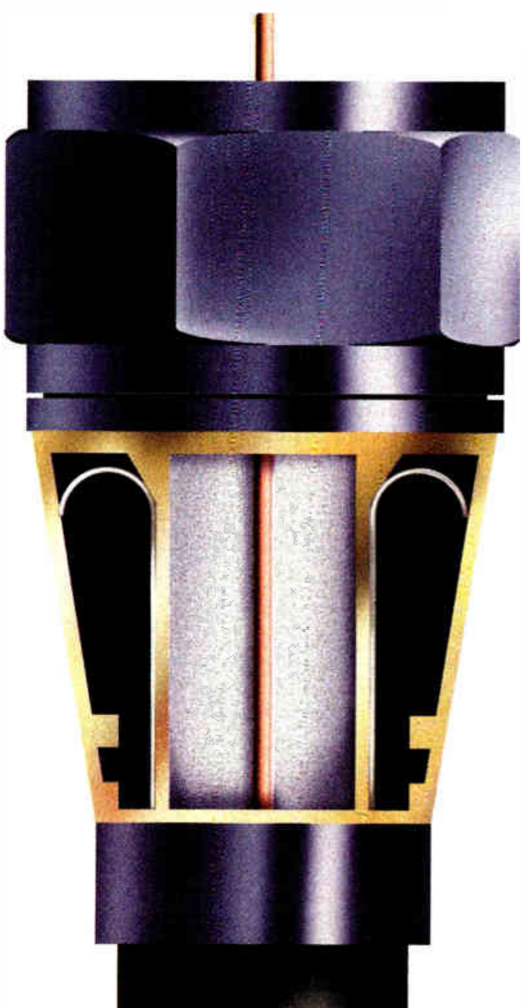
Whether it's addressable taps, interdiction, or a new form of service menu from the network operations center (NOC) computers, cable will begin to depend on electronic instructions instead of expensive truck-rolls. A recent study showed each roll of a truck with one technician costs about $75. With addressability or interdiction, many service calls can be handled electronically. And our image will be greatly enhanced when the customer no longer has to stay home waiting for the install or disconnect to be made.

The T word

I actually expected addressability and interdiction to pop back up. But guess what I heard at this show that just blew me away! I attended many of the presentations by the "Big Four." And they are beginning to use the "T" word. "Turnkey," that is. I have spoken to industry people about this very thing during this past year. It makes sense to me but from their reactions, I didn't think they thought turnkeys would ever be possible again. I think it's full-service marketing for the vendors of full-service network equipment to provide some turnkey service. And I don't just mean supplying all of the gear. I mean supplying financing for the projects.

When cable TV was growing in the '50s, '60s and '70s, most cable systems were built with turnkey financing. Turnkeys stopped in the early '70s because the cost of money went out of sight. I think our little system in Creston, IA (now owned by TCI) was the last system turnkeyed. But now that digital is being introduced, some companies are willing to discuss turnkeys again. Perhaps that's the way to get the industry really going into full-service networks with digital signals as part of the package. I believe companies who promote such service will control the leading share of sales as we roll toward 2000.

Rex Porter
Editor



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A Microsoft nation?

Microsoft's announcement at the NAB '97 show in Las Vegas regarding its $425 million buyout of WebTV Networks is a real threat to the cable industry. *CT* sister publication *CableFAX* reports that this may mean trouble for cable as the prospect of Bill Gates placing Internet TV devices in every American household threatens programmers' ratings while cutting into MSOs' growing share of the Internet access business. Industry analysts forecast minimal effect in cable in the short run, and some new opportunities for cable operators. While WebTV now uses a telco path for Internet access, satellite or cable versions of the device are sure to follow. Cable will get another programming outlet if Microsoft's efforts to develop a broadcast architecture for its Windows platform turns the PC into a satellite, cable and terrestrial broadcast receiver.

TV Rex e-mail update

CT Editor Rex Porter is sporting a new e-mail address—He can be reached at tvrex@earthlink.net.

Data options to get ahead of telcos

The Ventura, CA-based cable operator, Avenue TV Cable has installed an operational, fully commercial system for high-speed Internet access over a single-direction cable TV distribution system combined with traditional modem upstream data. Optimal Systems Integrators Inc. of Spokane, WA, under contract with Internet Ventures, installed the PeRKInet system and it is described as being able to provide users with twice the speed of an integrated services digital network (ISDN) Internet connection (256 kbps). →

Lockwood will be missed

Lawrence (Larry) W. Lockwood of Arlington, VA died March 29 due to complications from a stroke he suffered last year. Lockwood was a former *Communications Technology* writer and a life-long contributor to the development of television. Lockwood served as technical director of the National Broadcasting Network (NBC) from 1946 to 1961. He was involved in the earliest color TV presentations and responsible for the development of techniques for the improvement of videotape recording and studio production. Most recently, he was president of TeleResources. From 1981-1983 he was vice president engineering of Arlington Telecommunications Corp.

Is ingress making your return path a road to nowhere?

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And of course, the HP CaLan Sweep/Ingress Analyzer offers DigiSweep, the industry's fastest, non-interfering, digital-services compatible forward and reverse sweep. In fact, reverse sweep measurements can be performed in real-time — even with multiple users.

So don't let ingress slow you down. To find out how HP CaLan's Sweep/Ingress Analyzer can help you identify, troubleshoot, and eliminate your ingress problems, call **1-800-452-4844, Ext. 1749**. Or visit us at: http://www.hp.com/go/catv

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The system divides and routes individually the high-speed downstream cable TV's connection and the upstream telephone modem connection using hardware and software developed by Hybrid Networks. Commonly accessed information is stored in the system and allows cable subscribers to access the information without connecting to the Internet. The system is specifically designed for consumer and business applications where the users access and download more digital information than they distribute or publish.

One million direct hits

A national study conducted by the Consumer Electronic Manufacturers Association estimates that direct-to-home (DTH) satellite systems are drawing more than a million subscribers a year away from cable and enabling another 322,000 households to downgrade their cable options to "basic" service. The growing preference for DTH over cable results in an estimated $1.4 billion annual revenue loss to the cable industry, said CEMA.

Reasons? Of a random sample of 1,000 DSS owners, 92% said they purchased the mini-dish satellite equipment to have access to more channels and a greater variety of programming. Plus, consumers prefer the DTH picture and sound quality. According to CEMA, more than 2.2 million DTH systems were installed in 1995 and 3.5 million in 1996—4.4 million are expected to be bought in 1997.

Noncable modem data solutions

OpenTV Web is a new development from Thomson Sun Interactive that was created in conjunction with its OpenTV runtime environment and allows network providers to offer fee-based Internet access to subscribers through their TV sets. OpenTV Web uses a dial-up return path to provide Internet service from a broadcast of Web sites to full interactive use. Thomson's transaction server software is integrated with OpenTV Web and manages the flow of requests for information from set-tops on the network.

Notes

- **Interconnect of the Twin Cities** (Minneapolis and St. Paul), chose the SeaChange SPOT system from **SeaChange International** to deliver cable advertising. The Interconnect will provide single-point insertion of ads directly onto 20 cable TV channels in the **Paragon** and **Continental Cablevision** systems, which jointly serve the market.
- **DiviCom**, a provider of digital video networking solutions, selected **FrontLine Communications** to supply equipment to create the a digital emergency alert system. The FrontLine EAS system will interface to DiviCom's digital broadcast systems. **CT**


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Expo '97 draws near

SCTE's Cable-Tec Expo '97 will be held June 4-7 at the Orange County Convention Center in Orlando, FL, with pre-conference sessions to be held June 3. This year will mark the Society's 15th annual Cable-Tec Expo and its 21st Annual Engineering Conference. Attendee registration begins June 3 from 1 to 7 p.m., and pre-conference sessions are scheduled to take place from 2 to 5 p.m. Presently on the agenda are:

- "Data Network Protocols and Telephony Acronyms Explained";
- "Preparing for Technical Certification at the Service Technician and Telephony Levels"; and
- "Technical Standards Development."

SCTE subcommittee meetings will be held from 2 to 5 p.m. on June 3, and in the evening, the Arrival Night Reception will be held from 6 to 8 p.m.

Over 4,000 attendees are expected to participate in the various activities taking place at Expo, including the Engineering Conference's two panel discussions, Session A, "Preparing for Digital Deployment" and Session B, "Cable Modem Technology and Product Strategy." This year's conference will be held Wednesday, June 4, from 8:30 a.m. to 12 p.m., and will feature leading telecommunications industry engineers sharing their insights on the paths cable technology will follow in the immediate future.

The annual awards luncheon will be held June 4 from 12 p.m. to 2 p.m. Several SCTE awards, including Member of the Year, Field Operations and Personal Achievement, in addition to the SCTE Hall of Fame, are open to member nominations. Contact SCTE at (610) 363-6888 for further information.

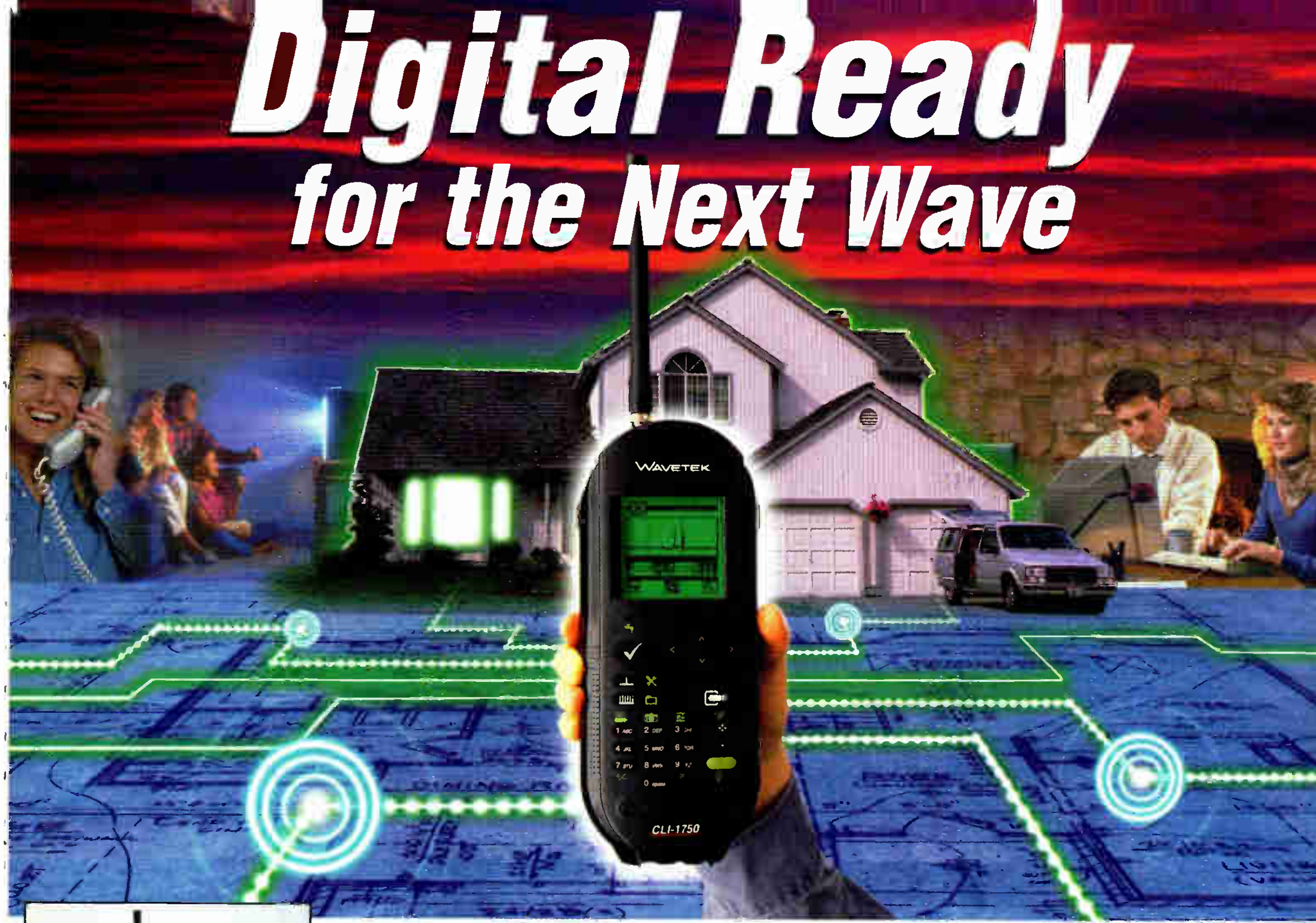
In response to requests from exhibitors and attendees of previous Expos, the schedule has been changed to provide additional exhibit hall hours. The Expo '97 Exhibit Hall will therefore open on June 4 at 2 p.m. With the expansion the Expo exhibit hall has experienced in recent years, both in terms of the number of exhibitors and the amount of floor space used, more exhibit floor hours were needed to allow attendees ample time to benefit from the valuable demonstrations and information available.

The exhibit hall also will be open on June 5-6 following Expo workshops, with Thursday hours set for 11 a.m. to 6 p.m., and Friday hours set for 11 a.m. to 4 p.m. Over 350 industry hardware vendors and service providers are expected to exhibit at Expo '97.

Expo workshops will be open on Thursday, June 5, and Friday, June 6, from 8 a.m. to 12:15 p.m. both days. Ten different workshops will be offered, and the schedule is designed to enable each attendee to participate in six of these workshops. Workshops tentatively set to be held during these periods include the following: "Cable Modems—Are They Plug and Play?," "Digital System Deployment and Measurements," "Inside Wiring Options," "Making Two-Way Work (Part II)," "New Revenue Opportunities," "Powering for Reliability," "Project Management of Your HFC Upgrade," "Return Path Problems and Their Solutions," "Quality Audio in the Headend," and "Surge Suppression, Fusing and 'Slugging.' "

BCT/E and Installer Certification testing will be offered June 5 and 6 from 10 a.m. to 2 p.m. and also on Saturday, June 7, from 9 a.m. to 12 noon.

For further information on Cable-Tec Expo '97, contact the Expo '97 hotline at (610) 363-3822, fax to (610) 363-7133 or visit the SCTE web site at www.scte.org. →



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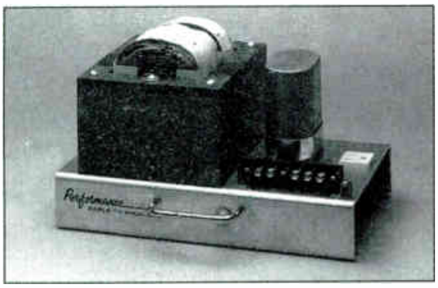

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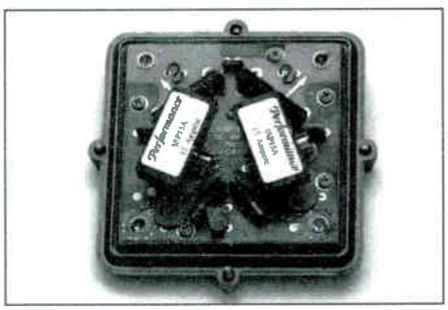

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HQ celebrates anniversary

Feb. 29, 1997 marked the one-year anniversary of the grand opening ceremony for the Society's new national headquarters building.

Based at 140 Philips Road in Exton, PA, this building was custom-built to SCTE's specifications and has housed its operations since January 1996, when the national headquarters staff relocated from its previous offices located in the nearby Exton Commons office development.

When first proposed, the construction of the new building was recommended to the SCTE board of directors as it would:

- Allow for significant increases to the national staff, which were not permissible in the limited space of the Exton Commons location;
- Make it possible for SCTE to host training seminars and industry events in its own building; and
- Provide the Society with its own warehouse for storing records, publications and show materials, which had necessitated the rental of outside storage space while the staff was based in Exton Commons.

One year later, a brief review shows just how successfully SCTE has adapted to its new headquarters:

- The Society staff stood at 17 full-time employees by the end of 1995. At present, SCTE has 24 full-time employees, with more set to join the staff in newly created positions made possible by the increase in available office space due to the relocation. By the end of 1997, the SCTE staff will approach 30 people.
- To date, SCTE has conducted three sets of regional seminars in the new building's training room.
- The creation of the SCTE warehouse in the rear of the new headquarters building has enabled the staff to streamline its fulfillment department, processing orders with greater speed and efficiency than ever before, and offering more publications and videotapes than it previously could.

Gear up for Cable-Tec games

The '97 SCTE Cable-Tec Games national finals will be held June 4 at the Renaissance Hotel in Orlando, FL. Competitors will include 24 local chapter, state or regional champions; a team of three from the Greater Orlando area (The Cable-Tec Expo Host Chapter and 1996 Nashville Cable-Tec Expo national champion, Lee Summers of Memphis, TN). Events include: Cable Jeopardy, hosted by NCTI; Cable Splicing, hosted by Gilbert; Meter Reading, hosted by Wavetek/Trilithic; and MTDR, hosted by Riser-Bond and Sencor.

Prizes include gold, silver and bronze medals and the '97 national champion will receive a complimentary registration transportation and hotel for the 1998 Cable-Tec Expo in Denver, CO. For more information, contact Region 8 Director and Subcommittee Chairman, Steve Christopher at (601) 824-6010. **CT**

By Alex Zavistovich

Engineers and architects

Have you noticed that the lines between engineering and architecture have gotten a little blurry lately?

It used to be, an engineer was an engineer. If it had signal going through it, it was engineering. Simple.

Now everybody is looking at two-way communications. All of a sudden you're expected to be an architect, too. Vendors aren't just selling hardware, they're selling "platforms" or "foundations," and you build your future services on them. That's architecture.

Engineering isn't the only discipline that romanticizes architecture. In Ayn Rand's classic novel *The Fountainhead*, the hero—the model of the ideal man—is an architect. On a more mundane level, isn't George Costanza on NBC's *Seinfeld* always itching to pretend to be an architect? What gives with this architecture thing, anyway?

Stick with me. This is all going somewhere.

Form and function

Engineering and architecture aren't too far removed, according to the Random House dictionary.

An engineer is a person "versed in the design, construction and use of engines or machines." An architect is "the deviser, maker or creator of anything." The word takes its meaning from "archi" or "lead," and "techt" or "worker." Lead worker. That makes sense: Before you can build something, you have to know what you're building. Somebody has to go first.

So now engineers are architects. Day One, Lesson One, Architecture 101: Form Follows Function. You have to know what you want a certain thing to do first. *Then* you can begin to devise its structure.

Whether you're deciding on the elevations for a building or deciding on a network architecture for two-way services, you need the proper architecture for the intended use. What's the best architecture for two-way service? That depends on what you're planning to offer in the way of services, how much you can spend, how much you've already spent, and the quality of the real estate—in this case, the return path—you're working with.

There are as many network architecture schemes as there are levels of two-way service. With all due respect to other players, let's limit ourselves to quadrature amplitude modulation/quadrature phase shift keying (QAM/QPSK), orthogonal frequency division multiplexing (OFDM) and synchronous code division multiplex access (S-CDMA), or we'll be here all day.

"There are as many network architecture schemes as there are levels of two-way service."

If your return path is reasonably free of ingress and you were you one of the early adopters of cable modem technology, you may have decided on QAM/QPSK. It has the advantage of being well-tested, and is therefore a pretty safe bet. If you've made a significant early investment on your return path and have already spent a chunk of cash on cable modems, you probably won't stray too far from QAM/QPSK. It's right in keeping with proposed specifications for interoperable digital equipment recently handed down by CableLabs.

Data and beyond

If data is just a stepping stone in your plans for bidirectional telecommunications, and you're planning to add telephony some time down the road, that's another matter—especially if you're dealing with a less than pristine return path. You're probably already looking for a burlier architecture, which may mean OFDM.

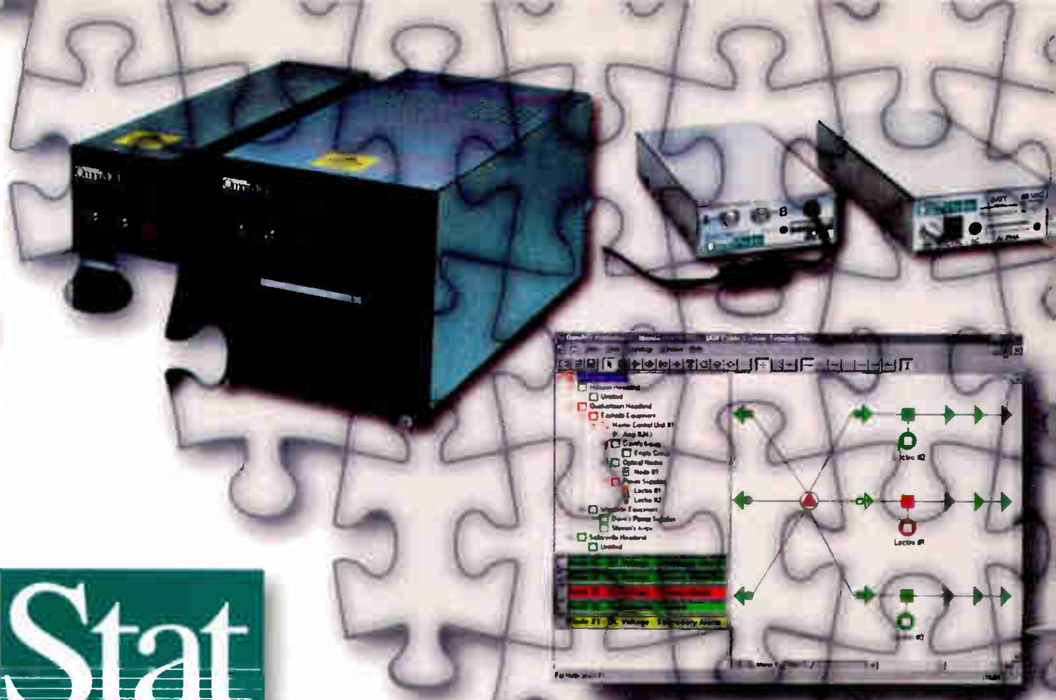
Imported from Telephony Land, OFDM is a proven architecture for broadband voice-related services. Its so-called "tone-hopping" characteristic means it's always searching out the strongest signal—so if you're dealing with a little dirt on the return, you may see improvement in overall system reliability.

Maybe you're not just dealing with a little dirt. Maybe you're dealing with a return path that's plain lousy with ingress. Are you a system operator of modest means, not completely built out with hybrid fiber/coax (HFC), and no immediate plans to upgrade? You may have decided that S-CDMA could be the ticket. A dark horse by dint of its late arrival in the industry, the scheme has shown promise in early testing, transmitting data accurately even in a murky ingress-laden atmosphere, or over simple coax line. S-CDMA is a close sister to the architecture of wireless and PCS systems, so it's not exactly unproved. As I said, a dark horse.

All this goes to show that, until the industry at large has completely readied the ground for future services, you'll be wearing two hats: engineer and architect. Don't be thrown by the vast array of modulation choices; just look to what you're planning to offer, and pick the network scheme that gives you the firmest foundation for success. Be an architect.

Hey, if George Costanza thinks he can do it, how hard could it be? **CT**

Alex Zavistovich is executive editor of "Communications Technology." He can be reached in Potomac, MD, at (301) 340-7788, ext. 2134.



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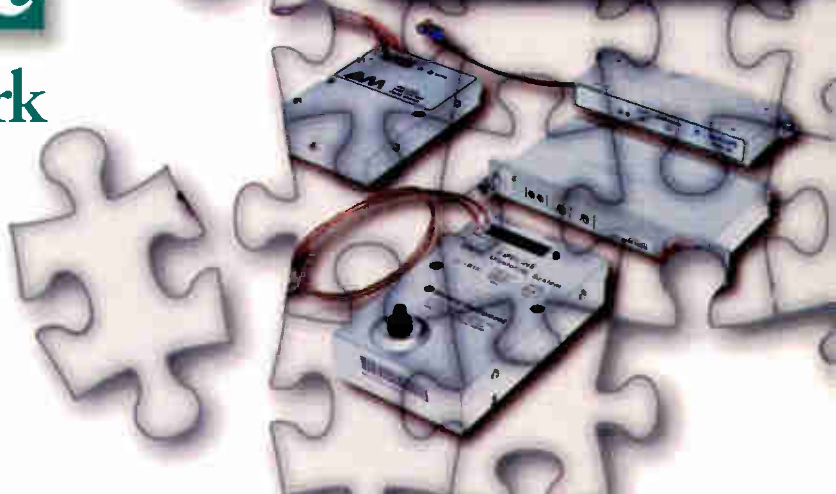

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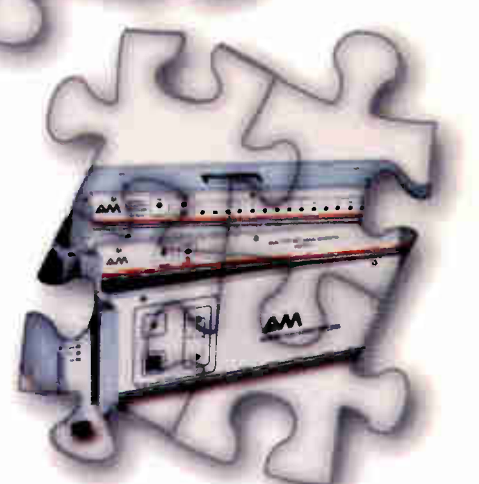

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By Ron Hranac

Cable chronicles

Just when you thought the popular press had nothing good to say about the cable industry, a piece in the May 22, 1997 issue of *PC Magazine* ("First Looks," pages 64-65) gives cable modems a positive bent. *PC Magazine* evaluated two services, TCI's @Home Network in Hartford, CT, and Continental Cablevision's Highway1 in Boston. Both received generally good marks.

According to the article, overall performance was impressive, with most Web sites appearing on the screen in about one second, and loading in five to eight seconds. It took *PC Magazine* staff only 33 seconds to download a 6.5 MB test file via the @Home service, and 60 seconds using Highway1. In comparison, it took at least 25 minutes to download the same file with a standard 28.8 kbps telephone modem. *PC Magazine* found that @Home Network's average effective data throughput was 199 kbps. Highway1 was judged to be about 50 times faster than a conventional analog modem.

It was refreshing to see *PC Magazine's* favorable comments about these two services, especially in light of John Dvorak's not-so-favorable column on cable modems about a year and a half ago. We need more success stories in the popular press like this latest one. A tip of the hat to TCI and Continental!

Condolences

In the not-so-good-news department, I received word that Larry Lockwood, a former *Communications Technology* columnist, passed away. We have indeed lost one of our best and brightest. My sincere condolences to Larry's friends and colleagues. We'll miss your keen insight, Larry.

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

Taking on the big boys

For years I've wondered why our industry's coaxial cable manufacturers haven't taken their collective expertise (more than 750,000 miles of 75 ohm CATV distribution cable are in use in North America alone) from the 75 ohm world and manufactured a 50 ohm product to compete with the 50 ohm world's big boys. Other than a few specialty non-CATV cables, it's been pretty much just 75 ohm coax from the companies we know so well.

A while back Comm/Scope and Times Fiber began manufacturing 50 ohm aluminum cables for express power applications and possible future RF applications, followed by 20-something ohm cables just for power. Going one step further, both companies now manufacture a line of copper 50 ohm communications cables for the PCS, cellular and two-way radio industries. Their intent is to take on the likes of Andrew which has an estimated 80% of the 50 ohm cable market and Cablewave.

Comm/Scope's new cable is based on the company's Quantum Reach line, but has a copper rather than aluminum shield. It's called Cell Reach, and the .540 size has a copper clad aluminum center conductor. The 7/8-inch cable has a hollow copper tube for the center conductor. Providing a one stop shop, Comm/ Scope also is selling coring tools and connectors for the cable. The connectors, by the way, come from Europe's Cablecon.

I've been playing with a couple of small samples of this new cable, and, to be perfectly honest, this stuff runs circles around traditional 50 ohm communications cables. Comm/Scope borrowed a few tricks from its 75 ohm line, such as true closed-cell foam dielectrics and bonded cable construction, and applied them to the new 50 ohm cables. The connectors require the cable ends to be cored, just like the 75 ohm distribution cables we use in our networks. This means connector integral mandrels are used for better physical support of the shield, as well as an improved electrical ground interface. I'm not aware of any traditional 50 ohm communications cable with this feature.

While I haven't seen samples yet, Times Fiber manufactures both braided and corrugated copper shield 50 ohm cables, which are marketed under the Amphenol name. The corrugated cables go by the moniker TXL, and are available with helical or annular corrugation. Amphenol makes the connectors for TFC's cables.

Next time you're looking at an application requiring 50 ohm cables, consider keeping your cable order in our own industry. It's my understanding that both companies use a separate sales force to handle the 50 ohm communications products, so your normal rep may have to refer you to someone else.

Cable '97

If you weren't in New Orleans, you didn't miss much. As much as I hate to say it, this year's NCTA convention was on the dull side. All three days on the exhibit hall floor seemed like what you usually see the last day of a show. I've heard various figures, but attendance was definitely down. Unfortunately this has been a regular theme at recent industry confabs. Western Show attendance was flat, SCTE's Emerging Technologies was down, the Texas Show was down, and NCTA continued the trend. Almost every hardware vendor I visited at this year's NCTA convention bemoaned the nearly nonexistent booth traffic. Unfortunately, industry cutbacks have hit everyone. →

Some positive news did come out of Cable '97: It was announced on March 16 that the Data Over Cable Service Interface Specification working group has finalized the RF specification for cable modems. This working group, known as the MCNS (multimedia cable network system) consortium, includes representatives from Comcast, Continental, Cox, Rogers, Time Warner, TCI and CableLabs. Shortly after the announcement, nearly every cable modem vendor's booth had a sign stating that their modem is (or, more realistically, will be) MCNS-compliant. This is a major step toward ensuring interoperability among the cable modems we'll have available to us and our subscribers, eventually even allowing cable modems to be available at retail. Expect MCNS-compliant modems to be available in quantity after the first of next year. For more information, contact CableLabs at (303) 661-9100 or visit the Web site http://www.cablemodem.com.

In between meetings, I did have an opportunity to visit several booths, and as usual, I spent some of that time looking for interesting things that don't always make the show headlines. A couple of interesting products caught my attention: A new 1 GHz power passing tap from Lindsay Electronics, and a fiber-fed PCS repeater from Ortel (and you thought they only made lasers).

As usual, there were several good technical presentations. Contact NCTA's science and technology department at (202) 775-3637 to get a copy of this year's proceedings manual.

SCTE-List

The SCTE-List surpassed the 1,100 subscriber mark on May 5. Wow! When I first wrote about it a little over a year ago, there were a little over 400 subscribers. The SCTE-List has become the industry's defacto technical exchange forum, with postings from around the world. If you have access to e-mail, you can subscribe to the list (also called an Internet list server or reflector). There is no charge to do so, other than what you already pay for your e-mail service.

For more information, check my column in the January 1996 issue of *Communications Technology*. A big tip of the hat to the University of Wisconsin and sysop David Devereaux-Weber for maintaining the list server.

While I'm on the subject of lists, Time Warner's Steve Johnson (and SCTE's recently re-elected Region 2 director) maintains a list of ham radio operators who are employed in the cable industry. Steve informs me that the ham list is over 680 strong. If you're a ham but aren't yet on the list, give Steve a jingle at (303) 799-5621.

SCTE elections

Finally, a big thanks to those of you who voted in this year's SCTE board of directors elections. Twenty two percent of you voted this time, up from last year's 17%. That's a big increase, and it shows you care. Next year let's try to get the figure over 25%. **CT**

By Justin J. Junkus

The ABCs of wireless telephony

Telephony isn't as simple as it used to be. It was tough enough when the industry started deregulation and consumers got to choose their own long distance carrier. Then, local service opened up, and consumers got to pick a complete phone company. (Sometimes, it was even their cable telecommunications company!) Now, they have to figure out which mobile telephone option best meets their needs. Since many cable companies are either offering or exploring wireless telephony, I thought it might be useful if we took one issue to explore wireless telephony options.

Justin Junkus is president of KnowledgeLink Inc., a telecommunications training and consulting firm specializing in the cable telecommunications industry. To discuss this column further or to find out more about KnowledgeLink, you may e-mail him at jjunkus@aol.com.

The wireless distinction

First off, notice that I did not say cellular telephony. That's because cellular is only one of the wireless telephony options. We'll see later that in many cases, the distinction amounts to signal frequency and features rather than the basic architecture defining a cell. Like so many other topics in telephony, this might be easier to understand after we follow the history of the technology.

Like its landline counterpart, wireless telephony began as an analog technology. In fact, it's somewhat ironic that the initial architecture for wireless telephony is very similar to the first cable TV systems. Early cable TV systems solved the problem of connecting many subscribers on a landline network to a few signals received at a community antenna. Early wireless telephony likewise connected the many subscribers of the public switched telephone network to a few mobile telephones. Then, as now, part of the challenge was the two-way requirement of telephony. ➞

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To solve the problem, the phone company modulated the telephony voice signal onto a high-power RF signal in a limited frequency spectrum broadcast from a single tower and bulky mobile units. Given the limits on frequency allocation, even when multiple frequencies were available, the number of subscribers was limited to a few tens per metropolitan area. Mobility was constrained by distance from the tower and the maximum power levels at the tower and the mobile unit.

About 20 years ago, telephone engineers came up with the cellular concept to increase the possible number of mobile phones that could be provided in any given area. The theory behind the concept was that mobile subscribers would be distributed across a metropolitan area, so it would be possible to offer service from several lower power transmitters at towers spread across a region, and reuse frequencies across a service area. The distance from each tower to the furthest point able to receive a signal defined the "cell," which is typically shown as a hexagon. (Yes, anyone with a radio background realizes that a hexagon is not the actual transmission pattern, but the circular footprints of the transmitter power ranges for metropolitan coverage intersect in six points that can be connected to form hexagons.)

As mobile subscribers move from cell to cell, their call is "handed off" to the next cell, at a different frequency. The Federal Communications Commission allocation of spectrum in the U.S. market is 25 MHz to each of two carriers per market for cellular service. 30 kHz is required per analog voice channel, so the maximum number of channels per carrier is 416.

These channels are allocated across the number of transmitter cells in a defined reuse pattern, such that adjacent cells do not interfere with each other. Within a given cell, several simultaneous conversations can be handled by a combination of analog frequency division multiplexing, and frequency modulation within each frequency range. This technology is known as frequency division multiple access (FDMA).

The Telephone Industry Association defined a cellular hardware architecture consisting of three components: a base station, a mobile terminal, and a mobile telephone switching office (MTSO). The base station maintains the interface for communications to any mobile station within its cell This includes the transmit and re ceive functions, as well as call pro cessing, signaling, maintenance and diagnostics.

The MTSO interconnects the cellular network to the public switched telephone network (PSTN). It provides all central office type functions, such as switching, call processing, call statistics and billing. In addition, it coordinates all base station activities such as channel assignments for users in each cell, and handoffs between base stations.

The MTSO is connected to each base station via dedicated links, such as T-1 trunks. Finally, the mobile terminal is the familiar cellular telephone, comprised of transceiver, antenna and a user interface consisting of keypad, display and audio interface. It stores certain parameters in permanent memory that uniquely identify the terminal upon power up. These include the mobile identification number (MIN), electronic serial number (ESN), and station class mark (SCM).

The mobile terminal can be designed to operate at various power levels, depending on its power class, ranging from 6 dBw to -2 dBw. In the United States and Canada, the name for the analog technology suite that includes FDMA and the TIA defined standard cellular architecture is advanced mobile phone system (AMPS).

Almost as soon as analog cellular service was introduced, its popularity started taxing the limit on maximum number of users based on frequency allocations. Although there was some relief by cellular's design structure that allows cells to be split into smaller cells to increase call handling capacity, eventually it became expedient to introduce digital technology just to gain channel capacity. A side benefit of digital is the increased security of digitally encoded and time multiplexed voice calls.

Digital technologies

In the U.S. market, two digital technologies have emerged: time division multiple access (TDMA) and code division multiple access (CDMA). TDMA increases channel capacity by segmenting the available frequencies into timeslots. Cellular users could thus share a frequency within their cell by being allocated that frequency only during a portion of the time, called a timeslot.

Both digital AMPS (DAMPS) and global system for mobile (GSM) are examples of TDMA. DAMPS provides three timeslots per 30 kHz channel, while GSM provides eight. CDMA increases system capacity even more by spreading digital signals over the entire frequency allocation, rather than over just the 30 kHz channels. Unlike the case with TDMA, additional channels can be added without a limitation. However, noise levels on every channel will increase as the number of users in the frequency band increases.

PCS

As I indicated at the beginning of the article, wireless and cellular are not necessarily the same. Telephony professionals call the set of analog and digital technologies I have described up to this point "cellular telephony." In the United States, cellular telephony is characterized by the two service provider per market structure. Another category of wireless, called personal communications services (PCS), also provides wireless communications, sometimes using cellular technology. PCS adds the dimension of personal mobility to cellular's concept of terminal mobility. Its objective is to provide individual two-way communications independent of location or the type of telephone terminal a subscriber may be accessing at the moment. Obviously, this implies a network database that can track the subscriber's daily activity, and direct a call accordingly. While personal mobility is a PCS concept, cellular telephony providers also are beginning to offer PCS-type services over their cellular networks.

"It's somewhat ironic that the initial architecture for wireless telephony is very similar to the first cable TV systems."

Wireless architectures

There are two wireless architectures for PCS networks. One is similar to the cellular architecture we have just discussed, but operates at different frequencies than cellular services. The details of these frequency allocations and how they were awarded to various providers are too complex to describe in this column, but have been well documented in other trade literature.

However, the bottom line is that each metropolitan market has the potential for seven PCS wireless telephony service providers, in addition to the initial two cellular carriers. Each PCS service provider can use its own chosen technology. There are seven standards available to U.S. providers of PCS services. They are GSM, CDMA, DAMPS, PACS, CDMA/TDMA (hybrid), DCT-based TDMA, and wideband CDMA.

To make the choices for mobile communications even more complex, there are additional varieties of satellite-based PCS called personal communications satellite systems, which replace the base station with a satellite, and the MTSO with an earth station as the link to the PSTN. In general, these systems have a wider coverage than earth-bound PCS, and may be operated in cooperation with some traditional landline telephony service provider.

The only thing common to all the wireless choices is that each technology connects to the landline network. Unfortunately for the consumer, most of the mobile terminals are not compatible across technologies, so when the consumer purchases wireless telephone service based on the terminal alone, he is actually buying the provider as well as the terminal.

"The biggest difference between service providers is the amount of coverage."

This is changing as dual mode terminals appear on the market, capable of using more than one technology to communicate with a service provider's equipment. An example might be a terminal that could use both TDMA and CDMA.

The biggest difference between service providers is the amount of coverage. While up to nine pro-viders can be within one market, not all providers offer service in all markets, or even uniformly within one market. Coverage depends on the number of base stations within the market, and the number of markets in which the provider has a presence.

For the first round of PCS frequency auctions, five service providers have consolidated PCS spectrum owners across the country through purchases or alliances and are able to offer almost national coverage. All others can only offer partial national coverage. Cellular coverage tends to be more universal, since there has been more time for mergers, consolidations, and agreements covering "roaming" between provider territories.

Finally, this discussion of wireless telephony would be incomplete without some mention of the so-called lower-tier PCS technologies. Lower-tier is a subset of PCS also known as low mobility, because its applications exclude vehicular speeds and wide area coverages.

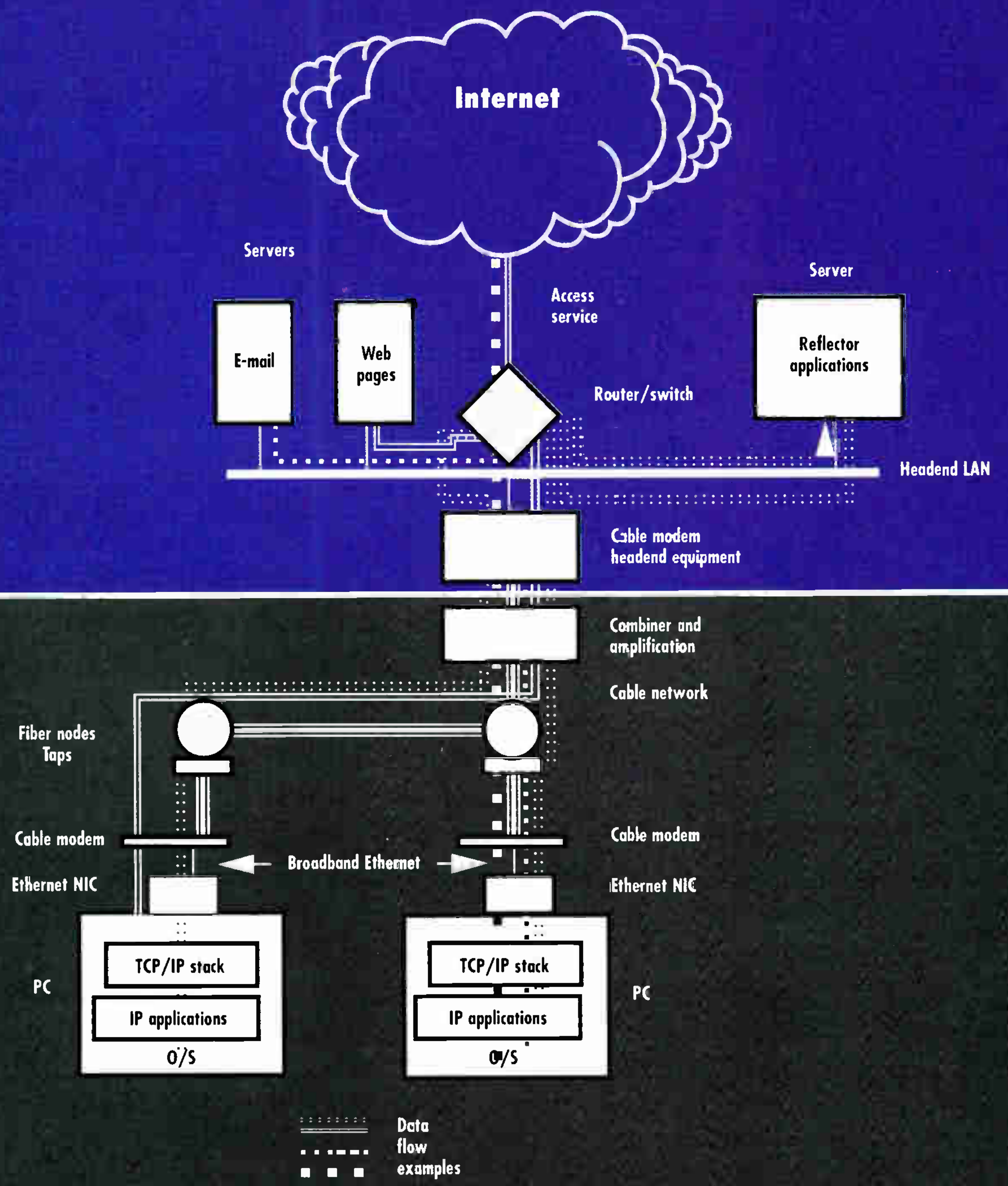
Examples of applications include the wireless local loop, wireless private branch exchanges (PBXs), cordless telephones, and campus wireless applications. Much of the recent wireless activity of cable telecommunications companies has been in these areas. AT&T also has made a major product announcement.

Personal access communications system (PACS) is the U.S. standard for lower-tier PCS.

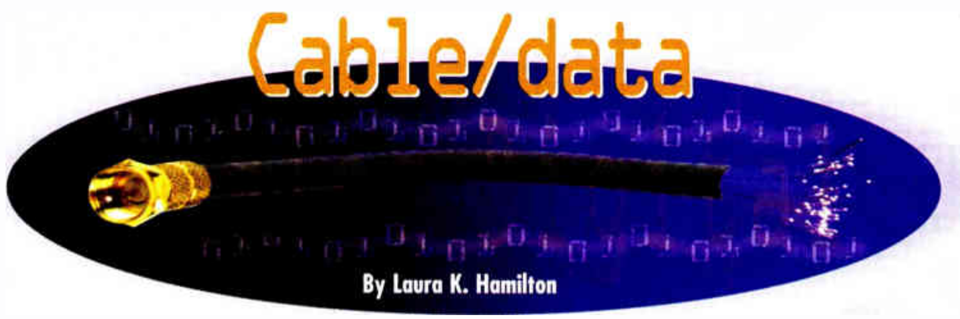
The PACS architecture consists of a radio port, which is the interface to the landline network, and some type of subscriber unit, which transmits and receives to the radio port over an air interface. Depending on the application, handoffs between radio ports may or may not be provided.

So you see, the choices for telephony service have multiplied. Both cable and traditional telephony company personnel need to have a high level understanding of the consumer's options, to better position their own products and services. **CT**

Special cable/data report
Part 1: The headend



Schematic courtesy of Convergence Systems Inc.



The Webheads' headend

Welcome to "Communications Technology's" special series on high-speed data delivery over cable TV networks. In this issue we take a look at your headend, while in June and July, "CT" will cover the outside plant and the customer premises, respectively.

When the technical community crowds around the topic of making a cable system brawny enough for data delivery, the conversation almost invariably ends up at the customer premises. That's no wonder with experts like Tom Staniec, director of network engineering at Time Warner's Excalibur Group, pointing out that around 95% of the garbage that gets dumped into a system's upstream path comes from that very area.

Networks bogged down by this kind of ingress are a hotbed of talk for good reason, and we'll certainly put the topic under the microscope in our July issue. But what we'd like to look at over the next 20 pages or so is your headend.

As we interviewed engineers and hardware vendors about what was necessary for top-notch, high-speed data delivery, the following headend pointers kept coming up over and over. This is not an exhaustive listing—the articles that follow go into much more detail.

• **Consider space, organization and the pipe to the Internet.** As Paul Gemme, vice president of plant engineering for Time Warner, puts it: "The first thing you need to do is properly plan where you're going to put everything."

It may sound simple, but pre-planning a dedicated home for all those optical transmitters, optical receivers, patch panels for fiber, routers, servers, etc., is the logical first step. And what about the temperature effect some of this equipment will have on your headend? Gemme says that it's extremely important to be aware of what kind of heat will be generated so you can put in a sufficient amount of cooling.

Coaxial International's Senior Vice President of Engineering Ron Hranac adds that the data-dedicated portion of the headend doesn't exactly have to be a "clean room" but proposes, somewhat tongue-in-cheek, that it be a "quasi-clean room." In other words, cigarette smoking in this part of the headend probably isn't a good idea.

Then there's still the matter of the connection to the Internet itself.

"You need to decide how big that pipe is based on how many customers you are going to have," says Scientific-Atlanta's Mark Schutte, director of engineering for broadband data networks. Schutte is quick to point out that you can start as small as a single T-1 and add on as your system develops or as more customers ramp up.

"There are economic trade-offs between multiple T-1s vs. a DS3. But you don't necessarily have to get into the business at the high end. It can be scaled," he says.

• **Pick a network management strategy**. For years, the industry has discussed tools and methods that would allow operators to quickly isolate problems from the comfort of the headend (without rolling a truck). But it's really the promise of high-speed data delivery that has spurred new commitments to network management processes and procedures.

Take one method Rogers' WAVE uses to keep track of the robustness of its return path. Frank Cotter, vice president of operations and general manager, touts what the company refers to as its noise platform in the headend.

"It consists of a computer-controlled spectrum analyzer and a bit error rate tester, all of which are remotely controllable from the network operations center," says Cotter, "That provides us with continuous and ongoing visibility as to the health of the return plant, and if and when there are any problems, we are able to isolate them and take corrective action."

• **Validate the integrity of your signals both out of and into the headend.** TW's Gemme points out that a very important step is ensuring that combining networks are calculated properly so you won't have a poor carrier-to-noise ratio (C/N). He adds that even though effective signal leakage programs certainly have minimized a lot of ingress, those thorns do still exist and need their due attention.

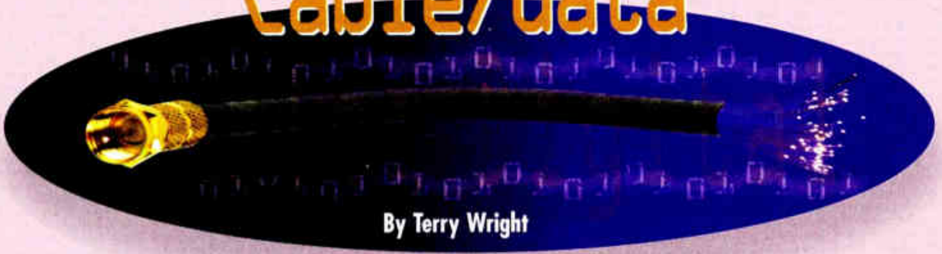
• **Think about backup power.** Data delivery demands clean and reliable power. Coaxial's Hranac underlines the need for a serious commitment to line conditioners, uninterruptible power systems (UPSs), backup generators, surge and lightning suppressors and good grounding.

Gemme of TW agrees, "If you want to provide good data service, you want to make sure you have good UPSs on all of your storage disks and on the modulator for that service."

• **Start now, even if you need to use the telephony return as a bridge strategy.** S-A's Schutte calls it sending a "canary in the mine." Even if your return path is in a less than desirable state, many in the industry recommend that you get your headend ready, start "playing with the equipment" and put in those learning curve hours. **CT**

Laura Hamilton is senior editor for "Communications Technology."

Cable/data



By Terry Wright

Data from the headend down

If you're thinking about getting into data over cable, you'll be relieved to know that there are actually many similarities between offering Internet/data services and offering entertainment.

The headend is where traditional entertainment services are received from wide area distribution mechanisms (such as satellites) and transmitted to subscriber TV sets via the local cable distribution plant. It also is where Internet and other data content are received from wide area networks (WANs) and transmitted to subscriber personal computers using cable modem technologies. In addition, the headend is likely to be the source of local content (newsgroups, popular web pages, and so on), similar to the way local spot ads and programs are sourced from traditional headends.

Of course, the headend is not where Internet/data service value is consumed; that's at the subscriber end, where Internet/data services are accessed through appliances such as PCs or set-top boxes.

Further reinforcing the similarities of entertainment service and Internet/data service delivery is the blurring of boundaries between TV sets and home computer appliances. The similarities between traditional set-top boxes and cable modems are obvious. What might not be so obvious, however, is that just as some consumers own cable-ready TV sets (enabling bypass of the set-top box), it is quite probable that future personal computers/Internet appliances will contain imbedded cable modems. (A great deal of standardization must first occur before we will see this level of integration.)

Terry Wright is chief technical officer of Convergence Systems, a systems integration company based in Atlanta. He can be reached at (770) 416-9993.

Another similarity between entertainment and Internet/data service delivery is that subscribers pay for the services on a monthly basis. But this is where the primary attributes of delivering both entertainment and Internet/data services begin to diverge.

"Connecting to an Internet 'gateway' with a full T-1, for example, doesn't always mean you will be getting a full T-1 onto the Internet backbone."

Delivering services

As cable/broadband network operators continue to increase their roles in the delivery of Internet/data services alternatives (to local corporations, institutions and a continually expanding consumer market), performance-based packaging options will likely dominate these service offerings in the near term. Unlike entertainment services or a "work-at-home" scenario where subscribers are provided access to a specific corporate server or network, the Internet and other on-line services represent virtually unlimited content. A typical premium entertainment service might include access to a half-dozen or so specialized programming channels. However, even basic access to the Internet or other on-line service, represents access to virtually millions of channels of diverse content.

In the world of cyberspace, subscribers can essentially create their own content lineup through manipulation of their World Wide Web browsers, newsreaders, personal newspaper services, e-mail clients, and even the screen-savers on their PCs. Access to the Internet and other on-line services offer subscribers the ultimate in channel surfing capability, and as the form of on-line content continues to evolve toward that of traditional entertainment services (video, sound, and graphics—all dynamically changing), the whole concept of entertainment as an individually valued service could easily get lost in the wake of cyberspace.

The performance advantage enabled through cable's local broadband delivery networks represents a key competitive advantage in the emerging on-line services climate.

The performance available through broadband-based Internet access/data services sets them apart from traditional dial-up Internet/data services. Broadband-based services, delivered over an appropriate network infrastructure, can outperform even premium telco-based services such as integrated services digital network (ISDN), asymmetric digital subscriber line (ADSL), and many dedicated private line services.

They do not compete with traditional dial-up services, and their pricing should reflect the performance advantage they can deliver.

In addition, pricing for cable-based Internet/data services should reflect the elimination of a second telephone line, elimination of the dial-up procedure, and the entire new class of "push" services cable-based services enable for subscribers. (Since cable-attached subscriber PCs can be on line all the time, new service applications are being developed that take advantage of this constantly connected state where content can be "pushed" at subscribers versus waiting for subscribers to request or "pull" it.) This enables many possibilities for added-value service in the future via "know-bots" and other so-called subscriber agents that package customized content on behalf of subscribers. These service enhancements represent significant value beyond traditional dial-up access.

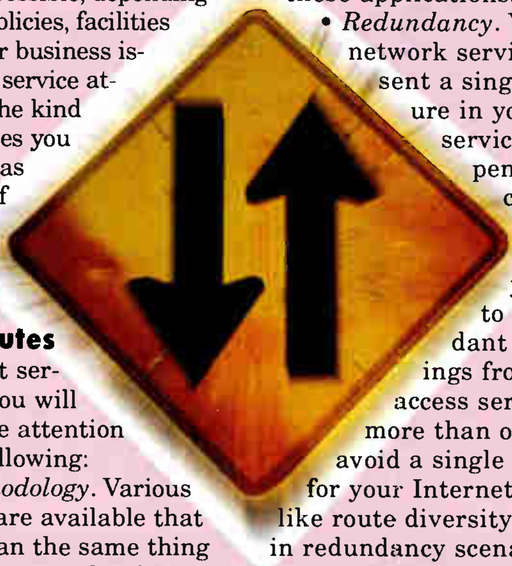
Internet backbone

The headend represents the primary crossroads of your data/Internet services solution. Depending on the solution architecture you adopt, the headend is typically where:

- The Internet network service interconnects with your cable network.
- The nature of the Internet network system portal is defined by your selection of access equipment (such as switchers and routers).
- Where the capabilities and behavior of your local access (cable) network are defined by the network architecture and related equipment you select, together with the capabilities of the cable modem solution headend-resident equipment,
- Your subscriber service accounts server(s) reside,
- Your network monitoring and maintenance equipment reside, and
- Where subscriber and locally-oriented content reside.

It is important to have a good understanding of Internet network services before you select the headend-based equipment you will use to connect your cable network with the Internet. This information also is necessary for determining the classes of Internet access services you plan to offer your subscribers, how to price these services, and even what cable modem solution capabilities you'll need.

There are a number of Internet network services, including those offered by MCI, AGIS, PSINet, CerfNet, Digex, SprintLink, UUNet, IBM, ANS, WorldCom/MFS's GridNet and other network service providers (NSPs). These Internet network services offer a variety of connectivity options, access capacity, services, operating policies, and pricing scenarios. Co-location options also are possible, depending on the NSP, its policies, facilities posture and other business issues. All of these service attributes impact the kind of Internet services you can offer, as well as various aspects of your business plan and strategic agenda.



Service attributes

Some Internet service attributes you will want to pay close attention to include the following:

- *Access methodology*. Various access methods are available that don't always mean the same thing across NSPs. For example, if you are considering a private line T-1 service onto the Internet, make sure you understand how that service actually connects to the Internet network backbone being offered. Connecting to an Internet "gateway" with a full T-1, for example, doesn't always mean you will be getting a full T-1 onto the Internet backbone. Your T-1 service may terminate on a switch with many other T-1s in your geography, all of which contend for a finite amount of capacity (typically less than the aggregate of T-1s connected) onto the actual Internet network backbone.
- *Access capacity*. Many NSPs offer what's called a "burstable" service where you have access capacity at the full port speed available, with a minimum committed information rate (CIR) typically less than full port speed (a subrate multiple such as 256 kbps on a 1.544 Mbps T-1 service). These types of services handle traffic above the CIR on a nonguaranteed basis. Depending on the congestion of the network at the time your traffic exceeds your CIR, your traffic can become discard eligible and require retransmission. Not all data protocols have "end-to-end" delivery guarantee such as datagram service, and may drop packets during congested periods with this type of Internet access service. Various end-user applications utilize Internet protocols in different ways, so you'll want to understand the effect your Internet network service may have on these applications.
- *Redundancy*. Your Internet network service can represent a single point of failure in your subscriber service offerings. Depending on the classes of service you intend to offer, you may want to explore redundant service offerings from an NSP, or access services from more than one NSP, to avoid a single point of failure for your Internet service. Issues like route diversity come into play in redundancy scenarios. In addition, you'll want to understand the redundancy inherent in the Internet network service itself. (What happens if one of the primary nodes on your NSP's network backbone network fails?)
- *Performance, architecture, and interconnect presence*. You'll want to understand the manner in which your Internet network service interfaces with other Internet network backbones. What kind of capacity and data exchange arrangements are in place at the major network access points (NAPs)? In addition, hierarchical networks are often implemented such that multiple router hops exist between your access point and the actual Internet backbone. Each of these router hops can represent a single point of failure as well as a performance bottleneck. A "flat" Internet network backbone service eliminates many of these failure points and performance bottleneck, and can offer interesting alternatives for redundancy. Some NSPs can even offer a virtual NAP presence.
- *Traffic reports*. To properly manage your network and the quality of service being delivered, you'll

By Allen Beasley

Morph from cable operator to ISP

Internet protocol (IP) switching is a practical, high-performance architecture that can serve as the foundation for next-generation IP services networks. If you're planning to deliver Internet service over your cable network, keep the following thoughts in mind.

Allen Beasley is the international product marketing manager at Ipsilon Networks in Sunnyvale, CA.

The old vs. the new

While the worldwide Internet services market is an estimated $2.3 billion industry growing at a healthy clip, today's Internet service providers (ISPs) face a very difficult business. The average ISP has been in the business just under two years, has about 13 employees, generates gross annual income of only $637,000, and, in North America alone, faces over 3,000 competitors. At times, selling thumbtacks sounds like an easier proposition than selling Internet services.

And now, the old Internet is giving way to a new Internet, driven by a different business model. In the old Internet, ISPs charge a premium for managing an Internet services network over the cost of the lines they lease from the telco. Unfortunately for today's ISPs, anyone can do it, and 3,000 "anyones" are doing it in North America. The new Internet, however, has a different set of rules and a different set of players. New ISPs build an infrastructure (or use an infrastructure they have already built) and sell Internet services

to customers using this infrastructure. Since the provider now owns the infrastructure, the provider is in a better position to capitalize on the Internet services opportunity.

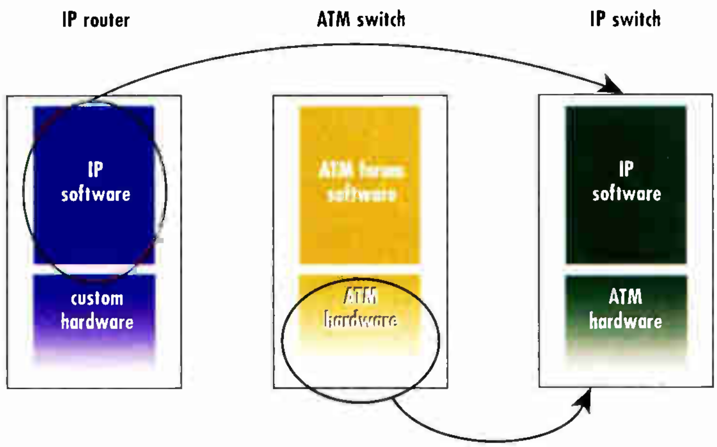
The issue for companies that have significant investments in infrastructure (cable companies, local telephone companies, long distance telephone companies, power companies, etc.) is how to tap the new Internet opportunity.

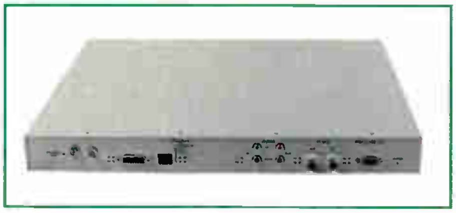
Enter IP

IP is the universal language of the Internet. IP defines the format of data as it traverses the network, and IP "routing" defines how data gets from Point A to Point B—even if Point A is in San Francisco and Point B is in Stockholm. The Internet's ability to scale to over 16 million connected hosts is fundamentally dependent upon IP routing—effectively, everybody in the Internet must speak the same routing "language."

One of the problems with the Internet, however, is that the devices that forward data in the Internet—the so-called "routers"—have not kept up with the increase in Internet traffic and data throughput rates. While two years ago, residential Internet users received only 9,600 bits per second worth of Internet access (if they were lucky), these same users can now enjoy as much as 1 million bits per second via advanced cable modem technology or other local loop architectures. Likewise, on the backbone of such a network, it is now possible to use switches capable of transporting data over high-speed fiber links at more than 622 million bits per second. Unfortunately, routers, which are required to add the IP routing intelligence to the network, cannot come close to forwarding data at these ever-increasing backbone rates. →

Figure 1: IP switches employing (ATM) technology



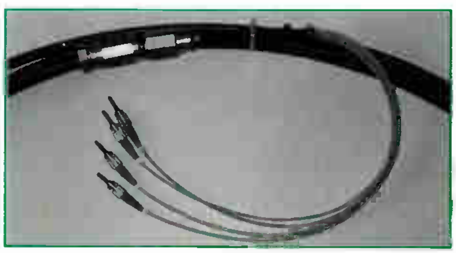


New System Combines Video, Ethernet and T1

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

New Cost-Effective Last-Mile Telephony Products

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



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 62

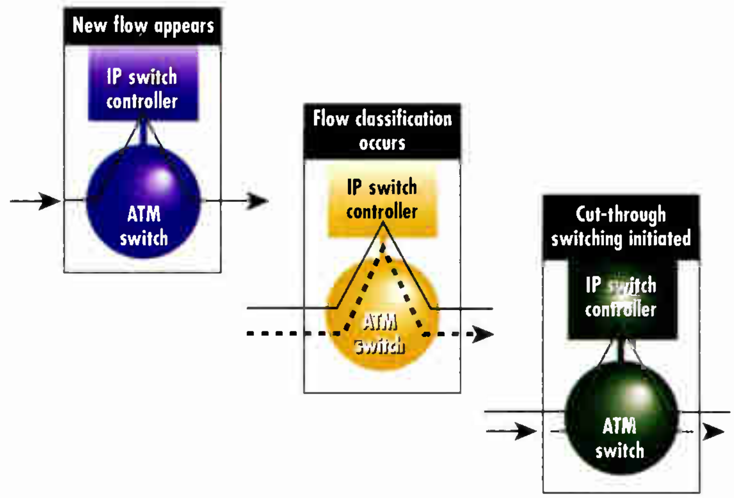
The problem is inherent in the router's architecture. A router is essentially a proprietary minicomputer, in which a central processor must process or "touch" every single "packet" of IP data. This architecture simply cannot scale to keep up with increasing traffic demands, as Internet traffic growth is currently eclipsing even processor performance increases.

What's the alternative?

IP switching is an alternative to routers. IP switching was architected under the premise that IP routing works very well, but that the IP router and the economics of the IP router industry need an overhaul. As such, IP switches consist of standard IP routing software using high-performance standard switching hardware to achieve greater throughput and scalability at a lower price point. Specifically, the first implementations of IP switches employ high-performance asynchronous transfer mode (ATM) switches as a data backplane, and use IP routing software as the control software. (See Figure 1 on page 38.)

To accelerate performance, IP switches rely on the concept of IP flows. An IP flow is a sequence of packets sharing certain characteristics. IP switches use intelligent software to route initial packets of an IP flow, but then switch future packets belonging to these flows through ATM hardware, accelerating throughput. Traffic studies have shown that up to 80-90% of Internet traffic would be recognized by the IP switching software as suitable for "cut-through" switching in ATM hardware. As this cut-through switching process scales from IP

Figure 2: Cut-through switching process



switch to IP switch across a network, it is easy to conceive of how to build a very high-performance IP switching network using advanced local loop technologies on the access side and high-speed fiber on the backbone to pursue the new Internet opportunity. (See Figure 2.)

What you should know

There are four main things you need to remember about IP switching. It's practical, cost-efficient, supports different service classes and supports "one-to-many" transmission. (See the accompanying sidebar for more details.)

Market change

With IP switching technology in your networks, cable operators might just change the business model of the Internet from a market populated by a large number of relatively small players, to a market dominated by a few players leveraging an existing transmission infrastructure. The question is not whether this will happen, it is when. **CT**

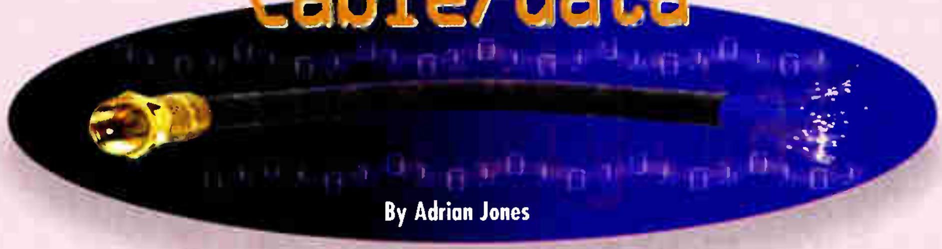
The boons of IP switching

1) IP switching is practical. Although IP switching offers greater performance and scalability than conventional routers, it does not "throw the baby out with the bathwater" in the sense that IP switches look to other network devices like conventional routers. IP switches speak the same language as other routers so that managing an IP switch is similar to managing an IP router. There is nothing new to learn.

2) IP switching offers better price/performance than routers. By relying on standards-based components such as Intel processors and asynchronous transfer mode (ATM) switches, IP switches are not only able to exceed the performance of conventional routers, they are able to do so at a fraction of the price. Future enhancements to the IP switching architecture are not limited to improvements being pursued by only one vendor, as each component of an IP switch has an entire industry behind it—IP routing software, Intel processors and ATM switches.

3) IP switching supports different service classes. IP switches are able to harness the unique ability of ATM hardware to deliver different levels of service to different customers. Specifically, IP switches enable a provider to offer different service levels based on different data transmission rates. A customer paying for "first class" service might receive a data rate of one million bits per second, while a customer paying for "economy" class service might receive only 256,000 bits per second.

4) IP switching efficiently supports one-to-many transmission. Not only are routers not keeping up with the overall growth in Internet traffic, they do a notoriously poor job of sending one copy of a data stream (say, a real-time video stream) to multiple recipients. IP switches are able to use high-performance ATM switches for this process to efficiently support emerging applications that use a new technique called IP multicast.



By Adrian Jones

Cost-effective, smart upgrades

There's no way around it: Offering high-speed data services over your cable plant will affect your existing cable business and operations.

For example, you can expect changes in your existing cable operations, support services, and technical support procedures. That's just for starters. Add to that new considerations in allocating RF channels, maintenance and billing practices, and you begin to get an idea of the magnitude of the job that lies ahead—to say nothing of the cost.

When you upgrade your plant for data service, design the system strategically, with headend cable modem data controllers, data concentrators, Internet protocol (IP) routers and other servers in remote distribution hubs or centrally located headend systems. That way, you'll be able to support a wide variety of cable plant architectures and create a cost-effective data network system that allows service to grow in a scalable and modular manner.

Also consider taking advantage of efficient transmission schemes, such as spread spectrum or synchronous code division multiple access (S-CDMA). You may find that using these or similar technologies may enable you to put off more expensive plant upgrades until you can offset that expense with revenues.

Consider a consolidated headend architecture in your system design. You can centralize network management functions, helping to simplify and streamline operations, administration and maintenance responsibilities. The ability to provide a complete view of your network and its elements allows for more comprehensive network performance monitoring, correlated fault analysis and more cost-effective failure recovery. Data service and customer management can be coupled with existing legacy operation and business support systems, which translates to superior customer service and more highly integrated business procedures.

Data controllers

Data services offered over the cable network use one or more digitally modulated RF channels located in available channels in the forward spectrum, typically over the range of 50-550 MHz. In the reverse direction, RF channels bringing data back from the subscriber are generally in the 5-30 or 40 MHz range.

Newer and upgraded HFC cable systems are generally designed to extend the forward spectrum to 750 MHz and the reverse to 42 MHz. They often are based on a hierarchical architecture consisting of a regional

Adrian Jones is director of business strategy for Terayon Corp. in Santa Clara, CA.

Five steps to reduced return path ingress

There are many reasons to reduce return path ingress when offering bidirectional digital services, but the most persuasive one is the effect this phenomenon has on bit error rate (BER). As BER degrades, system availability declines. That means substandard performance and loss in revenue.

Filters are often cited as the solution to ingress problems, but recent studies indicate that filters alone are not sufficient to eliminate the problem signals. Hence, it is necessary to continuously monitor the network and respond to ingress as it becomes apparent—and hopefully, before subscribers complain about service quality.

One of the best tools for detecting ingress on the return path is the traditional spectrum analyzer. Its advantages are fast sweep speed, wide dynamic range and the ability to look at the entire return path spectrum of 5 to 40 MHz. An alternative approach would be to use step-tuned receivers at a lower price. However, today's versions are slower, have less dynamic range and provide fewer data points than spectrum analyzers.

For cost reasons, return path ingress is best characterized and monitored at the headend of hybrid fiber/coax (HFC) networks. Fortunately, traditional labor-intensive, reactive approaches can now be replaced with proactive, automated techniques that enhance quality of services.

Stuart Fox is marketing manager for SAT Corp. of Mountain View, CA. He can be reached at (415) 390-0300.

Causes of ingress

In an HFC network, 95% of the return path ingress originates on the drop to the consumer's premises or in the consumer's home. The number of homes passed in today's typical HFC architecture varies between around 500 and 2,000 subscribers.

On the return path, all these signals funnel back to the headend. A single source of ingress, therefore, can affect the service of hundreds (possibly thousands) of customers. Telephony services could be disrupted, data speeds reduced, and interactive services could be impacted.

Of course, you could observe ingress by coupling off from the drop at the point where it connects to the tap, but if every drop was monitored this way it would quickly become prohibitively expensive. In addition, such monitoring would not allow the funneling effect to be observed. This is particularly important in the characterization stage when data needs to be collected for use in allocating the return path spectrum for optimum performance and loading.

As you go about hardening your system against ingress, it's important to remember one thing: Ingress is a moving target. The sources of ingress on the return path include shortwave broadcast signals, two-way radio communications, power line corona, household appliances, cordless phones and other similar devices. All these signals vary through the day and from day to day. A drop that appears to have sufficient isolation during daylight hours may be inadequate during evening hours. In addition, the isolation of a drop will change as connectors age, cables are damaged, or for numerous other reasons.

Characterize, monitor

Every node has its own unique characteristics and for some nodes, these characteristics change all the time. For example, older systems are much more prone to ingress due to connector wear and cable damage.

So how do you reduce the effects of ingress? Basically, it boils down to characterizing the problem, adjusting the system to bring it up to optimal performance levels, and monitoring system performance to ensure that ingress doesn't creep up on you again. Here are some simple step to follow.

Step 1: Determine if a data transmission problem is caused by ingress. This is much easier to do if you use a process of elimination. Of course, this requires knowing what the system characteristics looked like when everything was working correctly and ready to be certified.

When making your ingress determination, two statistics to remember are the maximum signal level and average signal level over a reasonable period of time; 24 or 48 hours is typical. Although spectrum analyzers can measure maximum and average signal levels, they are not suited to providing this data in an easily analyzed format. →

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Specially designed software available today can help get around such limitations. With such software, the spectrum can be divided up into channels and the maximum and average signal levels calculated for each channel. The maximum signal level data can be used to minimize the chances of laser diode clipping. Similarly, average signal level data can be used to set up acceptable signal-to-noise ratios.

Photo: Bob Sullivan

By using a computer to control your spectrum analyzer and to collect the data from each sweep, you can develop an extensive statistical database. Then, algorithms in the software can be used to calculate the maximum and average signal levels on a channelized basis for display in graphical format or analysis in a database program. The resulting data can be used as part of the system certification documentation.

Steps 2 is obvious: Reduce or eliminate the ingress signals using the data you've compiled. **Step 3?** Use the characterization data to find the "sweet spots" in the return path spectrum for critical services such as data delivery or telephony, as well as to identify the problem frequencies to avoid.

Step 4: Set accurate alarm levels for effective monitoring. You don't want to use alarms when characterizing data, because the objective is to determine the amount of ingress present and then to reduce or, if possible, eliminate the ingress. Once you've attained acceptable ingress levels on each node, these same levels can be used as the basis for setting monitoring alarms.

All nodes in a system have to be monitored all of the time. For economic reasons, this is best accomplished by using a switch to sequentially cycle through each node. This means that each node is being sampled for ingress.

"As you go about hardening your system against ingress, it's important to remember one thing: Ingress is a moving target."

To capture short duration ingress signals, or to have a meaningful sample when there is a large number of nodes, it is important to sweep and switch as fast as possible. For example, for a headend with 100 nodes, a system with a monitoring rate of 4 nodes/second would result in a sample interval of 25 seconds. It is only possible to achieve this frequency of monitoring using an automated system. This kind of performance is particularly important if telephony services are part of the return path communications.

Analyze stored traces

Step 5 in reducing return path ingress is to use an automatic monitoring system to keep track of ingress occurrences. Automated monitoring systems capture as stored traces the signals that triggered the alarm threshold you've set. An automatic monitoring system can provide a wealth of accumulated information, including the date and time the ingress occurred, as well as frequency and signal level data.

When looking for an automatic monitoring system, look for one that uses a spectrum analyzer window to display the stored traces. Three display modes are especially useful for viewing the ingress signals. They are the standard spectrum analyzer display of signal amplitude vs. frequency; a spectrogram display that adds the time dimension to the amplitude and frequency axes, and finally a waterfall display, which is another three-dimensional display of stored traces. These displays can be used to build up information that can be used proactively to prevent ingress from disrupting the new interactive services now being deployed using the return path. **CT**

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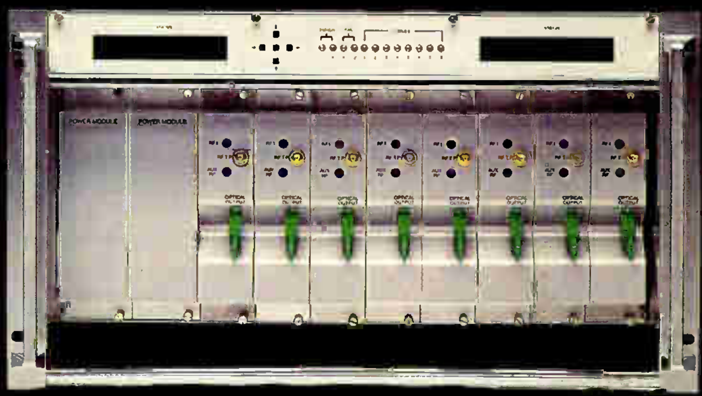

The new 1310 nm DFB laser with power and performance for any network application

The Pegasus 1310 nm DFB Transmitter is another of the new optical elements in the Constellation Series. Designed especially for expanding analog/digital requirements of the CATV industry, Pegasus offers advanced performance and features, such as dual isolated RF inputs, full status monitoring of the Constellation and network management with the new Hercules SNMP Proxy Agent

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Reader Service Number 160

By Robert J. Rance

Tips on network security

This article has been adapted from a paper presented at the Society of Cable Telecommunications Engineers' Emerging Technologies '97 in Nashville, TN. The proceedings manual from that conference is available from the SCTE by calling (610) 363-6888.

Sending data services, voice services and digitally-encoded premium entertainment over hybrid fiber/coax (HFC) media to cable modems could put you at risk of electronic piracy and malicious "hacking."

You might have heard that a mutually authenticated link encryption system might be useful protection against hacking. With that type of system, both the headend and cable modem actively confirm that every encrypted message arriving from the other side has been transmitted by that entity, not by some third attacking party. Encryption means that the transmitted information is totally obscured to anyone not holding the appropriate keying information. Surprisingly, even using such technology, your HFC system is still susceptible to attack. Here are some things to keep in mind.

Cloning and its threats

Many attacks on mutually authenticated links arise from "cloning" a legitimately registered cable modem with or without its owner's consent, or from cloning a headend. A clone is hardware and/or PC-based software that emulates the functionality of a cable modem or headend and additionally clones its identity by copying its secret keying information. The clone becomes indistinguishable from a legitimate unit as seen by the headend or cable modem unit being attacked.

Threats to data come in various forms. The pirate can masquerade as a registered cable modem and steal data service. This is called a "theft-of-service" attack and is typically only detected when the legitimate customers receive spurious charges on their end-of-the-month bill.

A second threat is one against privacy. Here, a pirate listens to the HFC channel and copies sensitive personal or company proprietary information, or banking or credit card information. In the case of electronic commerce, pirates have an even more dangerous plan of attack. The pirate masquerades as a headend to the cable modem and accesses the user's PC, which can contain significant amounts of electronic cash, as well as other financial information.

Cable modems and headends also are susceptible to attack via bogus software download and control signal spoofing. These can enable many of the attacks described previously, or can merely be malicious.

Forms of attack

There are several ways to mount an attack. The pirate can make a clone by copying keying information from a legitimate cable modem. Perhaps more easily, the pirate can break into databases where the keys are stored, either at the headend or point of presence. Such a break-in can be achieved by exploiting a weakness in the service provider's firewall, by an insider attack, or by "recycling" a discarded hard disk. A particularly damaging attack is where the pirate modifies a new software version to be downloaded to a large installed cable modem base, or otherwise initiates a new download.

The replay attack is subtler. Here the pirate or hacker need not have a copy of the keying information, but merely copies and replays later a given payload or control message. If the pirate can attach significance to the timing of a message, significant damage or monetary loss can occur. For example, the pirate can replay an encrypted broadcast message downstream granting every subtending cable modem the permission to watch entertainment to which they have not subscribed. Another example would be to replay a set of messages that effect a transfer of funds into the pirate's account.

Exhaustive key search is yet another possible attack. This is where the attacker tries all possible keys in an encryption algorithm until he or she gets a match of input and output. Currently exportable 40-bit keys are widely considered insecure. Various sources have cited that major governments are financially capable of developing dedicated key-cracking machines that routinely and efficiently break single-DES (data encryption standard) 56-bit keys. A business case can be made for an off-shore piracy concern to have the same capability.

Moore's Law holds that computing power nearly doubles every year and a half. That means in 20 years, all PCs equipped with some dedicated hardware also will be able to crack 56-bit DES keys. So, if you're using single-DES, make sure it's consistent with the value and lifetime of the data it protects.

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Even though a fielded system may not have an operational life of 20 years, the information it secures may need to be protected for that long. Decrypting data that is copied today from a "secured" HFC link using technology 20 years down the road may therefore be advantageous for the pirate. Encryption algorithms are potentially vulnerable even without resorting to exhaustive key search techniques. The only provably secure encryption algorithms are those that require a memory size on the order of 2^{64} bytes at both ends of the link. This requires more memory than all of the computing resources on this planet! The successful encryption algorithms in use today are those that no one knows how to break. In some sense, we have only scratched the surface in defining encryption algorithms and exploring their attack suite.

Solutions

Once you've designed an HFC security system to withstand attacks, you'll need an additional implementation-dependent attack analysis. For example, keying may be accomplished by either a secret key-based or public key-based key distribution system. The impact of the former is that the cable modem manufacturer and/or service provider may need to retain large databases of secret keys with both high security and high redundancy. The clash of these two opposing objectives yields a rather user-unfriendly key distribution system.

I mentioned the issue of raiding points of presence for keys. One way to reduce this vulnerability is to restrict keys to those areas where they are specifically needed. In particular, there is no significant advantage in exporting session keys from the headends to the point of presence.

If you've elected to use public keying algorithms and in particular, public key certificates, for key management in large-scale HFC systems, which type should you choose? Various algorithms are possible: RSA, Rabin, Diffie-Hellman and elliptic curve, to name a few. Regardless of the choice of an actual algorithm, there is the differentiation in capability between what I call "global certificates" such as RSA and Rabin, and "Point-to-Point Certificates," such as Diffie-Hellman. Point-to-point certificates cannot service a distribution model where an individual buys, owns and cryptoinitializes a cable modem from a distributor. Global certificates can accommodate both this model and another model where the cable service provider-owner security linkage is done at the modem factory.

Some of the attacks we've discussed are enabled by a bogus software download. Cable modems or network interface units (NIUs) may be always downloadable for two reasons: their firmware is not sufficiently mature, and the service providers might want an easy path to install new features.

There are two basic methods to protect against bogus downloads. One is to partition the cable modem/NIU into three areas: ROM-based download software, NVM-based operational code, and a separate security area. The second method does not bifurcate the functionality into a separate and possibly expensive security area, but to authenticate all downloads. Of course, that leads to the question of who will be the authenticator: the manufacturer, the service provider or both?

All this leads to some broader issues: Which parties have security interests in the link? Who will install and own the cable modem?

Four parties could have simultaneous security interests in a given user's cable modem: the service provider, the user himself, the content provider and the corporation in work-at-home applications. One method of serving this mix would be to establish a somewhat tamper-proofed security partition within the modem where the partition is enforced and secured by publicly-accessible code developed by a manufacturer.

Link security is complementary to end-to-end (typically application-based) security. Most HFC systems will need both. The two securities complement each other in two ways: different services require a varying mix of privacy afforded by the two securities, and the two securities protect against different types of active attacks. Some services, such as telephony, are physically secure until the link, and require only link security, whereas proprietary data secured at the application layer does not require link encryption of its payload. On the other hand, theft of e-cash and other sensitive information from an individual's PC requires link security. In fact, link security here will protect against revelation of passwords and other secrets used for end-to-end security.

Multifaceted HFC systems provide a new fertile ground for piracy. An HFC security system must address an HFC-specific suite of potential attacks as well as more generic attacks. Choose security components based on a study of possible attacks against all potentially interested parties. **CT**

By Chris Brozenick

How to maximize uptime when testing HFC telephony

With increased competition in the telecommunications industry, many cable TV companies are exploring the possibility of providing telephony service. However, the increased revenue generated by providing telephony does come with a responsibility. Testing the telephony signals in the hybrid fiber/coax (HFC) network is vital to providing reliable service—and testing should begin with a proven test strategy.

Long-time providers of telephony services have spent years developing and fine-tuning procedures to diagnose and isolate sources of network trouble. The key to an effective strategy includes an understanding of the cable/telephony network, knowledge of in-service and out-of-service testing procedures, and utilization of the right testing tools.

The telephony trail

Telephony in the HFC network starts in the headend typically with a high-speed synchronous optical network (SONET) interface from a telephony service provider and continues out over the distribution plant to a subscriber's home.

In the headend, the telephony service provider—usually a local exchange carrier (LEC) or a competitive access provider (CAP)—will typically de-multiplex the high-speed SONET signal down to multiple DS1 signals. Each of these DS1s provides 24 channels termed DS0s. These DS0s contain the individual voice channels for each subscriber.

Test access to these DS1s and DS0 channels is provided by a digital signal cross connect (DSX-1) installed in the headend. Transmit and receive connectors for out-of-service testing, as well as monitor jacks for in-service testing, are provided by the DSX-1.

After passing through the DSX-1, DS1s continue to the host digital terminal (HDT). The HDT takes the individual DS0 channels and inserts them into the HFC distribution network. The HDT has fiber-optic outputs that are converted to coax prior to reaching the subscriber's location.

At the subscriber's home, the coax is sent to a network interface that provides both a coax connector for TV and a RJ-11 jack for telephony. This device is typically referred to as the remote service unit (RSU), network interface device (NID), or the customer premises unit (CPU).

Many factors contribute to the quality of telephony service. These factors include the condition of the signal when handed off from the telephony

Chris Brozenick is product marketing engineer for TTC.

Common transmission problems

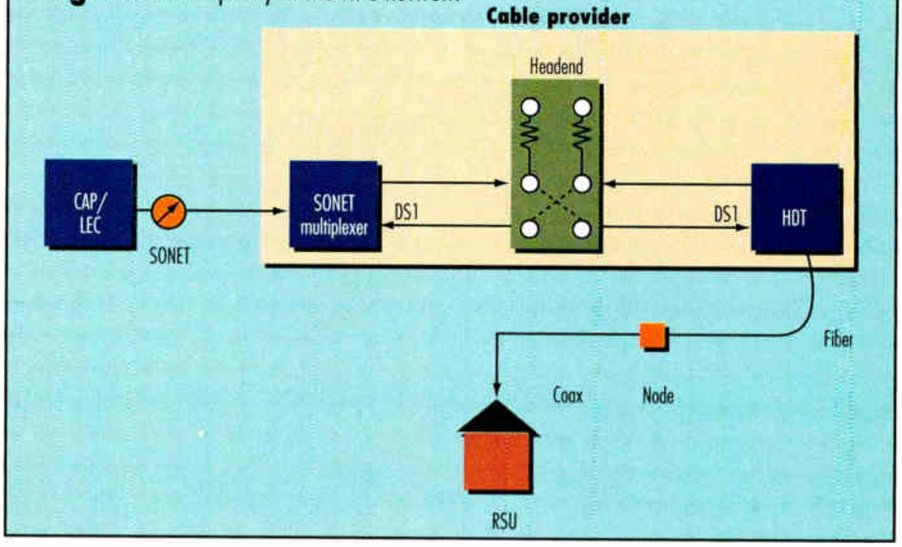
Problem	Indicates
Frame errors	Typically caused by framing differences between network elements. Consistent frame errors may be caused by timing slips.
Cycle redundancy check (CRC) errors	CRCs are an in-service performance measure. CRCs indicate noise on the span or possible defective network equipment.
Bipolar violations (BPVs)	Problem in the copper plant between the multiplexer and the HDT. BPVs aren't found in the fiber network.
Timing slips	HDT equipment and service provider's network equipment are out of synchronization. Check timing source inputs and settings.
Noise/garbled voice	Typically indicates problem on coax plant because of external noise, or problem with customer equipment.
Missing or incorrect signaling events or digits	Possible problem in provider's switch, improper routing, or problems with a customer's telephone.
Bit errors	Measures of quality of telephony signal. Bit errors can only be measured during out-of-service testing and indicate noise or poor signal.

service provider, coax plant quality and noise influences. Testing telephony during turn-ups and further maintenance testing over time ensures high-quality service to the customer.

Loopbacks

Loopback testing requires taking customers out-of-service. However, during turn-up or when troubles can't be isolated through simple monitoring, loopback testing provides the most reliable way to isolate problems and verify quality. Utilizing a test set with dual receivers and drop and insert capabilities allows loopbacks to be performed on a per-channel basis. This procedure allows individual subscriber channels to be tested without taking the remaining customers (23 on each DS1) out-of-service.

Figure 1: Telephony in the HFC network



Once the drop and insert connection is made at the DSX-1 and a loop has been established using the built-in capabilities of the HDT, stress patterns can be transmitted from the test set to test through the loop and receive back into the test set. Since these patterns are fixed sequences of ones and zeros, the test set can compare transmitted to received sequences for errors. The quantity and type of errors received provides a measure of the quality and type of trouble existing on a particular channel. A test set with multiple types of stress patterns allows the tester to simulate various traffic and transmission conditions. Automated patterns built into the test set provide a means to test with a variety of patterns quickly and easily.

Error-free performance ensures the cable operator's network is good from the headend to the subscriber's home. →

Voice frequency testing

During loopback testing (Figure 2), another measure of quality voice service is made through transmitting (voice frequency) VF tones through the loop. Typically a voice frequency test is done by sending three different tones—404 Hz, 1,004 Hz and 2,804 Hz. By measuring the return level and noise characteristics of these tones, one can verify voice quality. It is important that the test set used for telephony testing supports both tone transmission and noise measurements.

In-service monitoring

The key benefit of performing in-service monitoring is that it is transparent to the customer—you can resolve problems without taking them out of service. The four major tests described here are monitoring inbound and outbound DS1s, measuring timing slips, verifying voice quality, and monitoring signaling events.

Monitoring DS1s

First, check the quality of the DS1 signal itself. If the quality is unacceptable, the source of the trouble can usually be isolated through further testing. Verify DS1 quality by monitoring inbound and outbound DS1s for errors. This type of monitoring may be available through the built-in system software provided by the HDT.

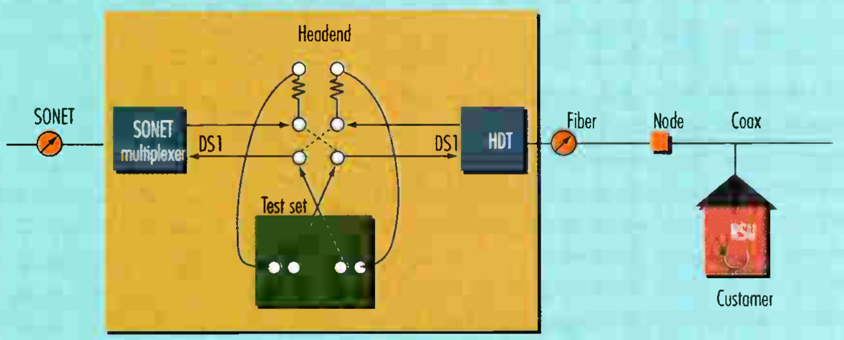
Timing slips

The purpose of checking for timing slips is to ensure that the service provider's equipment and the HDT equipment are in synchronization. If the timing between the service provider and cable network equipment is allowed to drift for even a short period of time, it can cause intermittent errors. Timing slip measurements compare the timing of the two circuits or locations and identifies the frequency deviations that cause the slips. A T-1 test set, equipped with dual receivers for two-way simultaneous monitoring, helps users identify timing differences before they cause errors.

Verifying voice quality

When a quick and simple test is needed to check voice quality, dropping a voice channel to an audio speaker provides an effective means to verify quality. Signal power levels and noise on the DS0 channel can be measured at this point as well.

Figure 2: Loopback testing



Again, a key function is that the test set has dual receivers, which makes simultaneous monitoring of both directions of the circuit possible.

Monitoring signaling events

Signaling—the process of transferring call status and routing information—is crucial to the delivery of telephony service. Monitoring signaling events will ensure that calls go through. Signaling events to watch are: on/off hooks and digits being dialed. By monitoring for the on/off hook states you can confirm that switch-to-customer communications are taking place.

The accompanying table on page 52 shows common transmission problems.

Telephony test set

The telephony test set is a valuable tool for solving service problems between the telephony service provider, cable TV service provider, and/or the customer. Choosing a test set that telephony providers already use and understand can speed this process. This test instrument must provide a wide array of capabilities including DS1 and DS0 testing, VF tone testing, signaling, and drop and insert capabilities. Additionally, the ability to integrate the test instrument into a remote testing platform with a test access switch in the headend enables complete testing of multiple DS1s from one location. This makes optimal use of your testing personnel, while increasing the uptime of your telephony network.

A simple, proven testing strategy carried out with a fully featured test instrument enables you to accurately qualify your network for operation, pinpoint the sources of telephony problems, and offer quality telephony service to your customers. **CT**

By Greg Hutterer

The case for OFDM

As Fred Slowik pointed out in his article on two-way architectures in the January 1997 issue of *Communications Technology*, "Planning system upgrades based on forward bandwidth expansion is no longer enough" (page 38). Why? Because the greatest opportunities lie in higher-bandwidth, two-way services—especially for the business market. Special services offer potential revenues many times greater than plain old telephone service (POTS). Special services include: universal voice grade for private branch exchange (PBX) trunk access, digital data service (DDS) for lottery and automated teller machines, or T-1 or Ethernet service for data communications and business access to the Internet.

Service providers can look to their hybrid fiber/coax (HFC) plant as the most cost-effective medium for providing two-way bandwidth for business customers, but it raises the following integral technical issues:

- How to get the most use from the return path.
- How to overcome impulse noise

Greg Hutterer is the program manager for the Homeworx Telephony Broadband Communications Division of ADC Telecommunications.

Figure 1: Modulation efficiency and ingress protection 240 DSOs channel/6 MHz

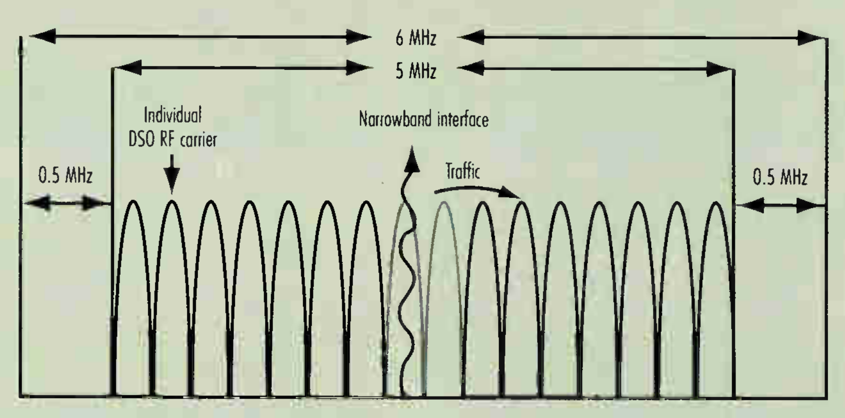
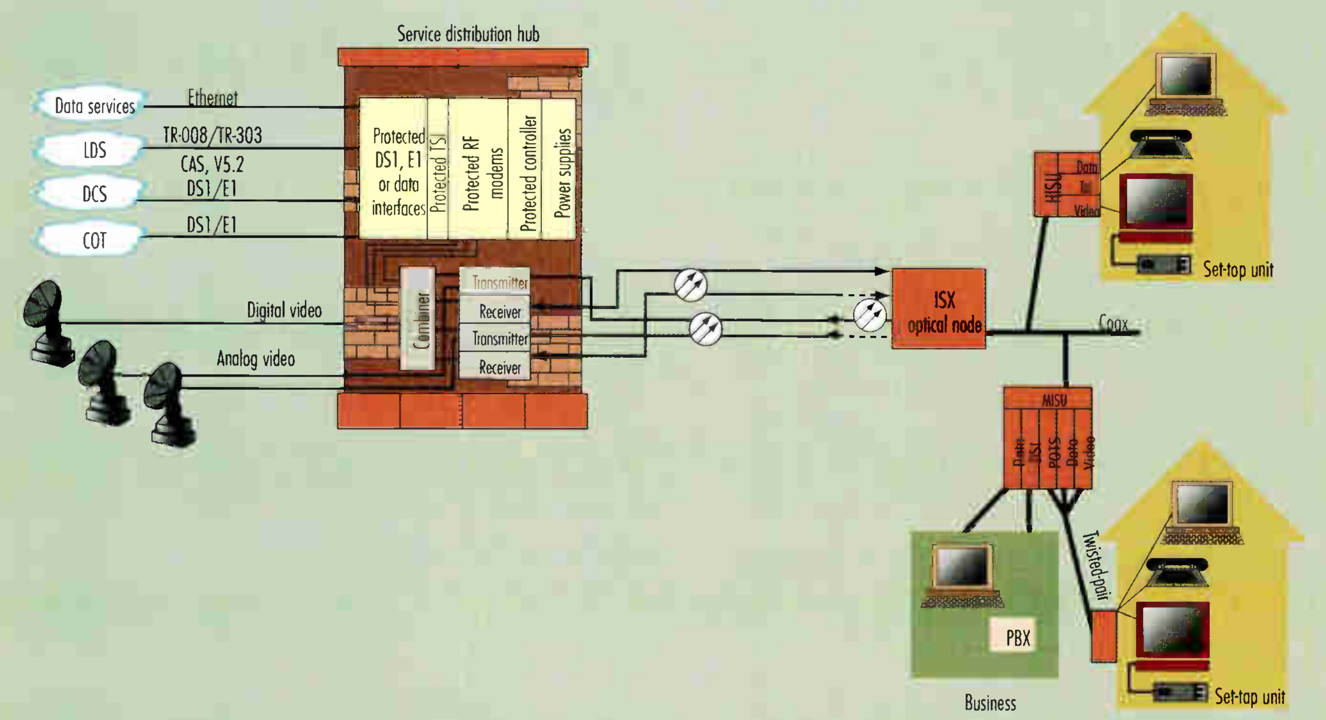


Figure 2: Service distribution overview



and narrowband interference.

• How to deploy HFC-based services to different sizes and types of customers.

A transmission technology called orthogonal frequency division multiplexing (OFDM) addresses all three of these issues. It provides superior spectral efficiency, resistance to interference, and flexibility in deployment.

Spectral efficiency

Transmission systems can use a number of digital modulation methods. One technique, quadrature amplitude modulation (QAM), exploits the ability of two separate input signals to be carried on different quadrature components of a single frequency carrier wave. One version of QAM uses binary-level modulation, generating an output signal space with four message points.

Each of these message points, or symbols, carries two bits of information. This is four-level QAM, also known as quadrature phase shift keying (QPSK). QPSK multiplexes digital service, level 0 (DS0s) into a higher bit-rate data stream, and then modulates that data stream into a single RF carrier.

OFDM uses higher-level QAM to optimize bandwidth even further, by modulating the carrier frequency to six discrete levels of the two carrier wave components, which allows 6 x 6 or 36 potential symbols. Four of these are not used, yielding 32 usable symbols, or 32-QAM. In an implementation of OFDM with 32-QAM, OFDM maps half the DS0 into one frequency or tone, and the other half into a different frequency; the two halves are put together at the destination. Each DS0 is assigned to two RF carriers, and the entire signal consists of hundreds of RF carriers.

Each 6 MHz channel carries 480 frequencies or tones (excluding tones used for operations channels), so OFDM allows 240 DS0s to be carried within that 6 MHz channel. That compares with only 96 DS0s that can be handled by QPSK systems in the same bandwidth, assuming similar overhead. The result: OFDM allows you to provide more high-bandwidth services in the same spectrum.

Controlling interference

Narrowband and impulse noise ingress in the return path is a serious problem for data-intensive two-way services, which typically require a higher-quality signal. The coaxial legs of the HFC plant can act like a funnel, feeding noise into the optical distribution node for transmission to the headend, and making the return path a very noisy place.

QPSK transmission systems are single-carrier systems, so when they are hit by a powerful interferer, the whole carrier can be vulnerable. In fact, a narrowband interferer that falls anywhere within the frequency occupied by a QPSK signal can wipe out that entire signal. Broadband impulse noise can be even worse, affecting all QPSK frequencies. One way to handle this problem is to reserve other 2 MHz frequencies as backups in case the primary frequencies are

hit by narrowband interference. But if you reserve those frequencies as secondary, they are not available as primary channels; bandwidth efficiency suffers in this tradeoff. In addition, if impulse noise is the problem, there may be no regions of spectrum safe from interference.

In an OFDM system, on the other hand, each tone or frequency occupies a very narrow slice of spectrum, so fewer DS0s are affected by narrowband interferers. When an OFDM system is hit by narrowband interference, OFDM remaps the DS0 to another available in-band frequency, without dropping the call. (See Figure 1 on page 58.)

There will often be noisy spots in the spectrum. Take a ham radio operating at 29 MHz, for example. With QPSK, you can't use the block around 30 MHz. Clean slices of spectrum 2 MHz wide are required. With OFDM you can pack channels closer together, with a granularity of only 18 kHz (one DS0), making greater use of available spectrum. And if there is noise, the channels are remapped to other frequencies, without having to set aside large bandwidth reserves.

Impulse noise lasts a shorter time but occupies a wider frequency. Because frequency-multiplexed signals are not sliced up by time, they have symbol periods several times longer than time division multiplexing (TDM) symbols such as those used in QPSK systems. This longer symbol length makes OFDM substantially more resistant to low-level impulse noise. Adding a small interval between symbols, called a guard interval, makes OFDM even more resistant to multipath interference, turning the equalization process into simple phase and amplitude adjustment per tone.

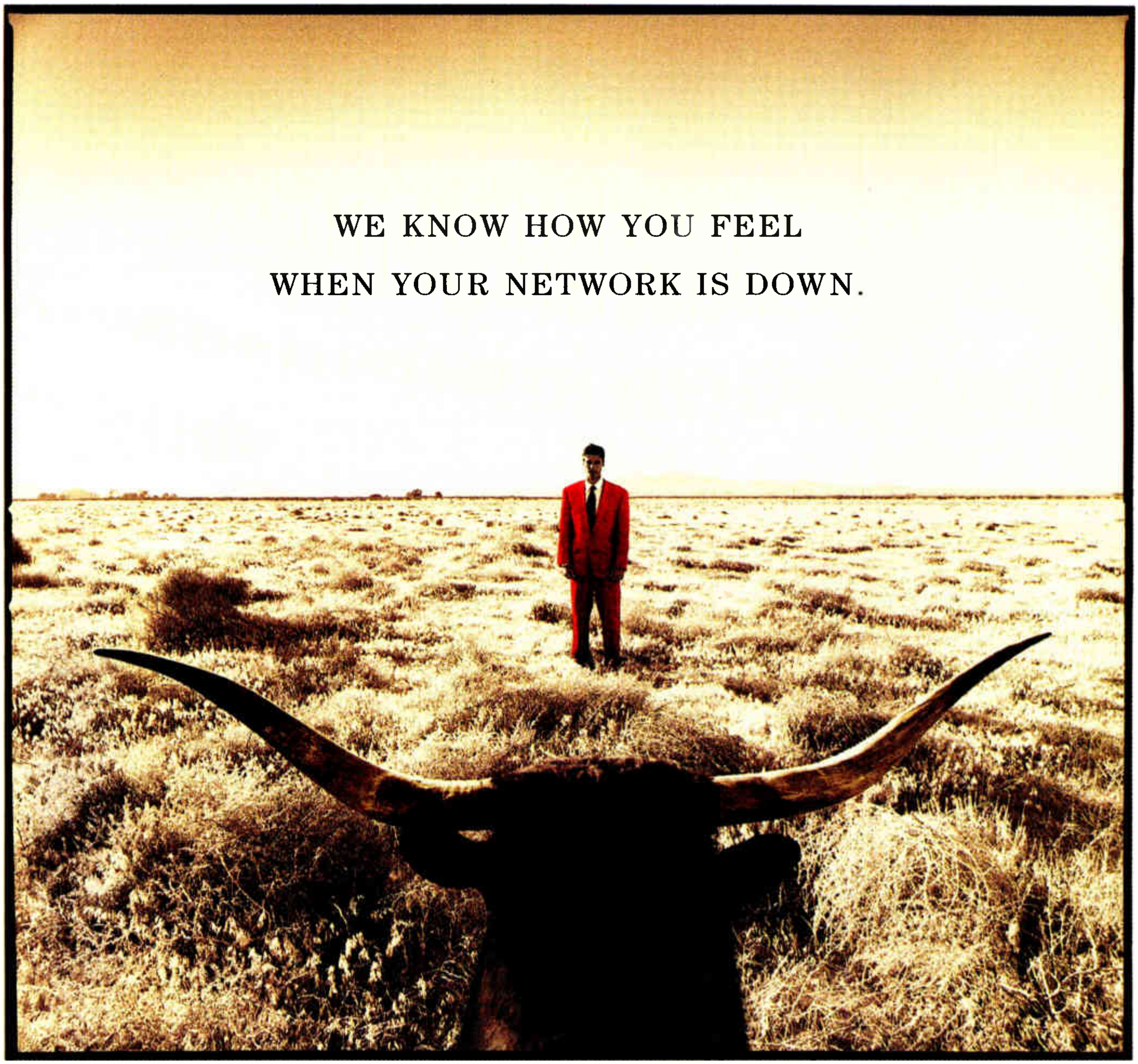
Flexible deployment

When it comes to deploying modems at customer premises, most QPSK implementations do not permit different-size modems to be served by the same headend modem. The scaleable nature of OFDM, however, does permit this mixing and matching of modems.

As a result, with OFDM, service providers can deliver a range of higher-bandwidth services to a range of customers more efficiently. And they can do so using the same hardware platform—at the headend and at the customer premise—for both telephony and data services, with the same network management system. (See Figure 2 on page 58.)

Special platform

Cable providers are looking for new revenue streams from a range of special services, such as DDS for lottery and automated teller machine connections, T-1, and Internet access. These are high-revenue, high-bandwidth services, which require more than POTS but less than four T-1s of total bandwidth—the level at which competitive local exchange carriers usually find it cost-effective to offer fiber-based services. HFC is a cost-effective medium for these two-way services, and OFDM makes the most of HFC in terms of spectral efficiency, reliability and flexibility. **CT**



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By Dan Kerr

Power distribution in a lifeline network

There have been many articles regarding the use of hybrid fiber/coax (HFC) networks for the reliable delivery of digitally compressed video services, high-speed data, telephony and lifeline services. But one detail has often been overlooked: The method of power distribution from a central lifeline-quality power supply to remote locations within the HFC network. This article will compare the materials and structures of theoretical and commercially available power distribution cables, and explain the development of an improved power cable, to help the reader determine the best option for their own lifeline service-providing HFC network.

A power solution used by the telcos is to put a big diesel generator in the back lot of the central office, complete with block warmers, preheated fuel and a solid preventive maintenance schedule. But there is more than just a pair of copper wires between your headend/central office and your customer. One must consider fiber-optic cable, redundant switching nodes, amplifiers in cascade from one to more than you might care to admit and perhaps even a line-powered, network interface device at every home.

For the HFC network operator, the headend cannot be in the same location as the power source. The nature of these networks require that power be inserted in locations that optimally balance the load with the current and voltage handling capacities of the line gear.

Dan Kerr is midwest regional network design manager for Continental Cablevision. He may be reached at (513) 435-2092.

"For the HFC network operator, the headend cannot be in the same location as the power source."

And if the HFC architecture being used has low amplifier cascades, the fiber-optic cable effectively isolates the fiber-optic node coverage areas from one another. In lifeline-capable versions of these networks, to achieve any economy of scale from expensive, difficult to place, generator-supported power supplies, a cable is required to transport the power to the optimum points within the multiple receiver HFC network.

In 60 Hz power conduction, what matters most is the cross-sectional area of the material in question. As in electricity's most common analogy—water pipes—the larger the pipe, the greater amount of water that can move through it. And according to Ohm's Law, E = I x R, the larger the wire, the lower the resistance and subsequent voltage drop and the less amperage needed to provide constant power to the system components.

The HFC system operator has several considerations in selecting the "right" power transportation cable: 1) the DC-loop resistance, if a coax, or the total resistance of a pair of conductors, if individual wires; 2) the weight and configuration of the cable, with and without ice, for pole loading; and, 3) the mechanical characteristics of the cable, for ease-of-installation and maintenance.

Materials

Total conductivity is a function of the cross-sectional area of the wire and basic conductivity of the material. Using the equation PI x R^2, doubling the wire's radius will quadruple its conductivity. If the

Table 1: Comparative volume of metric ton of aluminum and copper

Vital statistics	Aluminum	Copper
Cubic inches/metric ton	22,571	6,801
Specific gravity (Density relative to water)	2.7	8.96
Resistivity (micro-ohm-cm)	2.655	1.673
Material modulus of elasticity ("Stiffness" in millions pounds/square inch)	10	16
Dollars/metric ton (2,200 pound London Metals Market—2/20/97)	$1,606	$2,342

Reference: "Metals Handbook," American Society for Metals, 1948 Edition, Pages 20-21.

The cost of in-home installation and test can be murder on your budget.

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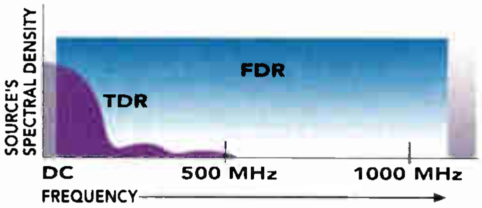
Anritsu Wiltron's Cable Mate accurately verifies the entire cable drop, including in-home wiring, from a curb-side test connection.



Cable Mate's advanced Distance-To-Fault mode displays SWR versus distance—clearly indicating the frequency response of all connections and splitters throughout the home. Additionally, a 5 MHz to 1200 MHz synthesized RF sweep verifies SWR specifications.

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The spectral magnitude of a TDR's pulsed DC output tends to roll off rapidly at high frequencies. Thus, traditional TDR-based tests do not measure at RF frequencies. With FDR, you specify the frequency range to meet the requirements of your system.

Cable Mate's user-friendly display, controls and menus simplify procedures. Up to 40 sweeps can be stored for comparison to historic data. So, if you want to ensure signal quality without the budgetary horror stories, pick up Anritsu Wiltron's Cable Mate.

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material is changed while the wire diameter remains constant, like results can be obtained. For example, the conductivity of copper is four times that of nickel. Choosing the correct material requires balancing the electrical requirements of the job against the material's cost, conductivity and physical and mechanical properties.

The four most conductive metals, in order, are silver, copper, gold and aluminum. Cost alone has narrowed these choices down to two materials: copper and aluminum. Some of the basic properties of these two elements are specific gravity, or weight per unit volume; resistivity, or how good a conductor the material is; the material modulus of elasticity, a measure of "stiffness"; and the material cost. As represented in Table 1 on page 64, the volume of a metric ton of aluminum is more than three times that of c opper. This means that for any given wire gauge, three times the length can be drawn from the same weight of material. Regarding "stiffness," a wire made of copper is 1.6 times as difficult to bend (assuming native, unannealed elements). As a conductor, copper requires about 63% the cross-sectional area of an aluminum wire to achieve the same conductivity. And finally the cost differences. Per unit weight, copper is about 150% more expensive than aluminum while per unit volume, the difference increases to about 480%.

In order to begin comparing these different metals, we need to equalize them. Given the ultimate goal of efficient power transmission, let's look at conductivity. In the coaxial cable arena, 0.30 ohms per 1,000 feet DC loop resistance is the best currently available. This will be used as the benchmark. To achieve the same using parallel conductors, a pair of 0.15 ohm/K' wires is needed. Using the following equation:

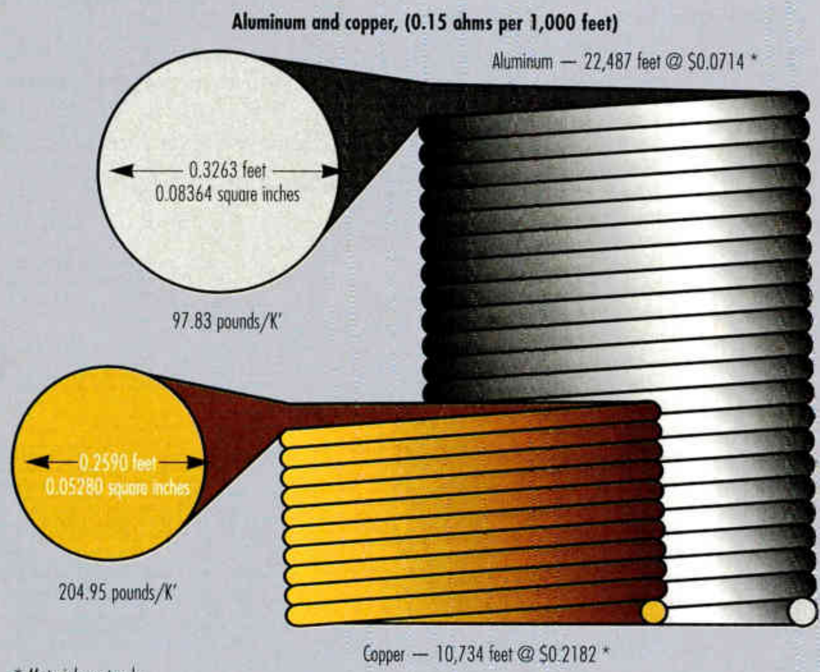
Material resistivity x length/desired resistance = area,

and solving for diameter with:

2 x SqRt (area/PI),

the sizes of wires with the given conductivity in copper and aluminum are, respectively, 0.2590 and 0.3263 inches. Figure 1 demonstrates that using the original metric tons of material, and equalizing for conductivity, twice the length of wire can be made from aluminum,

Figure 1: Comparisons of metric tons of wire



* *Materials cost only.*

Table 2: Weights and ice loads of theoretical and commercially available conductors

Notes	DC loop resistance per 1,000 feet	Complete circuit pounds/K'	0.25 inch support strand pounds/K'	Total bundle pounds/K'	OD of wire bundle inches	Bundle with 0.25-inch radial ice (1) pounds/K'	Bundle with 0.5-inch radial ice (1) pounds/K'	
Calculated pair of 0.15 ohm AL	0.30	272	121	393	0.9726	773	1,308	2,3
Calculated pair of 0.15 ohm CU	0.30	454	121	575	0.7580	888	1,357	2,3
Pair of 1/0 aluminum conductors	0.33	300	121	421	1.2100	875	1,484	4
Pair of #2 copper conductors	0.32	480	121	601	0.8400	940	1,434	4
Power 625	0.29	284	121	405	0.9350	773	1,297	5
1,160 TX	0.30	431	121	552	1.5	1,096	1,796	5

Notes:
[1] Weight of ice is 57 pounds/cubic foot.
[2] Wire size and performance based on elemental properties.
[3] For the 0.15 ohm Al, 80 mil insulation. For the 0.15 Cu, 60 mil insulation. Insulation weight—0.031 per cubic inch.
[4] Resistances for wire gauges from 1993 *NEC Handbook*, page 919, adjusted to 68°F.
[5] Diameter and weight of 0.625 and 1.160 TX include jacket.

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weighing half as much per foot and with a raw material cost of only a third that of copper.

The next step is to assess the effect of the differing diameters. In aerial cable construction, a point of more and more concern is the loading of poles. In areas of the country where ice is not a consideration, the weight of the calculated copper wires alone makes them undesirable (0.45 pounds/feet vs. 0.27 pounds/feet for aluminum). But with a full 0.5-inch radial ice load and a 1/4-inch support strand, the smaller diameter of the copper wires, and subsequent lesser ice loading, nearly negates any material weight per foot considerations. This is demonstrated in Table 2 on page 66. Note that the paired wires created and insulated by calculation are shown along with commercially available wires of comparable conductivity, #2 gauge copper and 1/0 gauge aluminum (and some like performing coaxial cables) yielding the same conclusion.

Of the parallel conductor pairs, the aluminum wires have the best overall performance for cost and pole loading. There are still difficulties with this solution; connecting parallel wires to a system based on concentric conductors and the installation charges for what are

Figure 2: Relative force to deflect (copper and aluminum)

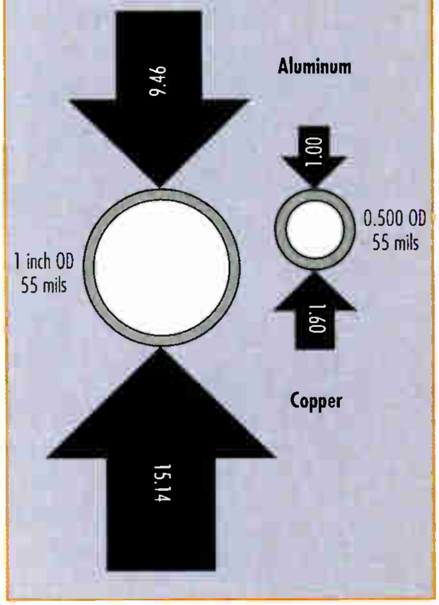
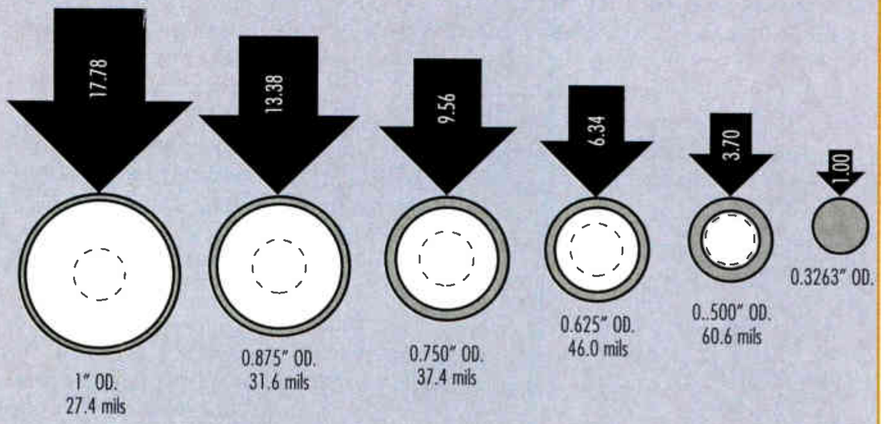


Figure 3: Comparative force to deflect aluminum tubes and wire

All cross-sectional areas are 0.08364 square inches or 0.15 ohms per 1,000 feet. (Dashed 0.3263-inch wire outline for reference.)



Tube section modulus = PI/64 * (OD^4 - ID^4)
Solid wire section modulus = (PI * OD^4 / 64
Deflection = (Load * $Length^3$) /(48 * Material modules * section modulus)
Deflection. length and diameters in inches; load in pounds.
Aluminum material modulus = 10 million pounds per square inch

Equations from *Elements of Strength Materials*, Timoshenko & MacCullough, 1949, pages 123 and 182.

essentially two feeder cables. However, if the reader is willing to overcome these problems, this may be an acceptable solution.

Structure

To date, coaxial cables have been the power transportation cable of choice. Traditional coaxial cables require a 75 ohm impedance that dictates a specific structural relationship between the center conductor and shield. For better conductivity, you cannot simply add more metal to a given cable without changing the impedance. A larger cable must be used.

These larger cables are significantly more difficult to work with. Empirically, a .500 coax cable is much easier to bend than a 1-inch coax cable, but they have different wall thicknesses and conductivities making a true comparison difficult. Let's first look at the relative effect of diameter on stiffness. Using a 55 mil wall thickness, the force, in pounds, required to deflect a 3-foot section of aluminum tube 1-inch is expressed in the following equation:

Deflection = (Load x $length^3$)/(48 x material modulus x section modulus)
Material modulus of aluminum is 10 million pounds/ square inch
Material modulus of copper is 16 million pounds/ square inch
Tube section modulus = (PI/64) x (OD^4 - ID^4)
For reference, the solid wire section modulus = (PI x OD^4)/64

From the previous information, it is calculated that the 1-inch aluminum tube is more than 9 times stiffer than the 0.5-inch tube of like wall thickness. If these same tubes were made of copper and the 0.5-inch aluminum tube is assigned a stiffness of 1, the 1-inch and 0.5-inch copper tubes yield a relative stiffness of 1.6 and 15.1 respectively. The use of aluminum has significant mechanical advantages. See Figure 2 on page 68.

The previous calculations, while useful in demonstrating the importance of diameter in any coaxial configuration of a power cable, do not balance stiffness with conductivity. In Figure 3, standard coaxial cable outer diameters are shown with wall thicknesses of a cross-sectional area equivalent to 0.15 ohms / K'. For this figure, a solid aluminum wire of the same conductivity as the tubes is used as a reference of 1 unit of stiffness. Again, the diameter, more than the wall thickness is the chief determinant of the cable's handling characteristics. The greater inherent stiffness of copper, even with the thinner walls its better conductivity allows, does not yield a mechanically superior tube, given the same conductive requirements and outer diameters.[1]

The solution that best combines conductivity, pole loading and mechanical properties is the smallest aluminum tube with the largest center conductor possible. Such a cable was designed and produced. Using the thickest available sheath, the 55 mils in a 1-inch coax, and the largest copper clad wire from which standard center conductors are drawn, a 0.625 OD. coaxial cable was created. This cable, with slightly more aluminum in its cross-sectional area than the largest commonly available coax, has a loop resistance of 0.29 ohms/1,000 feet and handles like an .840 or .875 coax cable.[2] It retains the craft-friendliness lost to parallel conductors and loads poles less than any other comparable solution (Figure 3 on page 69.).

The greatest difficulty with the design is the small clearance between the center conductor and sheath inner wall. An entry connector and splice have been designed that use an insulated mandrel to overcome any conductive problems. Also used was strengthening the seizing mechanisms to withstand the force this much metal can exert on a connector as the temperature drops. Finally, the pins on the entry connector and center conductor seizing mechanisms of the splice were increased in size to allow continuous loads of 25 amperes to be conducted without appreciable heat being created.

It can be seen from the discussion of metals, structural options and pole loading requirements, for the HFC system operator, this newly developed cable/connector combination is clearly the best existing solution to meet the power transportation requirements of a lifeline service capable, HFC network.

Notes

[1] For comparative purposes, the stiffness calculations (using the aluminum wire for reference) for like OD tubes made of copper having a cross-sectional area equivalent to 0.15 ohms/ K' (0.05284 square inches) are: 1 inch - 17.1 mil wall, 18.33 stiffness; 875 = 19.7 mil wall, 13.88 stiffness; 750 - 23.1 mil wall, 10.03 stiffness; 625 - 28.2 mil wall, 6.77 stiffness; 500 - 36.3 mil wall, 4.10 stiffness; solid wire -326.3 mil diameter, 0.64 stiffness.

[2] The measured flexural stiffness of a 0.840 cable is 23 foot-pounds, the power feeder 0.625 has a measured flexural stiffness of 24 foot-pounds

Acknowledgments: The author greatly appreciates the efforts of Mark Alrutz of CommScope Inc.; William R. Kerr, metallurgical consultant; Joe Hohlmayer of Continental Cablevision; Gilbert Engineering; and many others within these companies for their contributions. **CT**

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Reader Service Number 205

By Rick Marcotte and George Oughton

Juicing up your HFC net for the next decade

New services delivered over hybrid fiber/coax (HFC) networks such as telephony, high-speed data, energy management and interactive TV (ITV) are appearing on the cable telecommunications landscape so quickly, it's almost becoming a case of "sink or swim." The delivery of these services over the cable TV network is seen by a number of industry analysts as fundamental to many MSOs' outright survival.

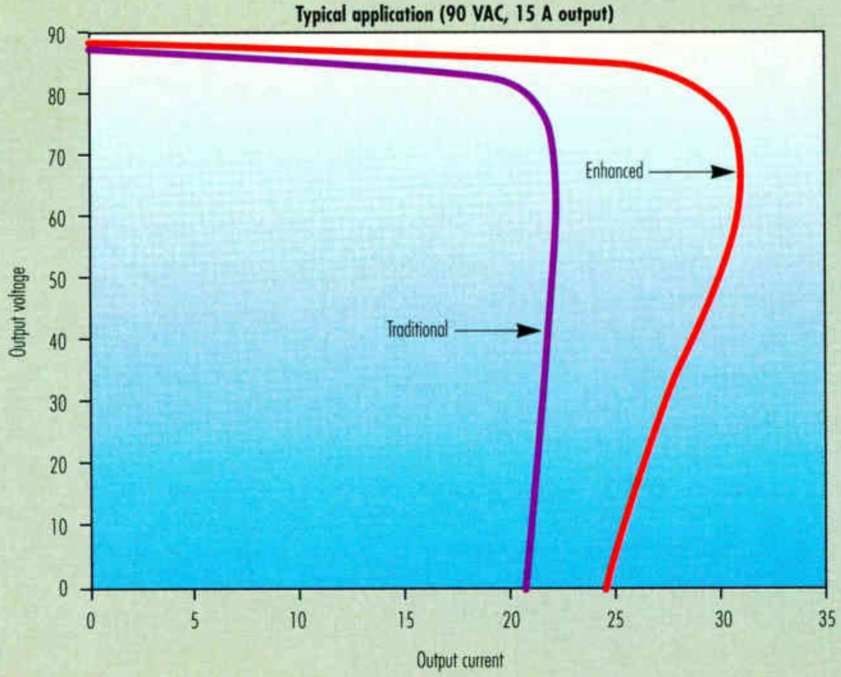
The expansion of information services on the HFC network requires a new breed of active components plus a dramatic increase in overall network reliability. Powering requirements will go beyond the capabilities of traditional cable TV powering architectures, creating "unknowns," particularly related to network interface unit (NIU) powered devices. Network powered loads such as telephones, energy management interface/controllers, certain cable modems and other yet-to-be-invented devices, will be turning on and off at different times at different points in the network with various power demands.

> **"The enhanced ferroresonant transformer is analogous to a 900-pound gorilla."**

In addition, the existing interaction of constant power coax amplifiers, regardless of the length of the cascade, will increase the dynamic power demands on the network power supplies. The normal service and repair process, where a large part of the load can be switched off, repaired and switched back on again is another example of a dynamic load on the cable TV power supply. These new and in some cases, unknown dynamic network powering demands will occur in both distributed

Rick Marcotte is director of sales and marketing and George Oughton is senior staff engineer for Exide Electronics' Emerging Technologies Group.

Figure 1: Ferroresonant transformer foldback characteristics



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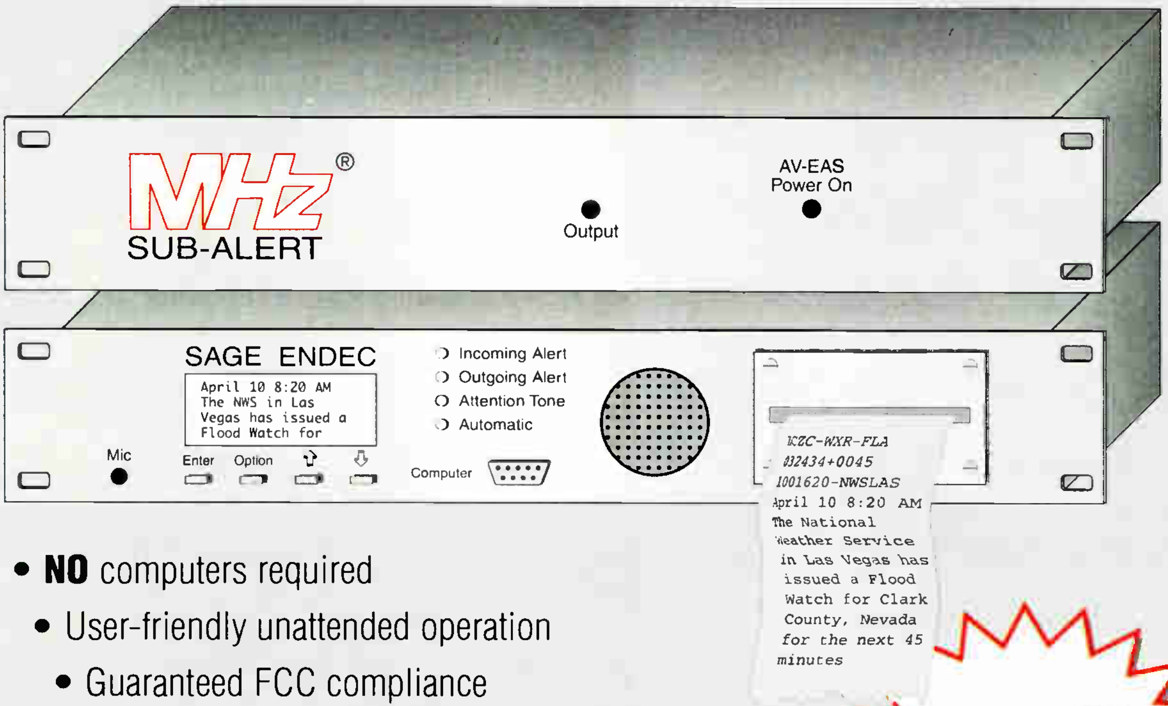

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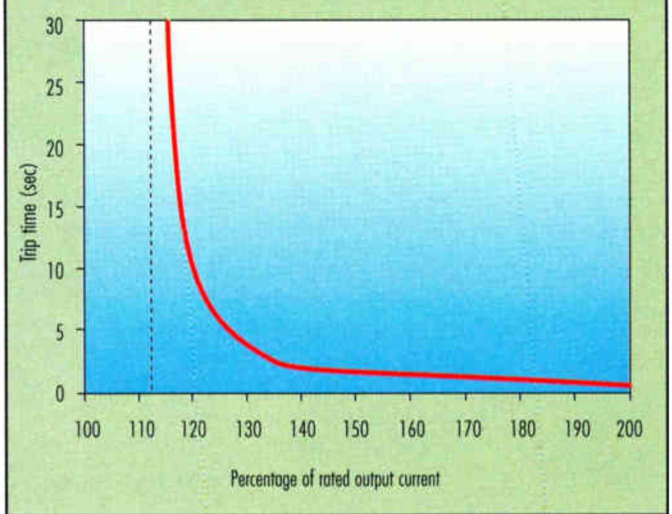
Figure 2: Virtual fuse trip curve



and centralized power architectures alike. In the absence of knowing what future dynamic loads will be, it's important that MSOs look ahead and plan for them now.

Two power "musts"

In order to handle the dynamic loads of tomorrow, two things have to be true. Manufacturers have to spec, design and build a more robust power supply to enhance overload capabilities. Secondly, the power supply has to have the intelligence to allow you to use that overload capability only when you need it, thereby controlling the "brute force" built into the supply. The future-proof power supply must enable the network to handle the peak power draws from these dynamic loads that could be of short duration, without dropping the load, or turning off the power supply. The power supply also must prevent the possibility of damaging the downstream network components by delivering sustained overcurrent.

When temporary overloads or short circuits occur, the inherent capabilities of the traditional cable TV ferroresonant transformer limits the amount of current that is delivered. If the overload or short-circuit demands more current than the transformer can deliver, the voltage collapses. It's then up to a technician to identify the cause of the overload and remove it.

This traditional method of dealing with overload is used by almost all in the cable TV industry today. It is inherently current limiting to a range of 125-150% of the rated output current of the power supply transformer. After reaching the current limit, the traditional ferroresonant transformer undergoes a "foldback" process and collapses its output voltage to zero.

Another option

A better way to handle dynamic load increases is to build in a larger short-term overload handling capability. The traditional ferroresonant transformer makes it possible to deliver more sustained over current than the network components can handle, thus causing actives/passives overheating, stress or outright failure. In some cases this overload capability is not sufficient to clear a short duration fault. In other cases, it is too much current, particularly when applied for a long period of time. Thus, the challenge is limiting the use of this increased overload capability so that damage does not occur to the cable network passive/active components or to the power supply itself. This requires a "smart" transformer.

Next-generation enhanced ferroresonant transformers available very soon will be capable of handling overloads up to 200% (almost like providing network insurance for those dynamic loads of today and the future). As seen in Figure 1 on page 72, this enhanced ferroresonant transformer can deliver up to 200% of the power supply's rated output current before foldback occurs. With this capability, the enhanced ferroresonant transformer is analogous to a 900-pound gorilla. Having a 900-pound gorilla is great, but it's even more important to control it. In this case, a digital microprocessor with advanced control algorithms has been deployed to harness the power of the gorilla. The microprocessor intelligence acts like a finger on a switch, turning the ferroresonant transformer off in an overload situation based on predefined criteria. This "turn-off" command acts like a "virtual fuse" to provide protection to the network components and to the power supply itself.

Ideally, the power supply should behave in a manner whereby short-term high overloads (i.e., 200% for one second) can be accommodated without foldback or shutdown. However, overloads of 200% for greater than one second would "blow the fuse" and turn off the power supply, saving the cable component and power supply itself. Fuses are excellent protection devices, but are difficult to replace. In a perfect world, the "virtual fuse" would be maintenance-free so that it would replace itself when the overload was removed.

In an overload situation, the "virtual fuse" would blow (i.e., the microprocessor has turned off the power to the ferroresonant transformer). Every five seconds the microprocessor would turn the ferroresonant transformer back on and monitor the output current. If the output current overload has ended, the power supply would remain on (i.e., "replace" the fuse). If the overload still existed, the virtual fuse would blow again and the process would be repeated. The brilliance of the microprocessor is that it allows for the configuration or adaptation of the power characteristics to correspond with changes in the loads that it is powering. As illustrated in Figure 2, the "maintenance-free virtual fuse" trip curve can be predefined in the microprocessor software code to deliver the optimal output current for the optimal amount of time.

The microprocessor is the ideal way to define configurability for several reasons, beginning with its flexibility. Through software code, operating parameters can be configured. The use of a microprocessor also reduces parts count in the power supply, thereby greatly increasing reliability. In addition, the accuracy of displayed readings improves. The microprocessor allows the cost-effective integration of a digital liquid crystal display (LCD), giving the ability for high resolution digital metering with true root mean square (RMS) measurement at no additional cost. Parameters such as input/output voltage, battery voltage, number of power events, time on battery and output current among others, are easily obtainable. Another benefit of the microprocessor is the built-in capability to deliver digital signaling for tomorrow's status monitoring requirements, via RS-232 or some other interface, once the network status monitoring systems migrate toward full digital end-to-end signaling.

Technicians today typically take their own digital meters to get RMS readings from the individual power supplies. With the microprocessor, all of those values (meter readings) are available through the LCD, making it unnecessary for cable technicians to carry expensive portable meters. Meter readings become easier, especially when power supplies are situated in hard to reach areas, like telephone poles. Technicians also are better prepared to maintain the equipment. When the product goes into standby, the microprocessor records it as an event, and then records the amount of time spent on battery. This digital reading shows how much the battery has been exercised since the last maintenance visit. The technician can then use this information in regular maintenance of the batteries, proactively deciding when replacement is needed or if maintenance checks need to be held more frequently.

No one can be certain about the nature of tomorrow's network from a powering perspective, but it is important to look ahead and anticipate future needs. The best anyone can do is to begin now by future-proofing HFC networks to ensure that today's capabilities don't limit tomorrow's progress. **CT**

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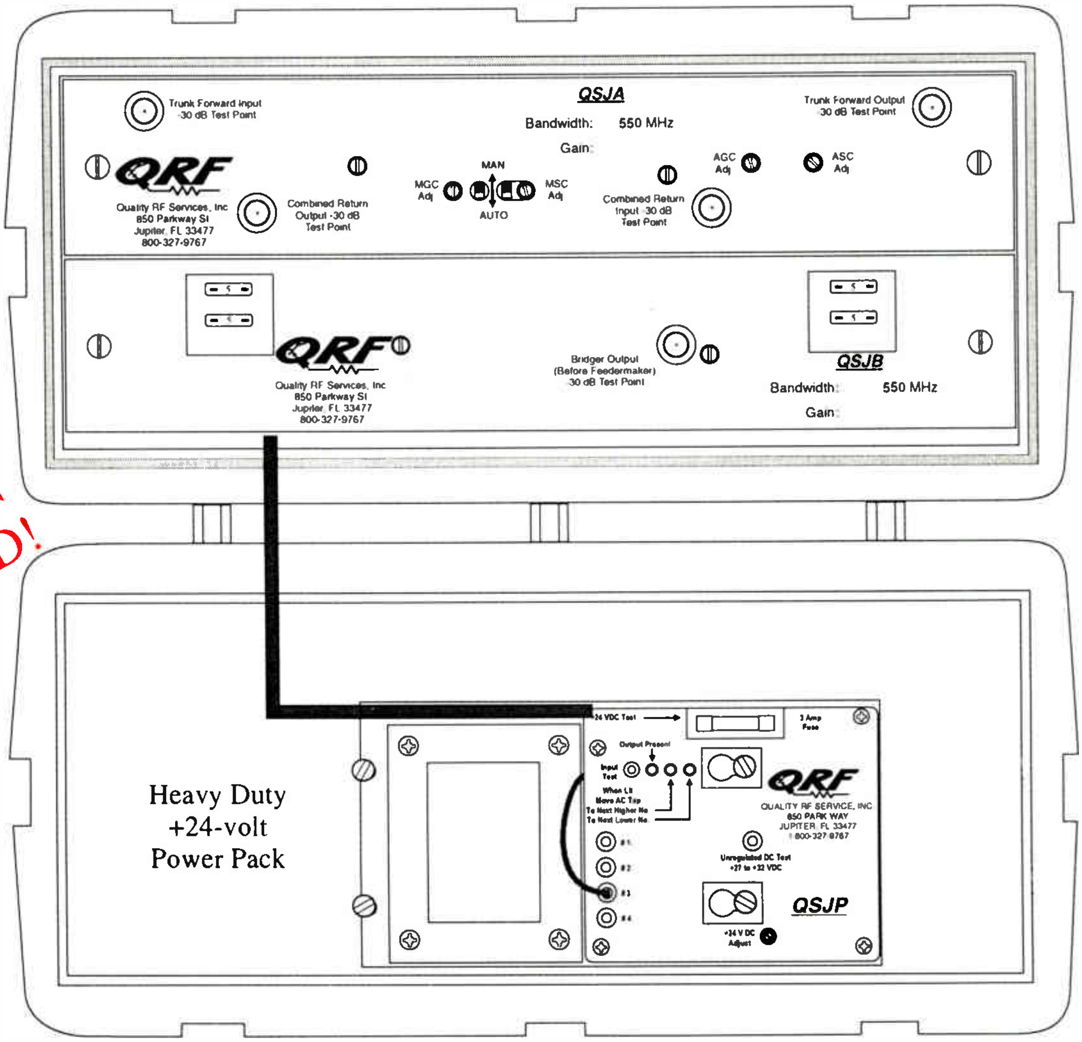

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Reader Service Number 89

By John J. Downey

Schemes and devices for "hitting nines"

With the advent of increased services and the demand for 99.99% reliable cable systems, more emphasis is being placed on the integrity of the powering. A brief amount of downtime caused by an unreliable powering scheme translates into service calls, irate subscribers, wasted time, and possibly lost revenue and customers. Many approaches can be taken to increase system reliability. The use of surge suppression devices and different fusing schemes is one such approach.

John Downey is a senior field engineer at C-COR Electronics in State College, PA. He can be reached at (814) 238-2461, ext. 2207.

Before any detail is given about surge termination in a cable system, it would be appropriate to mention something about mainline power supply problems associated with storms. If a nonstandby power supply shuts down because of a storm and starts back up, transient voltages may pass through the cable system until the power supply transformer becomes saturated.

Most standby power supplies have delay circuitry and many mainline power supply vendors offer optional delay circuits to connect to the secondary side of the transformer. This will eliminate these transient voltages from being passed through the cable system.

Another option is to utilize an uninterruptable power supply (UPS). The UPS provides AC voltage to the backup batteries, which in turn feed an inverter that converts back to AC voltage. When the AC is not present, the batteries immediately supply the power. This eliminates any interruption in power when the AC is momentarily shut off.

Grounding, bonding

It also is imperative to assure a well grounded system. According to National Electrical Safety Code sections 92C1 and C3, the cable system should be bonded at a maximum interval of four connections per mile. This sometimes translates to every first and fifth pole. An industry "rule-of-thumb" states that a separate vertical ground should be used on every active, mainline power supply, first, tenth and last pole. Some go as far to ground both sides of an active and place a shunt over the active. Vertical grounds should measure less than 25 ohms resistance. A vertical ground used for a mainline power supply should measure less than 2 ohms resistance. If these resistances cannot be met, certain grounding schemes can be used such as soil reconditioning and ground rod "ganging."

Power supplies, fusing

Voltage transients don't "blow" a current limited fuse, but the surge protection module (SPM) within the amplifier power supply will "fire" to protect the power supply and cause a current spike. This, in turn, will cause nuisance fuse blowing of the main fuse. Most amplifiers will use a 3AG, spiral-wound-type, slow blow, main fuse to eliminate this dilemma because it will accommodate specific current spikes for short durations. The following shows the current handling capability vs. time for this type of fuse: 110% for 4 hours, 135% for 1 hour, and 200% for 5 seconds. These fuses also are more stable with temperature than the spring-type, slow-blow fuses.

Placement tips

• **In the cable system**. Some transients are longer in duration and higher in amplitude than what the SPM can handle, therefore requiring additional protection. The ideal way to provide transient protection to your system would be to place a surge terminator in every active device, but this can be very costly. An optional scheme is described as follows. This method applies to each powering group in the system.

Maintain a fusible link between the source (mainline power supply) and the load (actives in system)—a circuit breaker or fuse in the power inserter (one for each direction power will travel) or in the first amplifier to see AC voltage on both sides of the inserter. Some people don't like to use circuit breakers because the intermittent power can be very taxing on your equipment and the consequential intermittent RF signal can be intolerable for your subscribers. A fusible link is to assure protection from serious surges that can occur because of lightning, electric company maintenance, etc. If there is no fusible link and a current of more than 40 amps continuous current is sent through a surge terminator, the surge terminator could fail and short to ground!

First, place one surge terminator in the amplifier on each side of the power inserter (the first amplifier to see AC voltage in each direction), or in the power inserter itself. Some mainline power supplies are furnished with fuses, circuit breakers and/or a surge suppression device, thus providing the fusible link and possibly eliminating the need for extra devices in the first actives. If you have additional surge terminators allocated to each branch, proceed with the following: Place one surge terminator in the end-of-line amplifier (i.e. the trunk/bridger amplifier furthest from the mainline power supply).

Working back from the end-of-line toward the power supply, insert one surge terminator in evenly spaced

amplifiers. The spacing of these amplifiers will depend on how many surge terminators you have allocated to each leg. Some locations that may need special attention are hilltops that are frequently subject to lightning strikes, locations which exhibit bad grounding, amplifier stations located near high tension power lines, etc.

- **In an amplifier:** It is important to understand in which fuse location the surge terminator should be installed. Do not place a surge terminator in the main fuse location. The surge terminator acts like a buss bar during normal operation. Place buss bars (slugs) in the trunk-in/trunk-out ports of all the trunk amplifiers in cascade. If cascading bridger amplifiers, "slug" these ports also. The best place to insert a surge terminator in a trunk/bridger amplifier is in any of the "slugged" ports. If no ports are being "slugged," place the surge terminator in the fuse location of any unused port.

It is recommended to use fuses or circuit breakers in the active distribution ports. If the distribution ports are "slugged," a surge on that feeder leg could take down the entire trunk run (including the node). The fuse would prevent this from happening. The fuse value is typically 1.5 times the actual current draw through that port. This is critical to the design. If the power inserter fuse is the weakest link in the cascade, it could still "blow" before the distribution fuse!

You also could use a buss bar or a surge terminator in the line extender through fuse location. If the line extender doesn't use the through fuse to power additional line extender(s), a jumper can be cut on the surge terminator to stop through power. (Note: Verify that MLP power paths are striplined or "slugged.")

Troubleshooting

Circuit breakers are very good for troubleshooting and eliminating blown replacement fuses. With a circuit breaker installed in the blown fuse location a signal level meter can be utilized to track down the span of cable that is bad. Use the 50/50 technique to cut the system in half. Disconnect the power continuity to a specific span and see if the intermittent RF signal becomes stable. If the RF signal stabilizes, then the problem is further down that branch. A mainline passive is a very good place to disconnect the continuity by pulling the face plate. A jumper with alligator clips can be used to energize a specific power path and further determine the bad span.

Conclusion

The method described herein should help to minimize certain nuisance outages while still providing adequate protection to the amplifier stations. This scenario also targets the one place where the fuse will "blow" and thus eliminating guesswork when an outage occurs. A circuit breaker can be installed to troubleshoot the system and eliminates wasted fuses. If a serious problem is encountered, a circuit breaker can save a trip back to the fuse location until after the problem is rectified. **CT**

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Reader Service Number 7

By Deb Nissen

A kinder, gentler TDR

The time domain reflectometer (TDR) is an instrument with a long and colorful history. Once reserved for only large cable systems and higher level engineers, the new, kinder, gentler TDR is taking its place among other test instruments as one of today's standard troubleshooting tools.

The acronym TDR is used for good reason. Most people can't remember what the letters stand for, let alone the full and correct pronunciation. But, even if you could remember, the name "time domain reflectometer" is just too darn long for today's casual and hurried society. Although the full name may be a mouthful, it is not the only hurdle the TDR has had to overcome. A history of complexity and premium pricing has limited the use of the TDR in the past. However, the simplified and lower cost TDRs of today have helped the instrument make a dramatic comeback for both metallic and fiber-optic cables. Today, the TDR has become one of the modern installer's preference for tools. The optical time domain reflectometer (OTDR) evolved as a direct result of today's telecommunications needs, but the traditional metallic time domain reflectometer (MTDR or TDR) has been around for over 50 years!

Deb Nissen is the regional sales manager for Riser-Bond Instruments located in Lincoln, NE.

Figure 1: Waveform-type TDR

Operation

The early TDR was an instrument that was very intimidating to the operator. The numerous knobs and buttons made its operation complicated and time consuming. Although helpful and accurate, the mere size and weight made it a cumbersome and not-so-portable instrument. In addition, the cost was very high. These factors resulted in limited usage by various telecommunications industries.

Time and technology have resulted in easy-to-use instruments that are a fraction of the size, weight and price of earlier instruments. A combination of these improvements as well as an explosion in telecommunications is helping the TDR make a dramatic comeback in almost every industry. Whether old or new, waveform or digital numeric, all TDRs work on the same basic principle: radar. The TDR sends out a pulse of signal energy. Any faults, components, or the end of the cable itself will reflect some or all of the signal energy back to the instrument.

The time for the signal to travel down the cable and back from the various reflection points is calculated, converted from time to distance, and then displayed as a numeric distance reading or as a waveform

Reader Service Number 29

interpretation of the cable being tested. These results are displayed on the instrument. From this information, the operator interprets the status of the cable under test.

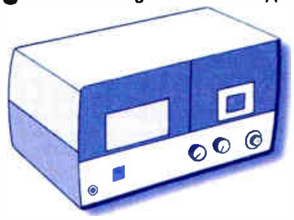
Two types

TDRs today come in a variety of sizes, shapes and options. There are two distinct types of TDRs today: the new, digital numeric type and the more traditional waveform type. (See Figure 1 on page 84 and Figure 2 on this page.) The digital numeric TDR is smaller, less expensive and provides only "distance-to-fault" readings. These instruments are designed to find only catastrophic problems and will read shorter distances than their more sophisticated counterpart. However, the low cost allows the possibility for a one-in-every-service-vehicle application.

The waveform TDR will read longer distances and will locate much smaller problems. A physical representation of the cable and condition is displayed as a waveform on the instrument. The "waveform display" feature provides the operator with more information regarding the condition of the cable and components.

The instrument will test any type of cable including coaxial, twisted-pair, parallel or virtually any other cable that has at least two metallic conductors or a conductor and a metallic sheath. In addition, the operator only needs access to one end of the cable in order to test. The TDR is "matched" to the cable by entering the velocity of propagation (VOP) of the cable being tested. This enables the operator to obtain the most accurate readings possible.

Figure 2: Digital numeric-type TDR



The TDR is also able to locate a variety of fault types. Opens, shorts and even partial opens and shorts can be located. System components, water in the cable, and almost any other factor that causes a change in the constant impedance of the cable can be located. Field experience and a trained eye can identify the type of trouble, or the component, that is reflected in the waveform. The severity of the fault can even be determined.

Features

The speed and accuracy of the TDR is probably the biggest reason the instrument has become so popular. With environmental issues forcing more and more cable underground, the ability to locate the distance to a fault underground is vital. A few minutes with a TDR can save hours (or even days) of work. Although the same basic principle and function of the TDR has remained the same since World War II, there are a variety of features on modern day instruments that enhance their appeal and usefulness. The following are some of the features you may find on today's TDRs:

- **Multiple cursors (or markers)**. These allow a TDR to measure between any two points along the waveform. Older TDRs or TDRs without this feature can measure only from the output pulse or connection point, out to a fault or the end of the cable.
- **Waveform storage**. This allows the waveform of a cable to be stored for use at a later time. It also allows the operator to compare one waveform with another.
- **Computer interface**. This is fairly common with many instruments today. Having the ability to download stored information to a computer for future reference is vital.
- **Intermittent fault detection.** This allows the TDR to monitor the cable, waiting for a momentary or intermittent fault to occur. This is extremely helpful for elusive faults that only occur occasionally.

The major stumbling block with any test instrument is the "learning curve." Even today's simplified TDR needs to be used and experimented with, in order to get the most out of all of its functions. The more familiar you are with it, the more you will be able to get out of it. With some effort, the TDR can become your most trusted and efficient test instrument. **CT**

Photo: Bob Sullivan

By Gord Lavery and Scott Crysler

Tool time: Today's & tomorrow's

Gone are the days when your customers wanted cable TV for receiving distant network channels or for better reception of their favorite programs. Today there is a vast myriad of programming that targets every interest. Add to that new services such as telephony, access to the Internet via the World Wide Web, and interactive services of gaming, shopping and banking. The deployment of these new services and use of new technologies has definitely changed the work environment for cable plant construction, installation and customer service personnel.

These new services, as well as the new specialty TV broadcasters that are being added to satellite broadcast services every month, take more spectrum and hence more space in the cable system bandwidth. In most areas of North America a 300 MHz system is considered obsolete and a 450 MHz system is barely adequate. They were quite acceptable only four or five years ago. To offer new services, the cablecos have had to assess their plant and consider the age of the cable and equipment, the design bandwidth, plus the technical specifications of the cable, passives and amplifiers.

Increased bandwidth, utilization of return path and adding digital services require considerations that follow.

What is the optimum forward and return bandwidth for our future service requirements?

Gord Lavery and Scott Crysler are in training and technical services for Ben/Hughes Cable Prep.

If the bandwidth requirement is too much for the current sub-channel assignment (available for the past several decades but not used too often) do we use a low-split or a high-split system architecture?

Should we consider digital compression to conserve bandwidth and make our program services more secure?

Since the additional amplifiers will require more power do we use our current 60 VAC power supplies and add more of them or do we purchase the new 90 VAC power supplies now available?

To meet the signal level specifications required at the customers' outlets, are we going to have to engineer the distribution system so there is more level at the multitap? Then consider changing out the customer service drops from the old standard RG-59 coaxial cable to RG-6 for the normal length service drops and use RG-7 and RG-11 for extra long drops.

Is it necessary to train our field personnel now so they understand the new technologies?

Should we consider purchasing the new tools that have been specifically designed for the installation of the cable and connectors developed because of new technology requirements?

Will we have to upgrade our field personnel's knowledge by giving them some additional training on the use of the new tools?

In addition to the previous training is there a need to upgrade skills concerning placement of equipment and connectorization because of technical considerations that have to be addressed for return path signal transportation, higher bandwidths and digital compression?

Yes, yes, yes to all the previous considerations plus many other important items such as the financial aspects and field personnel staffing level requirements. This article discusses changes in tools of the trade plus related training as a result of the technical requirements that are now becoming the norm.

Tools of the trade

Improvements in tool design have considerably increased productivity, provided a consistent level of professional results, and yielded a greatly enhanced system reliability. The use of tube cutters, knives and plastic scrapers on trunk and feeder cables, and utility knives, wire strippers and pliers on drop cables is quickly becoming the exception, not the norm. Newer combination strip/core tools used on the semiflex (solid sheath) coaxial cables and modern drop cable preparation tools leave the cable ready to install the connector precisely. The connectorization for drop cables is now more exact regarding specific strip lengths and the amount of braid required to fold over the jacket, and the length of the center conductor. Solid sheath cables require precise coring depths, score-free jacket removal and dimensioned center conductor protrusions.

It was once said that "Man is a tool using animal...Without tools he is nothing. With tools he is all." The point is that these modern tools make life easier for everybody concerned. Specialty coaxial cable cutters quickly provide a straight and rounded cut that makes cable insertion into preparation tools much easier and reduces the wear on the tip of the coring blade. Jacket strippers are being made to tighter tolerances and with plastic guide sleeve inserts to reduce the chance of scoring the outer conductor. Coring bits now have a cutting blade that leaves a bevel on the edge of the outer conductor that makes it easier to install the connector and less likely to damage the connectors internal "O" ring. Ratchet handles make hand coring easier in close quarters and reduce arm fatigue. Center conductor cleaners now provide equal pressure to both sides of the conductor to reduce bending and replaceable plastic scrapers eliminate conductor scoring.

Because of the need for reduced signal leakage, an improved moisture barrier, and better 75 ohm impedance match, F-type compression fittings are becoming more prevalent. They are quickly replacing the hex fittings because of the more concentric nature of the connector. This has led to the development of a new series of compression tools that cradle the cable and connector in the perfect position to allow the compression mechanism to be accurately and fully activated. One brand even has changeable inserts that allow for a variety of connector interfaces. Drop cable preparation has become (with the exception of quad cable) a simple one-step process. Dimensions are controlled by preset replaceable cartridges that precisely cut though the jacket, braids/tapes and dielectric, leaving the impedance of the cable intact.

Tools of the trade are becoming much better and easier to use, with consideration being given to field rugged requirements and a heightened awareness for more ergonomic designs and lighter weight materials. Consideration for the installer's safety also is a factor that tool manufacturers must make when designing new tools. Current manufacturing processes are providing more precise dimension yields in tools that leave little room for error by the installer.

Manufacturers specializing in production of tools for our industry must consider all Society of Cable Telecommunications Engineers and American National Standards Institute standards. Industry standards are being set by the SCTE Interface Practices and In-Home Cabling Subcommittee. This volunteer committee is now several separate groups working on developing further standards for the network interface device, surge protection, drop bonding and safety, drop and multiple dwelling unite (MDU) actives, drop passives, F-connector install and performance, as well as on-premise cable installation.

Training

Improved safety procedures and proper tool usage are provided by training, which has become a necessity rather than an option. This training provides assurance that the correct applications are followed for meeting the stringent requirements of today's very high tech broadband RF cablesystems. Training on tool usage results in far less damage to the cable and equipment. Therefore, service calls caused by poor workmanship and installation methods are reduced considerably. Less downtime caused by poor workmanship and improper tool useage equals more satisfied customers.

Training is being provided by some manufacturers in the form of tool clinics, video presentations, interactive catalogs containing instructional material, educational newsletters and hands-on demonstrations. Contact your manufacturer of choice for more information on how they can help you bring your staff up to speed with the new tools that are available.

The SCTE as well as other specialized training groups provide quality on-site hands-on training services. Training field personnel costs time and money but is truly an excellent investment that will pay great dividends.

Summary

Some of the basics have changed dramatically in the last few years, and they can not be taken for granted. Modern tools, more knowledge, and better workmanship combine to make a better field employee, which in turn creates an excellent broadband RF distribution system. This leads to a reduction in service calls (which saves the operator money) and less downtime for the customers. To improve bottom lines, system operators need to be giving more thought to the purchase of modern tools of the trade, job skills and upgrading of field staff when considering their rebuild requirements and future high tech service additions. **CT**

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Ground testers

AVO International enhanced its line of digital ground testers, which include the Megger DET5/4D and DET5/4R, four-terminal instruments, and the DET62D, a three-terminal instrument. They are designed for one-touch operation and automatically check for excessive current and voltage spike resistances and noise interference that could give misleading results. Shorting bars are included to simplify testing with two leads such as for continuity testing or ground electrode measurement.
Reader service #310

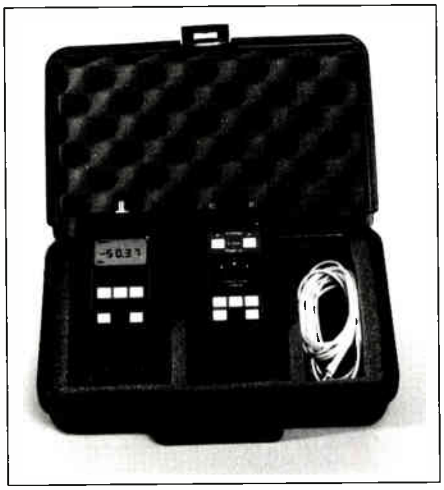
Routing switchers

A new line of small matrix routing switchers was developed by Sigma Electronics as an addition to the Series 2100 modular products. The Sigma Lite routing switchers are compatible with all other Series 2100 modules and functions. These switchers can reside in the same frame(s) with Sigma's analog and digital distribution, analog and digital color bars and black generators, plus analog signal processing products. The product is available in three sizes: 8 x 8, 16 x 8 and 16 x 16.
Reader service #309

Video file server

Sony unveiled its VideoStore video file server at the National Cable Television Association's NCTA '97 show in New Orleans. The file server is designed for digital ad insertion, program delivery and near-video-on-demand (NVOD) systems and features automated media management, predictive maintenance and hot-swappability. The system uses Channelmatic's MVP software, and currently runs 264 channels of video nationwide with 136 to be installed soon.

Channelmatic's software includes real-time traffic interface; responds quickly to late arriving copy; possesses global copy deletion and replacement; real-time network status and control; local and wide area networking/satellite content connectivity for national, regional and local zoning; library management; and positive verification. Sony's VideoStore offers 4 GB SeaGate disk drives, new serial digital input board (BKST 103), digitally encoded MPEG-2 output via an Ethernet connection, embedded clip ID numbers, closed caption support, and flexible and expandable open architecture.
Reader service #308



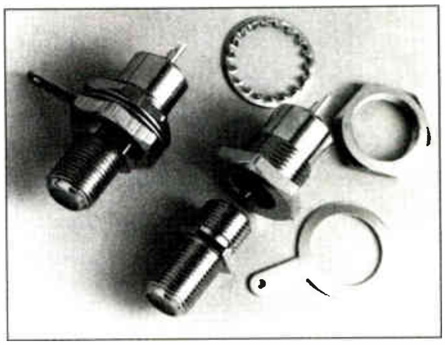
Fiber-optic kits

Wilcom now has four new test kits for fiber-optic fiber installation and maintenance. The kits come in both single-mode and multimode versions; and offer either a single wavelength or duel wavelength source. Wilcom also developed a dual laser source for both single-mode and multimode applications. The Model FS8514 offers laser outputs at 850 nm and 1310 nm with an output power level of -7 dBm, adjustable ±2 dB. Spectral width is less than 10 nm at 850 nm and 7 nm at 1,310 nm. Lasers integrated into a choice of ST, FC/PC or SC connectors are capable of launching into either multimode or single-mode fiber. The laser source also offers three selectable modulation frequencies of 270 Hz, 1 kHz and 2 kHz, which are useful for signal tracing tones.
Reader service #307

Descrambler

Motorola began a trial phase for its new HomeClear broadband video system, a cable TV device that provides centralized descrambling (+50 channels) for TV signals in the home and returns control of the TV set and VCR to cable subscribers. HomeClear is a 12 x 7 inch box installed on the side of a home. The system allows channels to be denied at the home, giving operators a way of tiering service levels.

Multichannel Communication Sciences based in San Diego, provided the key elements of the system with its broadband signal processing technology called OmniBand. The system provides all authorized analog signals in the clear and passes through all digital signals to enable deployment of lower cost digital TV decoders, which do not contain analog TV receivers or descramblers.
Reader service #306



F-interfaces

Recessed male F-interface connectors are now available from Bomar Interconnect Products Inc. a manufacturer of connectors and accessories for voice and data transmission. The connector is designed for use in applications where push-on plugs eventually erode the integrity of jacks threads. Bomar offers female/female F-adapters as well as adapters configured female F/TNC, female F/BNC, etc.
Reader service #305

BOOK SHELF

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.

☛ *Tap to TV: Strengthening the Weakest Link*—Robert Glass and Pam Nobles address the installer's function and career, covering training, service call reduction programs, bonding and CLI and fire code regulations in the context of cable material choices. (45 min.) Order #T-1102, $30.

☛ *Fiber-Optic Trunk Restoration*—Charles Mogray Jr., Dave Johnson and Ron Causey explore typical fiber faults that occur, as well as temporary and permanent repairs. They clearly cover topics such as site evaluation, damage assessment, repair/ restoration and what a typical restoration kit should consist of. (70 min.) Order #T-1103, $45.

☛ *A Look Back—The Birth of Broadband Communications*—Industry pioneers Edward Allen, Leonard Ecker, Kenneth Simons, E. Stratford Smith and Archer Taylor provide unique and entertaining insight into how our industry started and developed. (70 min.) Order #T-1105, $45.

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

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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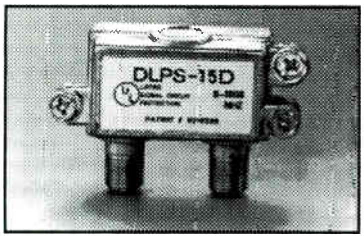

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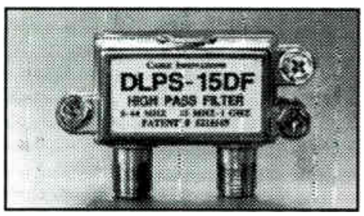

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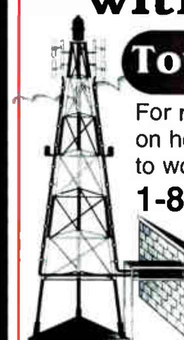

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B. Please check the category that best describes your firm's primary business (check only one):

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- 04. ☐ MSO (two or more Cable TV Systems)
- 05. ☐ Cable TV Contractors
- 06. ☐ Cable TV Program Networks
- 07. ☐ SMATV, DBS Operator
- 08. ☐ MMDS, STV or LPTV Operations
- 9A. ☐ Microwave
- 9B. ☐ Telecommunications Carrier
- 9C. ☐ Electric Utility
- 9D. ☐ Satellite Manufacturer
- 9E. ☐ Satellite Distributor/Dealer
- 9F. ☐ Fiber-Optic Manufacturer
- 10. ☐ Commercial TV Broadcasters
- 11. ☐ Cable TV Component Manufacturers
- 12. ☐ Cable TV Investors
- 13. ☐ Financial Institutions, Brokers & Consultants
- 14. ☐ Law Firm or Govt. Agencies
- 15. ☐ Program Producers, Distributors and Syndicators
- 16. ☐ Advertising Agencies
- 17. ☐ Educational TV Stations, Schools and Libraries
- 18. ☐ Other (please specify) ____________

C. Please check the category that best describes your job title: (check only one)
- 19. ☐ Corporate Management
- 20. ☐ Management
- 21. ☐ Programming

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- 23. ☐ Director
- 24. ☐ Manager
- 25. ☐ Engineer
- 26. ☐ Technician
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May

7: SCTE Great Plains Chapter seminar, installation troubleshooting, Bellevue, NE. Contact Randy Parker, (402) 292-4049.
7: SCTE Mid-South Chapter meeting, Installer Certification exams to be administered, Memphis, TN. Contact Kathy Andrews, (901) 365-1770, ext. 4110.
8: Society of Cable Telecommunications Engineers Satellite Tele-Seminar program, "Regulatory Issues," Galaxy 1R, Transponder 14, 2:30-3:30 p.m. ET. Contact Janene Martin, (610) 363-6888, ext. 220.
12-15: The Light Brigade training course for installers, maintenance personnel and engineer designers, "Fiber Optics 1-2-3: Installation, Design & Maintenance," Washington, DC, and Orlando, FL. Contact Lisa Johnson, (800) 451-7128.
14: SCTE Badger State Chapter seminar, safety, Fond du Lac, WI. Contact Vicki Marts, (316) 262-4270.
14: SCTE Ohio Valley Chapter seminar, BCT/E tutorial on Category V, "Data Networking and Architecture," Farborn, OH. Contact Dan McKay, (614) 236-1292, ext. 222.
14-15: Hewlett Packard's "Designing for EMC" training class, Dallas. Contact (800) 472-5277.
14-16: DTV: The Digital Television Forum, Santa Monica, CA. Contact Adam Abelson, (800) 647-7600, ext. 25.
15: SCTE Chesapeake Chapter seminar, preventive maintenance/headend-to-house drop, and BCT/E and Installer Certification exams to be administered, Bowie, MD. Contact Bruce Weintraub, (301) 294-7607.
15: SCTE Ohio Valley Chapter seminar, BCT/E tutorial on Category V, "Data Networking and Architecture," Pittsburgh. Contact Marianne McClain, (412) 531-5710.
15: SCTE Shasta/Rogue Chapter meeting, BCT/E and Installer Certification exams to be administered, Redding, CA. Contact Mike Smith, (541) 779-1814.
16: SCTE Dakota Territories Chapter seminar, upgrades, Wrangler, Mobrige, SD. Contact Tony Gauer, (605) 426-6140.
17: SCTE Cascade Range Chapter meeting, BCT/E Certification exams to be administered, Beaverton, OR. Contact Betty Reed, (360) 891-3295.
19-21: Society of Cable Telecommunications Engineers regional training seminar, "Technology for Technicians II," San Bernardino, CA. Contact SCTE national headquarters, (610) 363-6888.
20-21: Hewlett Packard's "Designing for EMC" training class, Denver. Contact (800) 472-5277.
22: SCTE Greater Chicago Chapter seminar, broadband architectures, Arlington Heights, IL. Contact Joe Thomas, (815) 356-6105.
22: SCTE Michiana Chapter seminar, BCT/E tutorial on Category V, "Data Networks and Architectures," New Buffalo, MI. Contact Russ Stickney, (219) 259-8015.
23: SCTE Oklahoma Chapter seminar, cable modems, Norman, OK. Contact Doug Huston, (405) 348-4225.
30: SCTE Wheat State Chapter meeting, BCT/E Certification exams to be administered, Great Bend, KS. Contact Vicki Marts, (316) 262-4270.

Planning ahead

Aug. 18-20: 1997 Great Lakes Cable Expo, Indianapolis. Contact show management, (317) 845-8100.
Sept. 15-17: ICSPAT/DSP World 1997, International Conference on Signal Processing Applications and Technology, San Diego. Contact Jennifer Call, (415) 278-5239.
Oct. 20-22: Eastern Cable Show, Atlanta. Contact Southern Cable Television Association, (404) 255-1608.
Dec. 2-4: Converging Technologies Expo & Conference, Los Angeles. Contact John Golicz, (203) 256-4700, ext. 121.
Dec. 10-12: The Western Show, Anaheim, CA. Contact the California Cable Television Association, (510) 428-2225.

June

1-5: Supercomm '97, New Orleans. Contact David Swanston, (703) 734-3300.

4: SCTE Great Plains Chapter meeting, BCT/E and Installer Certification exams to be administered, Bellevue, NE. Contact Randy Parker, (402) 292-4049.

4-7: Cable-Tec Expo '97, Orlando, FL. Contact SCTE special projects department, (610) 363-6888.

9-13: International Conference on Consumer Electronics, Chicago. Contact Diane Williams, (716) 392-3862.

10-11: SCTE Wheat State Chapter meeting, BCT/E Certification exams to be administered, Wichita, KS. Contact Vicki Marts, (316) 262-4270.

10-13: The Light Brigade training course for installers, maintenance personnel and engineer designers, "Fiber Optics 1-2-3: Installation, Design & Maintenance," Phoenix. Contact Lisa Johnson, (800) 451-7128.

11: SCTE Rocky Mountain Chapter seminar, powering/safety. Contact Hugh Long, (303) 603-5236.

12: Society of Cable Telecommunications Engineers Satellite Tele-Seminar program, "Digital Technology," Galaxy 1R, Transponder 14, 2:30-3:30 p.m. ET. Contact Janene Martin, (610) 363-6888, ext. 220.

12: SCTE Music City Chapter meeting, BCT/E and Installer Certification exams to be administered, Nashville, TN. Contact Ken Long, (615) 244-7462, ext. 319.

14: SCTE Llano Estacado Chapter seminar, construction practices, Lubbock, TX. Contact David Fielder, (806) 793-7475, ext. 4518.

18: SCTE Bluegrass Chapter seminar, digital, Elizabethtown, KY. Contact Max Henry, (502) 435-4433.

18: Smokey Mountain Chapter seminar, installation practices, and meters and leakage detection, Johnson City, TN. Contact Roy Tester, (615) 878-5502.

23-24: Society of Cable Telecommunications Engineers regional training seminar, "Introduction to Telephony," Chattanooga, TN. Contact SCTE national headquarters, (610) 363-6888.

24: Career Fair Coordinators Inc.'s high tech career fair, Austin, TX. Contact Ceilia Smith, (972) 462-8807.

25-27: Society of Cable Telecommunications Engineers regional training seminar, "Technology for Technicians II," Chattanooga, TN. Contact SCTE National Headquarters, (610) 363-6888.

July

8-9: SCTE Wheat State Chapter meeting, BCT/E Certification exams to be administered, Wichita, KS. Contact Vicki Marts, (316) 262-4270.

9: SCTE Great Plains Chapter seminar, HSD/wireline telephony, Bellevue, NE. Contact Randy Parker, (402) 292-4049.

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

10: Society of Cable Telecommunications Engineers Satellite Tele-Seminar program, in-premises wiring issues, Galaxy 1R, Transponder 14, 2:30-3:30 p.m. ET. Contact Janene Martin, (610) 363-6888, ext. 220.

14: Career Fair Coordinators' high tech career fair, Denver. Contact Ceilia Smith, (972) 462-8807.

16: SCTE Oklahoma Chapter seminar, telephony, and BCT/E Certification exams to be administered, Oklahoma City. Contact Doug Huston, 405-348-4225.

16: SCTE Piedmont Chapter seminar, interactive services and the how and why of Certification, and BCT/E Certification exams to be administered. Contact Tod Dean, Chapter Voice Mail: (919) 220-3889.

17: SCTE Chesapeake Chapter seminar, safety, and BCT/E and Installer Certification exams to be administered, Bowie, MD. Contact Bruce Weintraub, (301) 294-7607.

17: SCTE Greater Chicago Chapter seminar, installation—the last mile, Willowbrook, IL. Contact Joe Thomas, (815) 356-6105.

23: SCTE Badger State Chapter seminar, BCT/E tutorial on Category III, "Transportation Systems," Fond du Lac, WI. Contact Brian Revak, (715) 493-2605.

23: SCTE Rocky Mountain Chapter seminar, distribution/optical link performance. Contact Hugh Long, (303) 603-5236. **CT**

CABLE TRIVIA

By Rex Porter

Our historical guru (aka Editor Rex Porter) has provided us with these 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 February issue.)

Look for answers to this month's questions in a future issue (along with a new set of questions). The person supplying the most correct answers will be awarded a special Trivia T-shirt. You may only win once per calendar year.

To be in the running for a prize, your answers need to be postmarked or faxed to us by the 20th of the month of the issue date that the specific trivia test appears in.

The first person who sends in the most correct answers will be the award winner. Good luck!

Your answers need to be sent to: The Trivia Judge, *Communications Technology*, 1900 Grant St., Suite 720, Denver, CO 80203 or fax: (303) 839-1564.

Trivia #13 answers

1) Ed Allen
2) Warren Braun
3) Hank Cicconi
4) Ben Conroy, Jr.
5) Ken Gunter

Trivia #14

1) In 1954, the FCC granted the first common carrier microwave construction permit to:
A) United Video in Chicago
B) J. E. Belknap & Associates in Popular Bluff, MO
C) Valley Cable TV in Santa Maria, CA
D) AT&T in Casper, WY

2) The forerunner of the National Cable Television Association, the National Community Television Council, was organized at the Necho-Allen Hotel in:
A) New York
B) Pottsville, PA
C) Allentown, PA
D) Washington, DC

3) In 1970, the Federal Communications Commission allowed the merger of Teleprompter and H&B American. That meant Teleprompter, in 1970, would be the largest cable company in the country, serving 10% of the industry. Their subscriber total was:
A) 419,000
B) 256,000
C) 766,000
D) 936,000

4) Ted Turner's WTCG call letters stand for:
A) Worlds Tiniest Cable Group
B) Worlds True Communications Group
C) Watch This Channel Grow
D) Worlds Terrific Communications Growth

5) Channels featuring sports, programs for children families, women, minorities, etc., and aimed at specific interest groups, are usually known as:
A) Narrowcasting
B) Broadcasting
C) Multicasting
D) Imaging

6) In 1985, five cable MSOs purchased Teleprompter's parent, Group W. They were:
A) Storer, TCI, ATC, Century and Sammons
B) Storer, TCI, ATC, Comcast and Century
C) TCI, ATC, Comcast, Century and Daniels
D) TCI, Storer, ATC, Sammons and Daniels

And the winner is...

At press time, the winner for Cable Trivia #13 (which ran in the February 1997 issue) was not decided. Look for the winner's name to be published in a future issue of *Communications Technology*. **CT**

SCTE INSTALLER PROGRAM INFORMATION REQUEST CARD

The SCTE Installer Certification Program was created to establish minimum skill requirements for CATV installers and installer/technicians. Participants in the program must successfully complete practical examinations in the areas of cable preparation and meter reading, as well as a written examination on general installation practice. The program is being administered by local SCTE chapters and meeting groups under the guidance of SCTE national headquarters. All candidates for certification in the program are recognized as SCTE members at the Installer level, and receive a copy of the *SCTE Installer Manual*.

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By the National Cable Television Institute

Return signals in bridger amps: Part 1

This month begins a series on the return amplifier module in 450-550 MHz trunk/bridger amplifiers. Its purpose is to provide useful information complemented by training suggestions to reinforce the material in a classroom setting. The top portion is excerpted from a lesson in NCTI's System Technician Course. The hands-on training suggestions are modeled after NCTI's facilitator training courses for administering hands-on labs. © NCTI.

It is important to understand the operation of your system's trunk/ bridger amplifier(s) return modules, their controls and test points in order to quickly repair/replace any bad components or make any necessary adjustments to restore the return broadband cable data and RF signals to their proper operating levels.

A reverse amplifier module (Figure 1) amplifies the return frequencies (sub-split, 5-30 MHz; mid-split, 5-116 MHz; or high-split, 5-186 MHz), combines the return RF signals of the feeder(s) and trunk onto the same signal, and routes that signal to the trunk input port (Figure 2). These signals may be status monitoring, customer impulse pay-per-view buy signals and/or a return video carrier. Since reverse RF signals are lower in frequency and narrower in bandwidth than forward RF signals, there is less attenuation and cable loss at these frequencies. This means the reverse adjustments are more conservative compared to those made when balancing the forward RF path.

Figure 1: Scientific-Atlanta reverse amplifier module

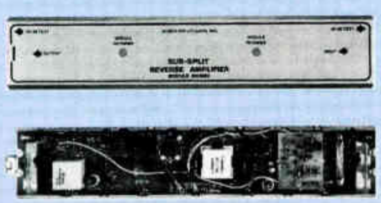

Figure 2: Return amplifier module in a Magnavox mainstation block diagram

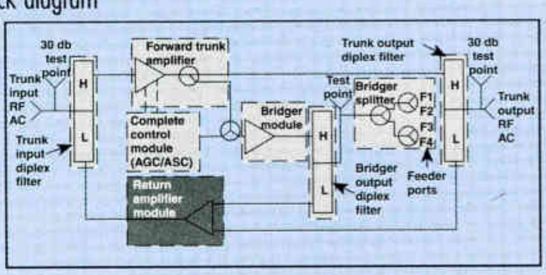

Figure 3: Block diagram of a C-COR return amplifier module

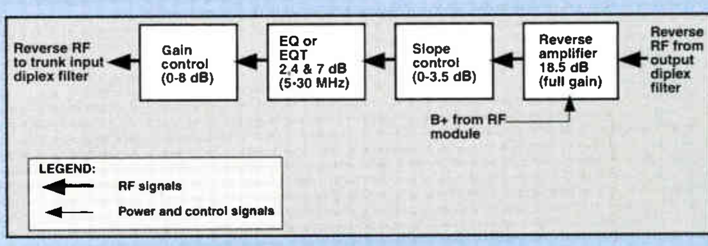

Figure 3 is the block diagram of a C-COR return amplifier module. This return amplifier module receives its input signal from the output diplex filter in the trunk amplifier module. The reverse RF signals are fed directly to the reverse amplifier and amplified by 18.5 dB (full gain). The output of the reverse amplifier is applied to the slope control, which is manually adjusted to vary the output slope by 0-3.5 dB. The signals then go to the equalizer (EQ) or thermal equalizer (EQT), where the slope is adjusted by 2-7 dB to a tilt value within the slope control's range. (During level balancing, the EQ/EQT is selected and inserted prior to "fine tuning" with the slope control.) These signals are then fed to the gain control where they undergo the final output signal level adjustment (0-8 dB). This adjusted output signal level is sent to the trunk input diplex filter and on to continue upstream to the next amplifier station.

Next month's installment will cover the controls, equalizers and attenuator pads used to adjust the return signals in 450-550 MHz trunk/bridger amplifiers.

Hands-on performance training

Proficiency objectives: *Identify the reverse RF frequency band used and the signal flow through the major components on a block diagram of your system's trunk/bridger amplifier(s).*

Provide each student with a block diagram of your system's trunk/bridger amplifier(s) and the specs for the return frequencies used.

Use the block diagram to show the return signal flow through the major components, while describing what each does and how it affects the signals in the amp's return path.

Verify that each student knows the return frequency band used and signal flow on a block diagram through the return path of your system's trunk/bridger amplifier(s), and can describe the functions of the major components. **CT**

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By Bill Riker

It's getting closer to Expo time!

The excitement is really building here at SCTE national headquarters as Cable-Tec Expo '97 draws near. By now, all Society members should have received their registration packages; many have already registered and are anticipating coming to the biggest and most progressive conference we've ever offered.

Cable-Tec Expo '97, which will be held June 4-7 at the Orange County Convention Center in Orlando, FL, is the industry's leading hardware trade show. Its unique format enables cable telecommunications vendors to interact with the field personnel who use their products on a daily basis. Conversely, Expo affords system operators the opportunity to ask questions about a particular product or service, and learn about new offerings. This is an educational event for exhibitors and attendees, not a sales-oriented show.

Events scheduled

Our 21st Annual Engineering Conference kicks off Expo '97 on Wednesday, June 4. The conference's general session has been reduced to four hours this year, rather than the full-day presentation of past years. This change allows for an additional three hours of exhibition time. While geared toward engineers, the Engineering Conference will address topics of interest to personnel at all levels of employment. Engineering leaders will explore current issues that impact our industry's future: from preparing for digital deployment, to cable modem technology, to product strategy.

Many of the Society's Engineering Subcommittees will meet at Expo '97 to develop technical standards. In addition to the SCTE Engineering Committee, groups planning to meet at Expo include our Data Standards, Design and Construction, Digital Video, Emergency Alert Systems, Interface Practices, Maintenance Practices and Procedures, and Material Management/Inventory Subcommittees. All SCTE members are urged to attend.

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

Immediately following the Engineering Conference, SCTE is hosting its Annual Awards Luncheon. Honors to be presented include SCTE Member of the Year, Chairman's Award and SCTE Hall of Fame. Recipients are recognized for their contributions to their industry, as well as their unceasing efforts to advance our industry through SCTE training, certification and standards. New senior members will be honored as seasoned professionals who meet the stringent requirements of their membership. Also, SCTE will award educational scholarship grants to industry personnel who show great potential for advancement. Our technical scholarship program gives tuition assistance to active national members who wish to further their knowledge of this industry through training. The Awards Luncheon will include a presentation of General Instrument's Milton Jerrold Shapp Memorial Scholarship, established in memory of the former Pennsylvania governor and founder of Jerrold Electronics. The recipient will be a high school student who is the child of a cable industry employee and has shown exceptional academic and personal achievement.

Of course, the primary purpose of Cable-Tec Expo is education. Ten technical workshops to be held on June 5 and 6 will provide "hands-on" demonstrations dealing with the proper design, operation and maintenance of broadband telecommunications systems. This unique scheduling will enable attendees to attend up to six of the 10 sessions. Topics for these interactive presentations include cable modems, quality audio in the headend, inside wiring options, return path problems and solutions, and surge suppression, fusing and "slugging."

In the Exhibition Hall on June 4, 5 and 6, SCTE will provide a Technical Training Center for exhibitors to demonstrate their products. A fiber-optic splicing demonstration area also will be available. You can receive training in the Philips Broadband trailer on the display floor. On June 5, 6 and 7, Broadband Communications Technician/Engineer (BCT/E) and Installer Certification testing will be available to members.

Exhibit hours

Based on attendee questionnaire results from Expo '96, and because of the show's growing popularity, we realized that attendees would need more time to fully examine the large number of informative exhibitions that are being presented. In response to attendee and exhibitor requests, this year's Expo has been expanded to feature 16 full hours of exhibits throughout the event. With more than 350 companies planning to exhibit at Expo '97, this schedule change was implemented to better accommodate everyone involved with the show. SCTE was one of the first organizations in the cable industry to offer a trade show with "exclusive" exhibit hours that didn't conflict with its training sessions.

Attendees won't want to miss the 1997 Expo Evening, June 6 at the Rain forest Cafe in the Disney Village Marketplace. The Society would like to thank Antec, CommScope, General Instrument, Philips Broadband and Scientific-Atlanta for sponsoring this special event.

I am greatly looking forward to this year's Cable-Tec Expo. From the pre-conference sessions on June 3 to the close of testing on June 7, it will be the most comprehensive program we've ever offered. I hope to see all of you in the "Sunshine State" next month. **CT**