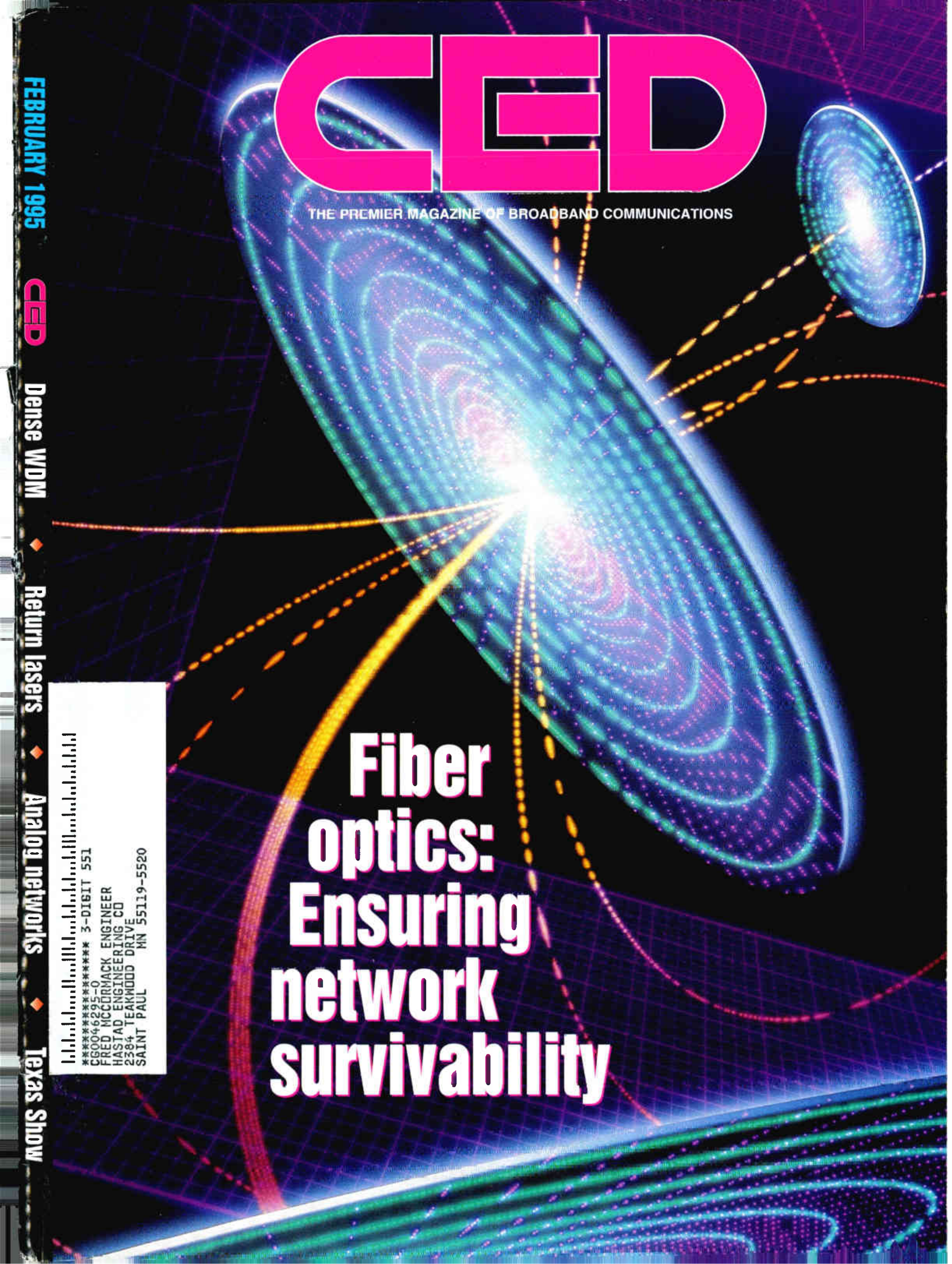
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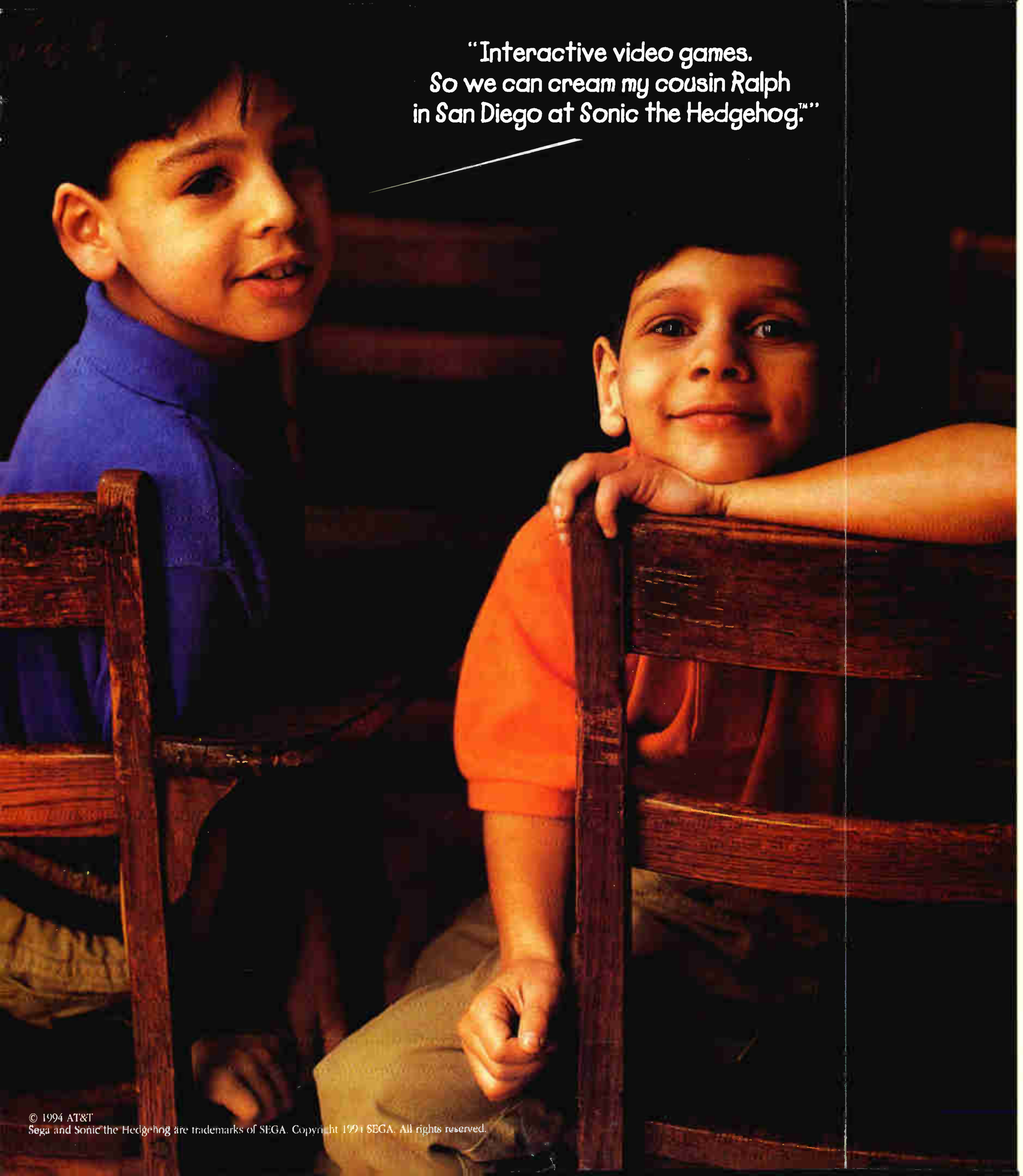

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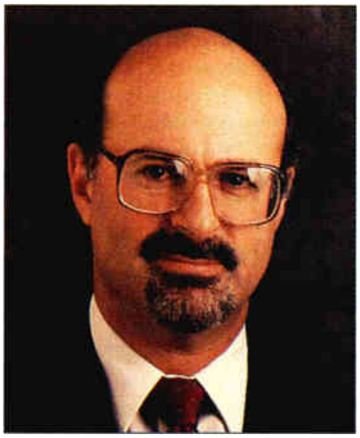
Further developments in location technologies



By Jeffrey Krauss, telecommunications policy guru and President of Telecommunications and Technology Policy

Several years ago, I wrote about emerging vehicle location technologies that cable systems could use to track their fleets of trucks. A new service is now on the horizon, to be provided as part of cellular and PCS services, because the FCC is requiring these services to support Enhanced 911 (E911). This new service could have far-reaching effects on the personal communications market.

FCC plans for E911

The number "911" is the nationwide emergency telephone number; with Basic 911 service, calls to 911 are routed directly to designated public safety agencies. With Enhanced 911 service, the calling number and the location of the caller are displayed for the call taker. But today, Enhanced 911 does not provide location information for cellular callers, because the caller's location is unknown.

In response to requests from public safety agencies throughout the country, the FCC is proposing to require cellular operators to provide caller location information for 911 calls. FCC Docket No. 94-102 is just a proposal right now, but it could be adopted as a rule in about a year.

Under the FCC proposal, wireless operators would have to begin providing some location information one year after the rules are adopted, and precise locations (to within 125 meters) five years after the rules are adopted. The timetable and the precision requirements could change, but the general policy seems certain to be adopted. And it will likely apply to all commercial wireless services.

This proposed FCC requirement, while intended to support public safety's needs, could have an impact far beyond that. Widely available wireless location services could have a major impact on the consumer personal communications marketplace in the next century.

Location technologies for wireless

The FCC has identified a variety of different location technologies that wireless operators might employ. The Commission probably will not adopt one of these as a standard, but will allow wireless operators to choose whichever location technology is best suited.

The potential technologies would require modifying either the wireless handset or the base station. For example, modifying the wireless handset to add a Global Positioning System (GPS) receiver would allow the handset to transmit its position back to a control center, but would raise the cost of the handset by about $300. And while GPS might be ideal for vehicles out on an open highway, GPS receivers don't work well in some urban environments, because they require a direct line-of-sight to the GPS satellites.

Techniques that add special equipment at wireless base stations can calculate location based on the signal received from the wireless unit. This calculation might be based on the direction of the received signal, or its strength, or its time of arrival. For example, precise direction-finding antennas could be installed at wireless base stations. Or the received signal strength could be measured at a number of receive sites. Or the time of arrival of the specially coded messages in the control channel could be measured. Time of arrival measurements, which are already proven as the basis for location services now operating in the 902-928 MHz band, appear to be the best candidate to achieve reliability and precision goals.

There are now more than 20 million cellular telephones in use, and this number is expected to grow to 32 million by 1998. It seems likely that wireless operators will choose location technologies that require special equipment at the relatively few base stations, rather than imposing additional costs on subscribers.

Communications system operators generally do not favor new FCC-imposed service requirements. But in this case, location service is a value-added capability that wireless operators can sell to customers. In addition to supporting more efficient operations for fleets of vehicles, it can provide a highly reliable stolen vehicle tracking service. As an incentive, insurance companies could give a discount to wireless subscribers.

Wireless operators could offer a "billing by location" service. In one example, a shopping mall operator could use this for promotional purposes, to pay the cost of calls you make while you are shopping at the mall.

And location service will also help to combat wireless phone fraud. Cloning of cellular phones is a serious and increasing problem. Calls from cloned cellular phones can be identified by analyzing calling patterns, but catching cellular pirates today is difficult because the pirate has unlimited mobility. A location system using technology at the base station could change this.

Other location services

Previously, I wrote about GPS-based services and time of arrival systems that operate in the 902-928 MHz band. The time of arrival systems (notably Teletrac, then part of Pacific Telesis, and now part of Airtouch) are tied up in an FCC proceeding, trying to work out spectrum sharing rules with other users of the 902-928 MHz band. This fight could go on for years.

GPS-based services are being offered by a few vendors. These require a mobile radio channel to send the location data back to a control center. Most commercial fleets already use private mobile radio systems, or they can lease airtime from a wireless data carrier like RAM or Ardis. But GPS-based services have not yet taken off in the marketplace. A location service incorporated into cellular and PCS systems would quickly dominate the market. CED

FCC's chief engineer promises action on digital standards soon

The Federal Communications Commission intends to begin a new proceeding soon on digital transmission standards for the cable industry, according to Richard Smith, chief of the FCC's office of engineering and technology. Smith made the announcement during the SCTE Conference on Emerging Technologies in Orlando, Fla. last month.

Cable engineers have reacted negatively to Smith's comments, complaining that the industry has already been the Commission's whipping boy for the past year or two. Others expect any proceeding on digital standards to slow down the rollout of new digital systems, which has already been hampered by the lengthy MPEG standardization process.

Specifically, Smith said the planned proceeding will "encompass standards for all video communications media, including cable, video dialtone and direct satellite broadcasting" and will include "standards for digital compression and a standard security interface system."

This latter point is likely to be problematical from a cable operator's point of view. Technologists have long argued against any security standard because of the possibility for piracy or broken codes. Even "renewable" security is considered by many to be risky–and expensive. Any type of national standard on security will likely run into opposition from the NCTA and others unless a method to protect services can be developed.

But the real issue will be over the timing of any new standards and how they may affect planned digital roll-outs by both cable operators and telephone companies. Smith said the Commission is aware of these timetables and wants to avoid unnecessarily impairing the development of new cable digital technologies and services.

"We are also aware that some in the industry are moving toward implementing digital transmissions relatively soon," said Smith. "I would caution these parties that we do intend to address digital standards, and they should pay careful attention to our schedule and actions in any decisions they might make . . . that might conflict with the standard we ultimately adopt."

Furthermore, the FCC intends to monitor the technologies MSOs will use to deploy telephony, Smith said. "This matter is a little farther out on the horizon, though, and we really haven't looked closely at the specific technical issues we will have to examine."

Zenith, AT&T partner on interactive device

Zenith plans to integrate the AT&T TV Information Center into its TVs and analog set-tops beginning in 1996.

Zenith Electronics plans to integrate new circuitry in its TVs and analog set-tops that will decode and display digital information provided by AT&T Consumer Products, it was announced last month at the Consumer Electronics Show.

AT&T intends to launch its TV Information Center in the second quarter of 1995. Its goal: to deliver information such as telephone messages, local traffic and weather, headline news, banking info and daily stock updates over the most ubiquitous display in the United States, the television screen.

AT&T will offer a standalone device for consumers for $329 within the next three months to customers in the Northeast, with rollouts to other parts of the country coming later. Zenith intends to integrate the technology into its products by 1996. According to a Zenith spokesman, the cost to integrate the technology into TVs and set-tops has yet to be determined, but executives have said publicly it will be under $100.

The system, developed by AT&T's Bell Labs, delivers voice and text over telephone lines to the in-home box. The box is then connected to the TV, which displays the desired information. The unit contains an AMD 29200 microprocessor and an AT&T DSP 16 chip developed by AT&T Microelectronics. It features a 2400 bits/second modem and more than 1 megabyte of DRAM flash memory. It can store up to 20 minutes of digital voice messages.

"This brings all the consumer's messaging needs to one spot," said an AT&T spokesman, who said this product is the first of a family of intelligent home devices the company will introduce this year. Additional products will be able to display messages on a PC or directly on a screen built into a telephone.

Al Moschner, Zenith's president and COO, said the alliance will help position the TV as the interactive appliance in the home. "Zenith is preparing for the indisputable digital future, but . . . we are aggressively working to offer appealing interactive services within the current analog world."

Time Warner unwraps Full Service Network

With much media splash, Time Warner launched its interactive Full Service Network in Orlando last December, giving the world a glimpse of the capabilities of the world's most powerful–and probably most expensive–broadband network. Time Warner Inc. Chairman and CEO Gerald Levin proclaimed, "The network's breakthrough architecture makes true video on demand a reality for the first time. With digital interactivity, consumers are in total control of the programming they bring into their homes."

Jim Chiddix, senior VP of engineering and technology with Time Warner, and Levin demonstrated the capabilities of the FSN. Using the Carousel navigational system, the two put the FSN through a number of acrobatic maneuvers, including ordering up the movie, "The Specialist," pausing it, ordering up "The Client," then entering the interactive shopping mall on the network to order products from the Warner Bros. Studio Store and the U.S. Post Office, as well as playing gin rummy across the network with an FSN test family. Returning to the "movies" venue, the two canceled their second movie selection and returned to their original choice, "The Specialist," which was still paused at the same scene. Whew.

Executives from several of the primary technology partners in the network were also on hand to discuss their participation in the FSN. Silicon Graphics Chairman and CEO Edward McCracken, whose company contributed the system software, Carousel navigator and media servers, among other pieces, commented on the speed necessary to support interactivity. "On the FSN, you can send a

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command from the remote to the cable headend miles away, and return it back to the set-top–in the same time that a standard remote takes to reach a typical cable box."

Scientific-Atlanta Inc. President and CEO James McDonald announced that the FSN is "the first implementation of MPEG-encoded and compressed video information using an ATM transport." S-A's contributions to the project included manufacturing the set-top terminal, in conjunction with Toshiba, as well as providing headend and distribution electronics.

In addition, Time Warner conducted tours of the Network Operations Center–the nerve center which houses the servers and switches that deliver the content–as well as the Digital Production Center, where promotional materials are created, and movies are digitized for the network. Event attendees also had the opportunity to visit "The Home of the 21st Century," where they could pick up FSN remotes and interact with the network.

TCI, Microsoft form on-line partnership

Tele-Communications Inc. jumped into high-speed, interactive computing by investing $125 million into Microsoft Corp.'s newly-formed On-line Services Partnership. The partnership, which will be 80 percent owned and wholly operated by Microsoft, will control the assets and cash flow of the computing giant's planned on-line service, The Microsoft Network. TCI's Technology Ventures group will own the remaining 20 percent. Executives with both companies said the partnership is non-exclusive and does not preclude TCI from delivering other on-line services, such as America Online, Prodigy or CompuServe.

The Microsoft Network, which will launch as part of the company's forthcoming Windows 95 software, was announced in November and includes applications such as electronic mail, Internet access and home shopping.

Through the partnership, Microsoft hopes to harness and use the high data rates inherent with broadband cable networks. Initially, however, the Microsoft Network will use standard, dial-up telephone lines to connect home PCs to data content, with plans to hook up the first broadband users sometime in 1996. According to Microsoft, the technology necessary for delivering on-line services over cable TV networks is still being developed.

Specifically, the technology under development includes high-speed cable modems and the associated headend interfaces, with signals ultimately routing to Microsoft's central operations center.

Separately, TCI and Microsoft's Advanced Consumer Technology group are involved in an interactive television project near Microsoft's Redmond, Wash. campus, and although the two companies have openly expressed an interest in high-speed computing, the initial plans call for a television offering only.

Sun expands effort into digital video

Sun Microsystems has significantly expanded its efforts to develop digital video solutions for both program providers and network operators over the past several weeks, including a new joint venture with LSI Logic and the David Sarnoff Research Center to develop MPEG-2 encoding systems, and a new interactive TV product from its alliance with Thomson Consumer Electronics.

Several weeks ago, Sun joined a consortium with Scientific-Atlanta and Siemens Stromberg Carlson to develop end-to-end video networks.

The agreement with LSI and Sarnoff calls for the group to develop a real-time MPEG-2 encoder based on Sun's SPARCstation 20 workstation in time to begin shipments in the summer of 1995. The group expects the encoding system to cost about $50,000, or half the cost of systems currently available.

Sarnoff will bring its expertise in algorithm development and television technology, while LSI offers its CoreWare design methodology to develop a chipset based on a scalable architecture for a variety of compression applications.

Separately, Sun announced last month at the Consumer Electronics Show that its alliance with Thomson has resulted in a new operating platform for interactive TV, called "Open TV." According to company executives, Open TV allows cable operators, telcos, satellite networks and others to download interactive applications to set-top decoders through their existing networks, then use the return path of the set-top to provide full interactivity.

The Open TV software has been designed to work on a range of set-top systems and can be deployed on broadcast or ATM-switched networks, company officials said. It is based on commercially available products and is available now.

CableLabs to spend $13.1 million in '95

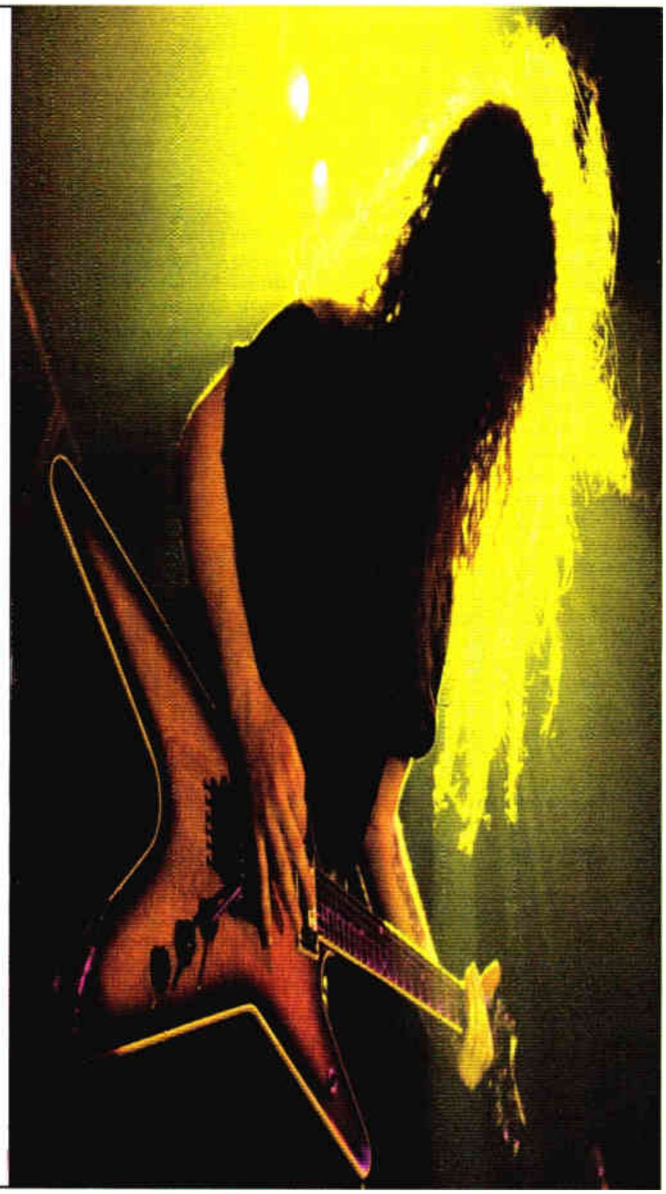
Cable Television Laboratories (CableLabs) will increase its spending by about $500,000 to $13.1 million in 1995, and will increase its staff from 50 to 61 persons.

The 1995 CableLabs budget calls for the Louisville, Colo.-based research and development consortium to spend $9.5 million in operations, $2.9 million in R&D projects and $700,000 in capital equipment. The R&D project pool is apportioned throughout the year for non-overhead projects with funding based on approval by the CableLabs project planning process.

The additional funds will allow CableLabs to hire several experts, including an RF and digital signal processing engineer, a video and telephony engineer and a vice president for network architecture and design development, all of which are positions that went unfilled in 1994. Other new positions include a membership services representative, a director of operations engineering projects, two MPEG software engineers, three administrative assistants and a senior adviser.

Jottings

General Instrument has contracted with **Probita Inc.** to jointly explore and develop "level 1" gateway solutions for interactive video network providers. Such solutions will manage interaction among set-top terminals, video servers, headends and optical nodes in real time. Level 1 gateway software will control the switch fabric, much like a telephone central office switch. A Level 1 gateway is defined as the connection between consumers and information providers. It coordinates all elements of the transport and access networks, making it possible for multiple hardware manufacturers to interoperate . . . **CableLabs** hosted the first meeting of the Cable/IT Convergence Forum during last month's ComNet '95 trade show in Washington, D.C. During the meeting, CableLabs officials were to discuss the role of the Forum, which is to bring vendors of computer and communications equipment to the cable industry by educating them about the industry, its capabilities and long-term strategies. Forum members currently include IBM, Digital Equipment Corp., Cisco Systems, Bay Networks and Apple Computer . . . Meanwhile, **Scientific-Atlanta** hosted a meeting last month of the Digital Audio-Video Council (DAVIC), which is leading the drive toward global open standards for interoperable, end-to-end digital video communications systems. Created following the development of the first MPEG standard, DAVIC is composed of more than 100 companies representing cable, telephone, computer and consumer electronics companies. . . CED



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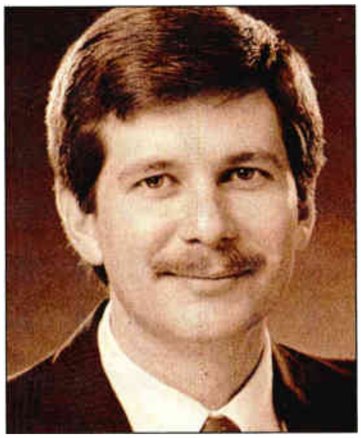
The further adventures of Eng



By Dana Cervenka

Beneath the calm, "I am a responsible adult" exterior of David A. Eng lies the Robin Williams of the cable industry–just waiting to leap out and pounce on any unsuspecting person he engages in conversation. Whether the Norwegian Eng is talking about a recent trip to Japan–"Eng-San, you're not Japanese!"–or lapsing into his ultra-oily radio announcer schtick to describe his trepidation at building the lab for CableLabs from scratch–"I was scared in a professional, yet technically intimidated, way"–he is apt to bounce off of any wall, at any moment.

The first of many firsts

Eng's sense of adventure has served him well, as it has freed up his imagination to enrich his professional life. His journey to his present position as manager of technical services with Cable Television Laboratories Inc. began because, rather than fearing the unknown, he joyously embraced it. As a student at Southwest State University in Marshall, Minn., Eng decided to spend one of his Christmas breaks by helping to wire the dorm rooms for cable, hooking up a small system for the college. That experience inspired him to apply for a job with his local cable franchise, Dowden Cable Systems, though his knowledge of the technology was almost nil.

"They said, 'Here's a pile of books. We'll see you in two weeks'," recalls Eng. " 'Go find an office, a headend site, finish the mapping, start the permit process. Crews will be in town in about a month, and the equipment will be arriving in about a week. Oh, and by the way, since you don't know cable construction, you need to work with the crews, because you are supervising them'." Eng, however, was soon climbing poles and hanging strand with the best of them. Though it was only meant to be a summer job, cable had gotten into Eng's blood, and he went to night school to finish his degree in electrical engineering. While working at Dowden, Eng established one of the first school interconnects, tying four schools in southern Minnesota together to provide them with eight hours of cable classroom programming.

After Dowden sold out to another concern, he made the move to Rogers Communications in Minneapolis as the manager of technical services. During his tenure there, he was responsible for completing the company's first fiber optic link–from Minneapolis to Eden Prairie. By the time Rogers was sold off to KBLCOM, Eng had become director of engineering. His first project with the latter was putting an FM fiber trunk between two headends, to consolidate them. That was in 1988. And then came CableLabs.

Once again, Eng was called on to do things he'd never done before. In 1990, "I was hired to build the lab at CableLabs," says Eng, "and it was an empty room with a pile of benches in it."

"I was the lab guy, the technical guy, one of two cable guys, and I also had to do the computer and phone systems," he continues. Not only that, but he was also responsible for building the CableLabs headend, defying convention in his design, utilizing open relay racks and a Siamese headend cable. "It was okay to ask 'why?' at CableLabs," notes Eng. "You didn't always have to think inside the box."

That's not my phone–it's my coat!

While working with the consortium, Eng has been involved in projects ranging from testing various compression schemes, to completing a study on 4 x 3 pictures shown on a 16 x 9 high definition screen, to testing telephony over cable. The latter was done in the days before it was politically correct for cable to hint at any interest in telephony. "We would do testing and literally hide the equipment under lab coats and other things," he recalls. "People would walk into labs and labcoats would be ringing."

In yet another first for Eng, he was put in charge of a digital compression demo in Montreaux, Switzerland. The demo took feeds off a satellite, and transported them from one area of the hall to another. Unfortunately, Eng was also dealing with European powering on American equipment, as well as floating grounds. "A slight electrocution thing happened, but it was only 90 volts," he grins.

After Montreaux, Eng and his team completed the technical design for the consortium's new building in Louisville, Colo., and then moved on to the CableNET project. As a systems integrator, Eng's task was to work with 45 vendors who hadn't necessarily worked together before, and who represented the cable, telephony, data and computer industries.

As you might expect, Eng's "why not?" philosophy carries over into his personal life. He has been known to scream down Colorado ski slopes on his mountain bike, and in his younger days, took part in motorcycle hill climbs. He and wife Anne have four young children: three boys and a baby girl. In his "spare" time, Eng also serves as the committee chairperson for a Cub Scout pack, and as the chairman of a committee at his church which is charged with selecting a new pastor (would you let this man be your spiritual guide?).

What's next for Eng professionally? Working with several departments at CableLabs on testing arising from the group's telephony RFP, as well as doing MPEG-2 conformance testing.

Clearly, Eng loves his work. "I've never been bored at CableLabs," he declares. "It's interesting to have one foot in reality, one foot in the future, and to be able to go between the two." CED

The new Congress and the cable industry

By Wendell Bailey, VP of Science and Technology, NCTA

In 29 years, one can learn a lot about a particular town. If your town was Washington, D.C., as mine is, you would probably learn more than what is good for you.

A case in point: the November elections, which shocked a lot more people than just President Bill Clinton and (then) Speaker of the House Tom Foley. They shocked a lot of us who toil in the vineyards, so to speak.

It's not that those of us who watch Congress and other politicians are not capable of making a better-than-average guess about the outcome of a midterm election; in fact, we're usually pretty good at those. It's just that absolutely no one in Washington would have placed even a modest wager on the possibility that the GOP (for "Grand Old Party," or Republicans) would capture control of both houses of Congress. Lest you think that we in the Washington business don't have Democrats as friends, rest assured that we do–and more than just a few.

So, the people spoke. Pundits and pretenders alike were surprised, and dare I say it, somewhat pleased. A lot of business leaders were pleased, because traditionally, they have believed that Republicans were more favorably disposed toward letting business people do business.

With increased competition coming after cable systems in the form of DBS, MMDS and video dialtone (the fake cable systems proposed by the RBOCs), the cable industry needs flexibility to meet these challenges. Unfortunately, that flexibility is something that the 1992 Cable Act and its implementation by the FCC took away from us.

The lessons imposed by this type of heavy-handed micromanagement did not go unnoticed, even by the members of the democratically-controlled Congress of pre-November.

But, while that body (the one that passed the Act, even over President George Bush's veto) made many public and private comments about the intrusiveness of that regulation, there was little in the way of a concrete acknowledgment that a wrong would or could be righted.

Careful what you wish for

So a fair question to ask of those who work in Washington on your behalf is this: Exactly what is the new Congress going to do? Speaking as one who was surprised by the results of the election, I am a little hesitant to claim that I know precisely what it may do, or even, for that matter, what we would like it to do.

This question of what we would have it do is a complex one. While we might all wish foroutright repeal of the Act and all of its evil offspring, this is not likely to happen. Even generally pro-business congressmen and women think that some of the criticism of the cable industry was deserved, and that some parts of the law were helpful in addressing those points

They do, however, feel that the regulatory detail was excessive, and that some of the most onerous regulations should be repealed. The trick, therefore, is to figure out what we want most, if it's a given that we can't undo the original deed in total.

I personally would vote for someone to talk about three areas that directly conflict with one another: the anti-buy-through rule, the must carry channel selection rule and the anti-scrambling portion of the compatibility rule. As anyone who may have thought through the ramifications of the simultaneous applications of all three of these rules has surmised, they cannot all co-exist in the form that the authors had in mind.

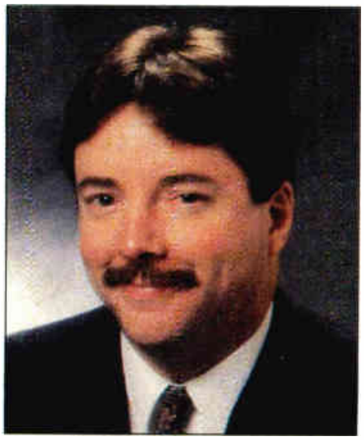
One of the problems that led to this conflict is that legislation is not a well-organized effort. I don't mean to suggest that the process that we all learned about in grade school civics class is not well documented and well understood. It's just that those well-known steps undergone by a piece of legislation do not reveal the underlying work of dozens of people who have their hands in the language that will ultimately yield law. These unheralded authors come at the project from several different points of view. Their expertise is, as you would imagine, in the area of government policy, and not in the area of technology. They nonetheless not only write words that make it into the final law, but they convince their bosses (the elected ones) of the correctness of their rules on the issue.

The result is that a law is actually not a monolithic thing. The Cable Act, as an example, had 24 separate proceedings that it called on the FCC to implement, and the FCC took them on (in some cases) as standalone issues. The result of all of this is complicated rules that do not accomplish what the original authors intended. What they do accomplish is frequently in conflict with something else that is contained in the law.

So, if we are to figure out what could be done to the 1992 Cable Act, we will have to be careful in analyzing which pieces should be revisited. As an engineer, I have my choices–and cable executives have theirs.

The ones that are the most talked about are the rate regulation rules. They not only are complicated, but they seem to have been aimed at a few bad actors and to have wounded all cable systems. These rules seem particularly unfair when you consider that this is an industry that was built with private money to provide a discretionary service to the public.

But what exactly would we all do if the rate regulation rules were deleted? Raise rates? Add new services? My guess is that the cable industry would begin a new cycle of growth in programming and technology-based services that would be like nothing ever seen before. Let's hope we all figure out our plans while ears sympathetic to American business are still in power in Washington. CED



Industry's future depends on its people

As the cable TV industry's technology futurists stir up new excitement over how a broadband network can support telephone, high-speed computing and interactive TV, there's a renewed urgency to re-engineer the traditional cable TV network.

System designers are exploring methods to build in reliability, fault tolerance and telemetry–all crucial elements to a system that achieves the magic 99.99 percent signal reliability figure dictated by Bellcore.

For example, Cox Cable Communications Inc. recently unveiled its new "Ring-in-ring" architecture that promises to reduce outage time to less than five minutes per subscriber per year. Similar efforts are underway in the large, urban systems owned by progressive MSOs who believe telephony will be the next great revenue stream.

But as Ted Hartson, the Post-Newsweek engineer and witty industry observer, noted during last month's SCTE Conference on Emerging Technologies, there is perhaps too much emphasis on the hyperbolic future and not enough effort being put forth today to deliver the product the industry was founded on–improved video.

Hartson says that there are too many systems that barely pass the technical tests, and not enough emphasis on training. These are not sexy issues, nor are they subjects the CEOs want to discuss. But it's time for things to change, says Hartson, because this is probably the last opportunity the industry will have to get things right before competition comes calling.

If Ted's right, and I suspect he is, cable system operators have maybe a year or two to improve customer service and their reputations before they run the risk of losing marketshare and being relegated to also-rans.

Indeed, the cable industry has come far in the past few years. In Colorado. you can often get cable installed in a new house long before the telephone company shows up. Customer service has improved dramatically. But there are still too many customers who are given lousy pictures and are expected to pay for them, and too many who can't get service when they need it. Installs all too often have to be done more than once, and the weather knocks out the signals more than it should.

Cable operators will soon have a great opportunity to compete against the telcos for residential and business voice services. But can an industry that has depended on techs who were short on education but long on desire follow that same model when it comes to telephony–or is there a reason why the telcos employ far more people than a comparable cable system? Are the MSOs ready to invest heavily in new, ongoing training programs? Is the industry willing to pay its front-line people more money and demand a higher level of education? Can they do all that and still be the low-cost provider of voice and video?

Technological innovation accomplishes only so much. In a competitive world, it's the human factor that often makes the biggest difference. Homeowners want to be treated fairly, have their questions answered quickly and expect high-quality service in exchange for their dollars and their loyalty. The time is now to set those wheels in motion.

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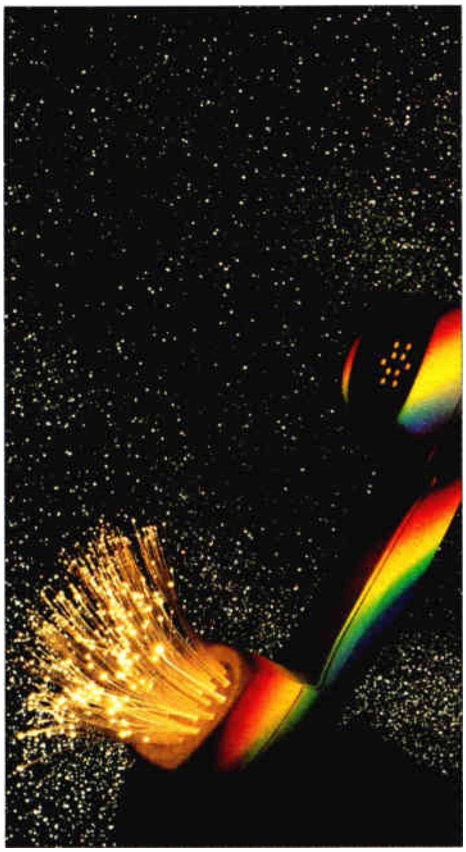

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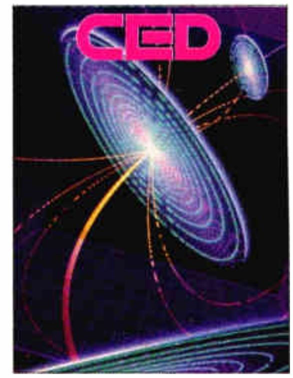

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Hot idea.

Circle Reader Service No. 4

The great drop cable conspiracy

By Chris Bowick, Group Vice President/Technology, Jones Intercable

For as long as I can remember, there has been a standing joke in the cable TV community about the amount of drop cable consumed every year. Ask almost anyone where it all goes, or how the industry could possibly be using so much drop cable (it seems to our bosses that we replace every drop every year), and you might get any number of different reactions: from a simple shrug of the shoulders to finger-pointing at the ever-growing rodent population. Those who don't know, however, usually have a theory they will happily share with you, and those who don't care usually say something like, "Look, drop cable is only about three percent of my capital budget, so it's not my biggest problem. Ask me about something that's important!"

It's interesting to note, however, that those who are true believers in the popular rodent theory also tend to believe that the correlation between the increase in the rodent population and the increase in drop cable usage patterns is not purely a natural occurrence. The belief, instead, is that the drop cable manufacturers, along with their suppliers, have conspired to create top-secret "super rodent" breeding grounds in which various species of rodents with brand loyalty, huge teeth, jaws of steel, and an insatiable appetite for drop cable are bred by the zillions and strategically released under the cover of darkness.

'The choice of the discriminating rodent'

This is done either on a quarterly basis, or whenever the manufacturers have fallen behind their revenue projections and need to "meet their numbers." This, the believers contend, is the reason drop cable usage patterns, signal leakage and outages all seem to be tied together, tend to be cyclic in nature, and tend to track the phase of the moon as well as the 11-year sunspot cycle. There must be some truth to this, since we all know that rodent breeding patterns are significantly affected by the phase of the moon.

I've heard that it's not especially difficult to breed rodents having big teeth, jaws of steel and an appetite for drop cable–the difficulty is the in-breeding of brand loyalty. It's my understanding that this has gotten to be a very competitive issue among the drop cable manufacturers. No manufacturer, after all, wants to breed a rodent that is especially fond of another manufacturer's drop cable. Since the manufacturers know that we MSOs are creatures of habit and will replace rodent-eaten drop cable with similar product from the same manufacturer, they tend to favor the breeding of brand-loyal rodents to increase their drop cable inventory turns, manufacturing efficiency, and thus their profits.

If we believe this theory, one obvious solution is to simply replace drop that has obviously been devoured by a rodent with cable from another manufacturer. Unfortunately, if we do this, then the manufacturers will quickly re-engineer the rodent-breeding process and focus on a more generic rodent.

When questioned, of course, the manufacturers deny any such covert operations. They all seem to agree, however, (with smirks on their faces) that, "It's a great idea. I wish I had thought of it, and it certainly deserves some further investigation."

I did speak with one manufacturer who seemed baffled by it all, was completely caught off guard, interrogated me for hours on the intricacies of the theory, wrote down every word and finally walked away mumbling something like, "No wonder my market share is so low. There must be something to this brand-loyal rodent-breeding thing. This could be my ticket to fame and fortune! Maybe we should build our first breeding facility through a regional interconnect with the New York sewer system! Hell, why stop at a regional interconnect–we could even create a national rodent superhighway, or even an underground, international rodent-breeding infrastructure."

The last I heard, this guy presented the concept to his company's board of directors, and when they didn't buy it, he quit his job to set up an international consulting company specializing in the breeding of brand-loyal, big-toothed, steel-jawed rodents. I wish him luck! He's a dreamer and will go far. Come to think of it, because the rodent population seems to be brand-loyal, and because this consultant's old company is the only one without a brand-loyal rodent-breeding program in place, wouldn't it make a lot of sense for us to replace all of our rodent-eaten drop cable with cable from this particular manufacturer? Rodents wouldn't touch it (none are loyal to this brand), and it would therefore reduce our problems with signal leakage and outages. I think we might be on to something!

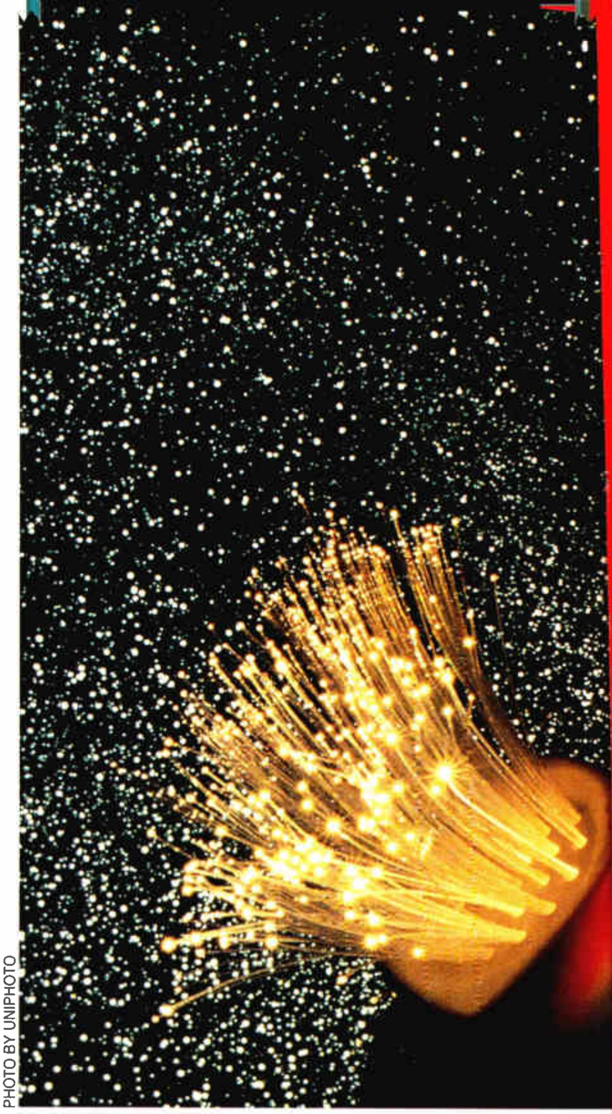
The brand-loyal rodent theory is just one of many possible causes of drop cable usage. (If you have a better theory, I'd like to hear it.) Because this has baffled us for years, a couple of months ago, Tom Elliot of TCI and I commissioned a joint study on drop cable usage patterns, and the results are in–sort of.

The answer isn't really a mystery at all, but includes a large number of factors, including waste, weather, rodents (this theory will never die), in-home cabling trends, standardization of drop type, the amount of subcontractor and building contractor activity, and the "commodity" nature of drop cable and its subsequent treatment as such by the MSO community.

If this subject has baffled you over the years, then stay tuned. If not, then stay tuned anyway. Word is getting around to upper-level management about this brand-loyal rodent thing, and we're all going to need the facts if we're ever going to have a chance of quashing this ugly (but is it true?) rumor. CED

Rings, clamshells and spurs

Fiber architecture reliability



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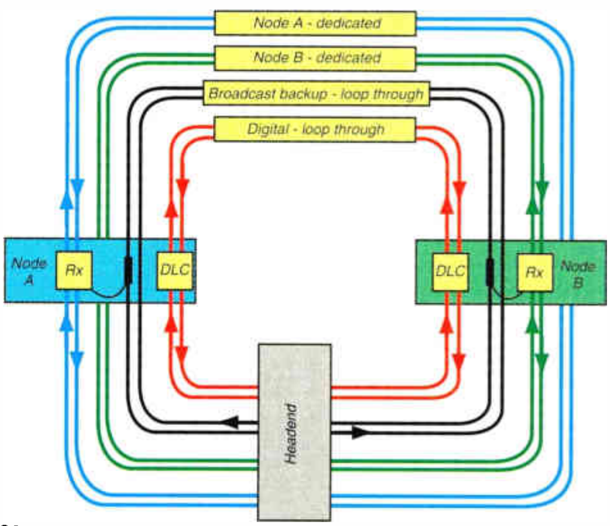
Editor's note: This article is adapted from a paper originally presented at the 1994 Western Cable Show.

By Cox Communications Inc. Corporate Engineering staff

Cox Communications Inc. has developed a new fiber optic network design known as the Ring-in-Ring architecture, which utilizes a radically different design concept. The Ring-in-Ring architecture provides significant improvements in reliability, flexibility and capability over existing non-ring networks. Cox believes the current practice of "tree-and-branch" or "star-bus" homerun fibers to the node will not provide the competitive edge needed to successfully provide future communications services.

Applications such as Plain Old Telephone Service (POTS) with emergency 911 capability must be extremely reliable. This level of reliability is difficult, if not impossible, to provide using homerun fibers or star topologies due to such things as backhoe cuts, torn-down utility poles or even house fires. A Ring-in-Ring fiber network not only offers a solution to improving reliability, but also offers the benefits of a multi-featured flexible architecture. The best news is that even with these qualities, the cost of Ring-in-Ring compares favorably with star networks having eight fibers serving a 1,000- to 1,500-home node.

Figure 1: *Two node ring-ring schematic*



Overview

At issue is a cost-effective architecture which has great flexibility in overcoming capacity constraints (both physical and interference induced) and the capability to serve a variety of unique applications having their own technical and reliability requirements.

Because the applications define the requirements of the architecture, it's necessary to assess the requirements of these service applications before going further. Initially, this task seems daunting, when considering the vast number of possible services and their unique requirements. Adding to the dilemma are the unknown future services and their requirements.

However, when analyzing the various services, it can be noted that most of these services can be generally grouped or classed according to their technical

requirements. As a result, Cox discovered it was more convenient to develop an architecture defined by the requirements of three distinct classes of applications than it was to address application requirements on an individual basis. These classes include:

Lifeline. Lifeline refers to a Bellcore standard for telephone services that establishes the average customer outage time at less than 53 minutes per year (which relates to a system availability of just under 99.99 percent annually). This particular standard applies specifically to telephone services. However, in this case, it can also serve as a level of service or class example for other services requiring at least this level of reliability.

Broadcast. These services originate from the headend and are distributed uniformly among all nodes and customers. These are the traditional analog or digitally compressed CATV signals.

Targeted services. These services are intended for customers served out of selected nodes, or services to be delivered to specific customers. Examples of services falling into this group include advertising (using local avails) and video on demand (VOD).

The basic concept of the architecture could be described as a ring within a ring, hence its name. One ring is a dedicated ring in which fibers originate at the headend and run to each individual node over diverse routes. The second ring is a continuous "loop-through" configuration which rides piggy-back on the dedicated ring. The loop-through ring begins at the headend but does not terminate at the node. The fibers in the loop-through ring pass through each node around the dedicated ring and continue from one node to the next around the ring, ending back at the headend.

The dedicated ring

The dedicated ring provides the broadcast and targeted services directly from the headend to the node, as well as possibly transporting reverse signals from the node back to the headend. The initial number of dedicated fibers designed to serve the node is a matter of choice. With some limitations, the absolute minimum number of fibers that could be run to the node and still support all three classes of services is one, provided backup is available in the loop-through ring (to be discussed shortly). For each additional fiber in the dedicated ring, the fiber network can support an additional node, should subdividing the initial number of homes passed be required.

The Ring-in-Ring architecture requires a minimum of four dedicated fibers–two fibers from the headend to the node, and two fibers for the return signals. Initially, the dedicated downstream fibers will carry both traditional analog and digital signals, while the upstream signal will be carried back to the headend on a dedicated upstream fiber. Later, if it becomes necessary, wave division multiplexing (WDM), or bi-directional couplers may be employed to carry both the upstream and downstream signals on one fiber. This would free two fibers which could be used to serve another node or carry other signals.

The Ring-in-Ring architecture requires a minimum of four dedicated fibers.

The loop-through ring

The loop-through ring consists of two sets of fibers. The first two fibers are being added to facilitate the potential deployment of Digital Loop Carrier, Sonet add-drop multiplexers or similar transport hardware which can multiplex many subscriber communications paths onto a single, high-speed digital signal. This also reduces return path problems caused by interference sources by separately terminating the coaxial distribution feeds and converting them to digital signals. Supporting the DLC requires two fibers into and out of

Figure 2: A two-fiber bi-directional ring

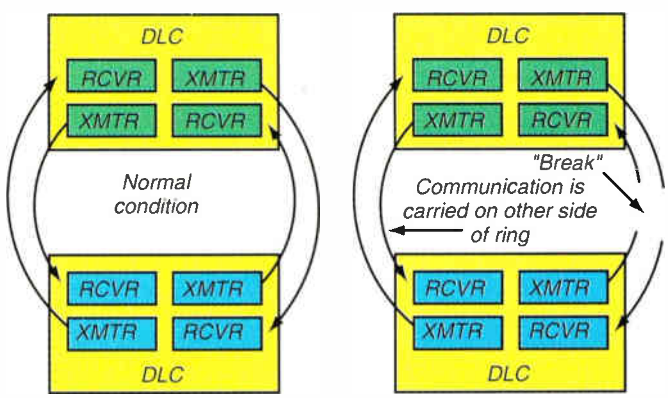


Figure 3: SONET Digital Loop Carrier. Possible equipment configuration

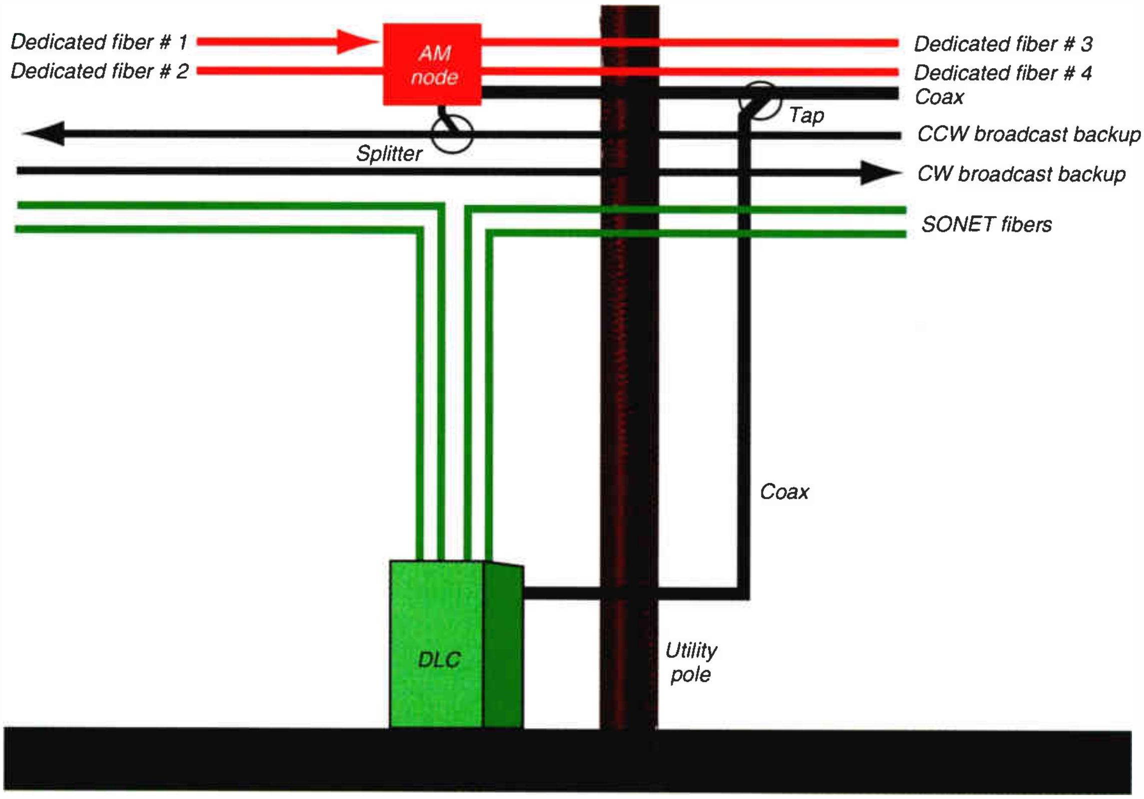


Figure 4: "Clamshell" layout

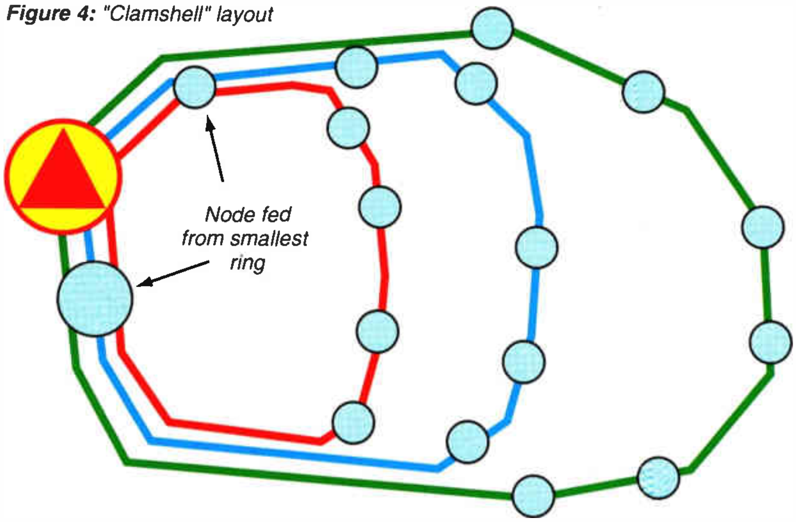
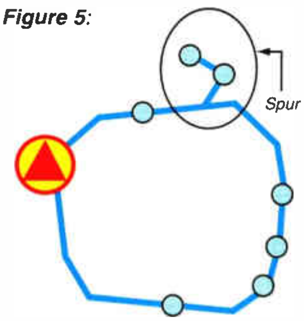


Figure 5:



the unit to provide primary and backup two-way digital traffic in the event of a fiber cut.

DLC features

In order to appreciate the magnitude of its capability, a brief description of the DLC concept should clarify the potential services which could be supported.

Until the early 1980s, most telephone subscribers were connected to a local switching office (LSO) via dedicated pairs of copper wires. Many wire pairs were cabled together and placed on poles or in the ground in a tree-and-branch architecture. Small numbers of subscribers shared wire pairs in a "party line." Primarily because of new service offerings, it became necessary to migrate all subscribers to single party service where each subscriber had his own assigned path to the LSO. These were 4 kHz analog circuits.

In order to provide the huge number of additional circuit paths required for single party service, and to improve the signal quality of very long circuits, electronic systems were developed which could convert 24 analog subscriber lines to digital data streams and multiplex them onto two pairs of copper wires, a 12:1 gain in circuit paths. These systems became known as digital loop carrier systems, or DLCs.

The first of these DLCs consisted of cabinet-mounted electronics placed in the field which digitized and multiplexed signals from the subscribers, and rack-mounted electronics placed at the LSO which demultiplexed and decoded the signals back to an analog format identical to that presented by a copper cable pair-based line. Because these systems were self-contained and could be used with any telephone switch, they were known as "universal" DLCs.

One of the early DLCs was the SLC-96 ("slick 96") built by AT&T Technologies. The SLC-96 converted 96 subscriber loops into four 24-channel T-1 digital data streams. The earliest systems used T-1 copper cable carrier methods which required a regenerator every mile or so and two copper cable pairs. Later systems were deployed using fiber optic carrier systems to transport the signals back to the LSO. The universal SLC-96 follows a Technical Requirement, or "TR," written by Bellcore on behalf of the Regional Bell Operating Companies (RBOCs), known as TR-57.

As digital switches became popular in the LSOs, Bellcore wrote another TR describing a T-1 interface to a digital switch which allowed the SLC-96 and its successor, SLC Series 5, to be interfaced to the switch at T-1 without the rack-mounted SLC electronics, or the usual analog line circuits for the switch. This interface saved money and improved quality by eliminating one A/D conversion. This arrangement also allowed a minimal capability to administer and monitor the SLC field equipment using the switch's maintenance subsystems. The TR describing this interface is popularly known as "TR-08." There have been many DLC systems built by numerous manufacturers which meet the specs of TR-

57 and TR-08. These systems are known collectively as DLCs.

Bellcore has written two additional TRs which describe an advanced DLC. Systems currently being developed and introduced which comply with "TR-303" and/or "TR-909" are popularly known as next generation digital loop carrier (NGDLC) systems. TR-303 describes a more sophisticated switch to the DLC interface with a larger control data stream that allows more control of the DLC field electronics by the switch, including dynamic assignment of communications paths on demand. This allows more subscribers to be served by a T-1 data stream by time-sharing the available voice paths under control of the switch. TR-909 describes a special variation of the NGDLC which can optically extend its lines in small groups closer to the subscribers. This is known as fiber to the curb, or FTTC.

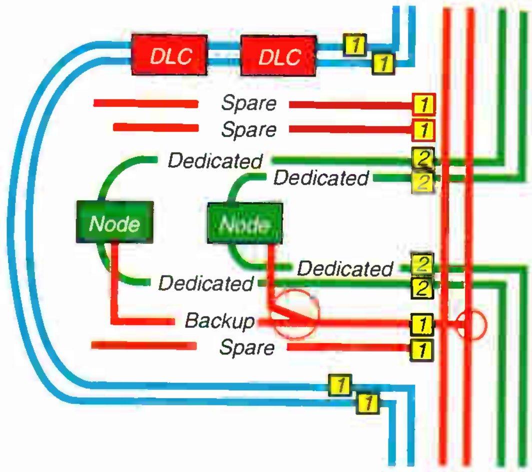
An important concept for cable TV operators is the fact that the TR-08 and TR-303 T-1 data streams can be transported over any mechanism which can transport standard T-1 data streams. Many equipment vendors are feverishly working on technology to transport T-1 data streams over the RF carriers common in the cable TV industry.

The most popular view seems to be that devices would be placed in the cable TV headend to convert T-1 data streams, modulated onto RF carriers, back to baseband T-1. These signals will be TR-08 or TR-303 T-1s destined for a digital switch either located at the headend or reached remotely using telephony-style fiber optic transport such as Sonet.

Cox believes that as subscriber penetration increases, the limited available return spectrum on the RF plant will force the deployment of electronics closer to the subscriber and use of high-speed digital rings to transport the signals to the headend and beyond, as necessary. A scaled-down version of the headend convertor described above could be packaged with an NGDLC in place of the analog line circuitry relatively easily. In addition, the TR-909 capabilities and T-1 extension capabilities inherent in NGDLC can be used to provide traditional telephony style lines to multiple dwelling units (MDUs) and T-1 service to business customers. The capabilities to monitor and administer this equipment through the digital switch are also attractive. Another attractive feature of the NGDLC is the fact that many manufacturers are integrating Sonet fiber optics capabilities into the field electronics.

It's clear that the limited return spectrum available in the CATV plant will require electronics placed closer to the subscriber in order to take advantage of the huge bandwidth of fiber optic cable. This would have the advantage of multiplying physical capacity and reducing return path interference constraints by separating coaxial distribution feeds at the node. When considering all the features required of the electronics, the NGDLC seems to fit most of the requirements, and is packaged for cabinet mounting in the field. NGDLC uses Sonet transport, an open payload begging for signals to be mapped to it. Administrative control is tightly coupled with that of the switch, well-understood, open and standardized. The NGDLC is built to *future* telecommunications reliability standards, and is a multi-purpose platform which could be used to terminate copper pairs, RF modulated T-1s, fiber extended T-1 and anything Sonet can carry. The one missing piece is the T-1 to RF conversion and control of subscriber home interfaces over coaxial RF plant. This technol-

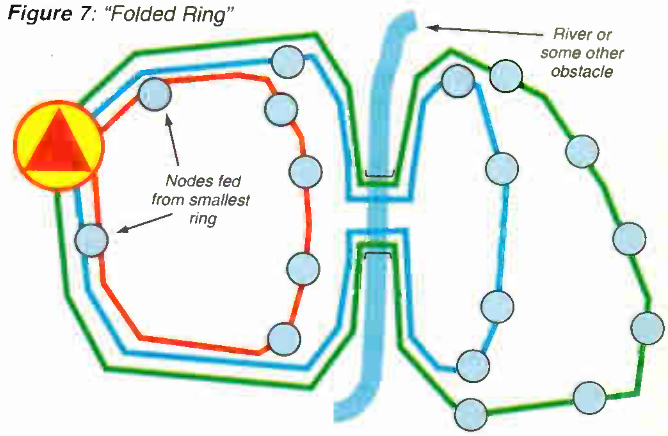
Figure 6: *Spur off main ring. Twelve fibers for the first node, plus four more for each additional node.*



ogy is being developed for headend deployment, and should be easily re-packaged for deployment with the NGDLC.

Cox is currently soliciting technology which would be capable of integrating and transporting not only traditional communications services such as voice and data, but other signals associated with CATV, such as IPPV and interactive game signals in an integrated manner. The DLC/Sonet technology may be adapted to meet these additional requirements, or perhaps other transport methods may become available. In any case, the Ring-in-Ring architecture is flexible enough to accommodate whatever the integrated solution or solutions may be.

Figure 7: *"Folded Ring"*



Broadcast backup

The ideal design provides full backup of all services through the utilization of at least two diversely-routed, dedicated fibers to each node. However, in cases where there is only one fiber dedicated to the node(s), or where there is no route diversity, it's possible to retain much of the reliability afforded by the dedicated ring.

Because fiber in the loop-through ring is relatively inexpensive compared to the cost of dedicated fiber, a second set of fibers in this loop-through ring could provide a cost-effective backup for the broadcast signals. This is possible through the use of a high-output laser, feeding two fibers constructed in a counter-rotating configuration. Directional couplers, placed on the last half of each of these fiber rings, drop off the signals to each node. The counter-rotating ring configuration ensures that if one side of the dedicated ring is cut, the signal arriving from the opposite side of the ring will be available to feed the node and maintain all broadcast services. This configuration would provide a more economical backup than homerun fibers and makes sense if all two-way services were carried on a DLC-equipped ring.

There is a limitation to this solution: In the event of a fiber cable cut, without a diverse-routed, dedicated fiber, the targeted class of services such as target advertising, VOD, etc., would be lost until the dedicated fiber could be repaired. The architecture provides considerable reliability, and whether or not to accept the consequences of temporarily losing targeted services is a choice dictated by the business requirements of the targeted services.

Figure 3 shows how this backup fiber comes into play. For the sake of explanation, assume the only dedicated fiber to the AM node is #1. The broadcast backup fiber would be able to continue to serve the node, should dedicated fiber #1 be cut.

Architecture layout

Laying out the first fiber rings begins after the node locations have been determined, according to the coax design to be used. Locations of fiber nodes must be carefully chosen with the idea that a cabinet possibly containing DLC type electronics, sufficient power plant and battery backup may need to be located at the node in the future. Locations must be less conspicuous and have right-of-way space nearby for the cabinet.

The Ring-in-Ring layout begins by connecting several nodes together in a ring which originates and terminates in a headend or hub. The layout involves several iterations during which all possible routes, including existing trunk routes and new construction, are considered for connecting nodes. A number of techniques and some amount of trial-and-error are used to choose ring routes which minimize cost and maximize ring design and reliability.

The Clamshell design. This technique involves choosing routes which connect a number of nodes in a natural ring, while minimizing route and fiber footage, then building additional routes in layers of rings. When viewed on a map, the design resembles the expanding rings on the shell of an oyster or clam, hence the term, "clamshell." The main idea is to close rings as close to the headend as possible in order to minimize the number of fibers per sheath segment. Each succeeding ring contains smaller fiber counts in its extremities, which minimizes fiber footage, and therefore cost. A series of these layered rings will typically result in some cable spans carrying three to five rings each, with six to 12 nodes served per ring. See Figure 4.

To use the clamshell technique, begin at the headend and proceed out in at least two directions connecting nodes together. Search for opportunities to bring the two routes together into a ring as soon as practical, and connecting as many nodes as possible. All possible routes, including existing trunk routes, pole lines, conduits or newbuild construction, should be considered at this time. Cox provides alternate access telecommunications in its systems; therefore, if any known or potential business communications customers are located near the proposed route, consideration is given to re-routing or moving the fiber cable closer to those locations.

Adding fiber counts to the ring for alternate access customers can be economical due to the ring configuration. The widescale roll-out of

The Homeworx family for linear broadband AM fiber optic transport

DLC or Sonet-type equipment at the node may not be possible until residential POTS or other revenue sources justify the significant capital cost. However, alternate access revenues being generated today can support the relatively low cost of adding fibers to the ring. When demand for alternate access starts, the integrity of the Ring-in-Ring fiber allocation and splicing plan would not be compromised if the fiber counts and routing have been carefully chosen.

Continue the clamshell design by building layers of longer rings on top of the shorter rings. Keeping fiber counts lower in the longer rings minimizes the cost. Typical designs yield three to five ring layers in one of these clamshells, with six to 12 nodes per ring layer. A cable system will have three to four of these clamshells with common cable sheaths close to the headend.

The Spur. A node or two will nearly always be aside from the main body of the area served, usually serving small groups of customers. Typically, these nodes are in remote areas where diverse access is not feasible or cost-effective. In these cases, the node may be constructed as a spur off the main path of the ring. This situation is usually limited to a maximum of two or three nodes on a spur. The reliability exposure to the customers served from a spur node is still only slightly lower than reliability to customers served from a ring node. Figures 5 and 6 are examples of the spur concept and a detailed schematic of a two-node spur.

The Folded Ring. Some situations, such as river and railroad crossings, will be too expensive to include all nodes in the ring. In these cases, it is possible to collapse the ring or "fold" it for a short distance. There is some risk in the location where the ring is folded, so special consideration should be taken to assure minimum risk in the folded region.

For example, in the case of a bridge crossing, the fiber cable can be routed on opposite sides of the bridge to reduce exposure to damage. If precautions can be taken to minimize any risk of damage, over what is usually only a few hundred feet, then cost savings may make folding a reasonable risk. In the worst case, the reliability is no less than the typical dedicated (star) topology. See Figure 7.

As mentioned earlier, when comparing the cost tradeoffs between fiber cost and construction needed to close off loops, it is worth noting that an additional aid to this process is a mapping platform and software which has the ability to automatically display the various routes being considered, as well as track each individual span and the footage associated with it. Figure 8 is an example of what a typical Ring-in-Ring fiber network looks like, after taking advantage of all the methods discussed.

Costs

Through the use of the fiber-reducing techniques discussed, Cox has been able to determine that the cost of Ring-in-Ring compares favorably with star networks having eight fibers to a 1,000- to 1,500-home node. Exceptions occur in areas which tend to be more rural, or in situations where the system feeds down a narrow corridor such as a peninsula. In both of these examples, the issue is lack of route diversity: There may not be any adjacent fiber routes available with which to form a ring. In these situations, costs have to be considered on a case-by-case basis.

The costs for electronics required to activate the redundancy and backup features of this architecture have to be considered separately.

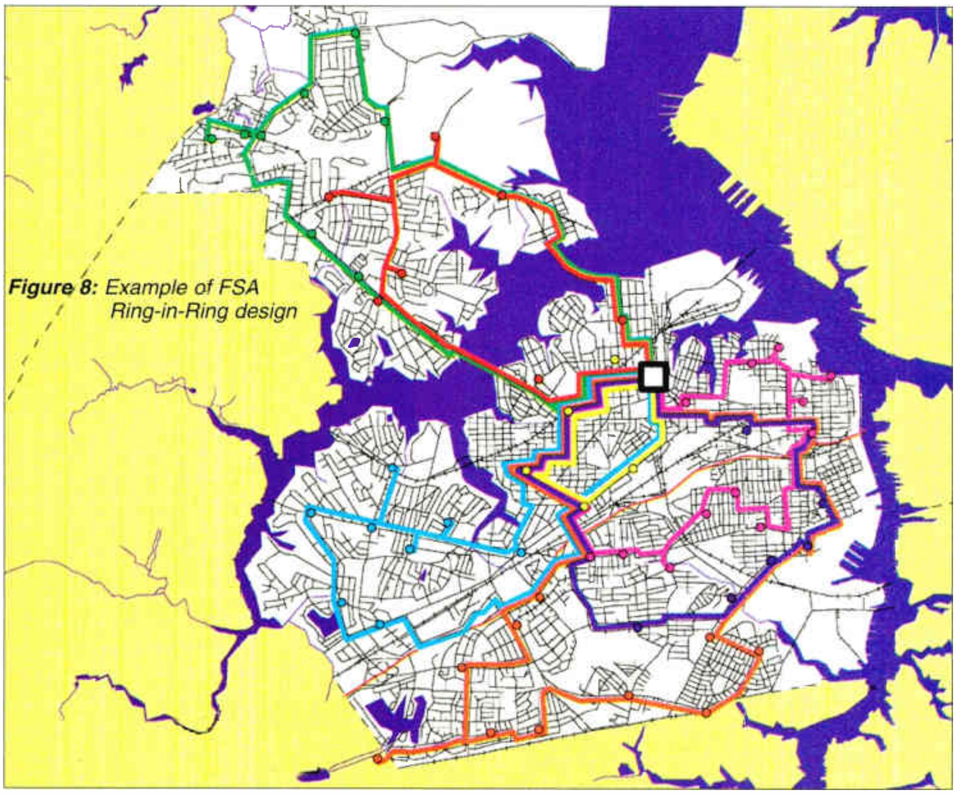


Figure 8: *Example of FSA Ring-in-Ring design*

Depending on how this is employed, and what applications the network is to carry, the electronics may be configured in various ways.

For the broadcast and targeted services, the fiber architecture will support the necessary redundant electronics, provided those are purchased and installed. It should be noted that if the fiber network is to be constructed, it would make sense to at least install optical receiver housings which have provision for multiple receivers and upstream transmitters. In addition, within these housings there need to be provisions made for automatic switching from one receiver to the other in the event of either a fiber cut or primary receiver failure.

Initially, voice, data and other two-way digital services may be deployed using digital to RF electronics placed at the headend. As penetration increases or bandwidth becomes constrained, the DLC type of digital transport could be deployed in the nodes where it is required. The looped-through fibers would be used to serve this transport equipment.

Summary

Cox believes future applications for hybrid fiber/coax (HFC) systems are going to play an essential role in the success of the cable industry. Beating the competition for new and existing services is going to require the provision of high reliability and flexibility. Using an example taken from actual experience, a cut on a fiber cable coming out of the headend with 144 active fibers took nearly one day to repair, averaging about 10 minutes per fiber to prepare and make the splice.

If the Ring-in-Ring architecture is constructed with four dedicated fibers per node, and with four fibers in the loop-through ring, the cost will be practically the same as an eight-fiber "star" design. When WDM is practical, the four fibers in the dedicated ring will allow for doubling the number of nodes without losing any of the reliability.

The use of DLC/Sonet type equipment provides tremendous application flexibility using existing and well-established technology. Where such equipment exists, it is easy to accommodate a "drop-in" business customer by simply extending a fiber from the local DLC unit to serve an on-premise interface.

Other more integrated transport technologies are emerging which may overshadow the capabilities of the DLC/Sonet devices. These devices will allow a more efficient use of precious spectrum. The Ring-in-Ring architecture represents a powerful, cost-effective, reliable and flexible platform from which the industry can launch and sustain a host of competitive services, both now and in the future. CED

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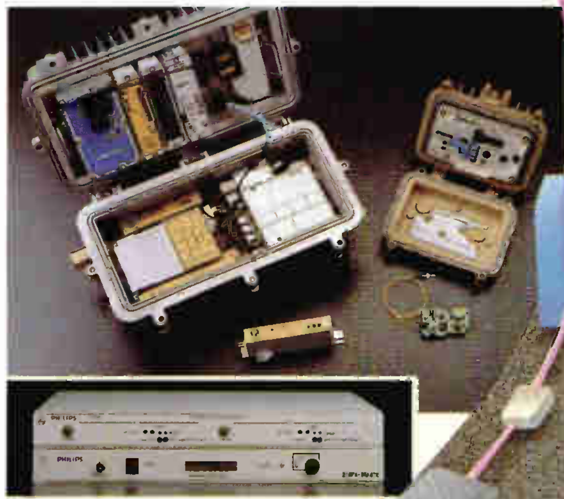

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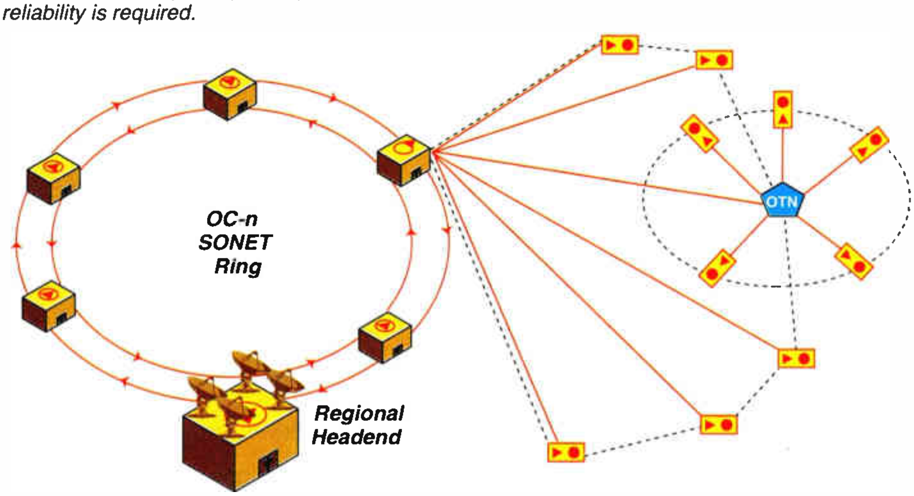
Establishing a reliable network

Taking the plant to the next level

Figure 1: In the regional network, bi-directional SONET rings deliver signals in both clockwise and counter clockwise directions. If a fiber break occurs, traffic is received from the protection fiber traveling in the opposite direction on the other side of the ring. In the residential network, diverse fiber paths also protect against a fiber break or equipment failure. Fiber links Optical Transition Nodes (OTNs) and optical receivers and can be added later when greater network reliability is required.



By Brian Bentley, Market Manager, Broadband Transmission Systems; and Michael Pritz, Director of New Business Development, Operational Support Systems, Antec Corp.

Broadband network operators positioning their plant for the future are now taking a closer look at how to make their networks "survivable." Survivable networks reroute signals around plant breaks or equipment failures, virtually eliminating service outages that may impact subscriber services. From perspectives of competitive marketing and legal liability, a survivable, nearly 100 percent reliable network will be required in the interactive broadband future–especially in delivering an essential "lifeline" service like telephony.

Broadband network providers can build survivability into their networks through several key steps. First, network providers should plan for survivability in their network design. At the regional or metropolitan level, digital Synchronous Optical Network (Sonet) transmission equipment, for example, provides inherent survivability by relying on ring architectures to reroute signals through unaffected portions of the network in the event of a fiber cut or equipment failure. In the residential network, establishing or provisioning diverse fiber paths should also be evaluated, whether that diversity is built into the network architecture today, or in the future.

Second, redundant components will help establish the survivable network. In the digital network, Sonet equipment provides redundancy for any circuit packs or optics whose failure impacts service. In AM applications, headends and regional hubs should be equipped with back-up transmitters and other components that can be activated in the event of an equipment failure. Many newer generation optical receivers incorporate RF switching capabilities, allowing technicians to use a back-up coaxial amplifier should a fiber break or other failure occur. Optical switching and the use of redundant fibers also enhances the reliability of the broadband plant.

Third, network survivability can be enhanced by network management systems. While network surveillance and remote or centralized network provisioning exist today, the various operational subsystems are not integrated. Ultimately, a larger, integrated umbrella operational support system for the digital Sonet and optical/RF platforms will allow technicians to manage the entire network from a central location.

The digital network

As more operators begin evaluating and implementing digital networks to enable new service delivery, reduce operating costs and establish the path for continued growth, Sonet appears to stand out as the preferred platform for the regional portion of the broadband plant. Based on international standards, Sonet delivers video, voice and data traffic over the same infrastructure, while providing the flexibility to use equipment manufactured by various vendors.

Sonet traffic can be picked up and dropped off at any node within the regional network, making possible new business opportunities such as alternate access, digital business services, enhanced telephone service, regional/local advertising insertion and video-on-demand.

Following Sonet installation, one or two master headends collect video information and transmit those signals to each regional hub site (formerly headends). With two master headends, the system would be able to bring a secondary master site immediately into service, should disaster strike at the main regional headend location.

Sonet offers complete network redundancy for components that directly impact service delivery. If a circuit pack fails, the software inherent in the Sonet equipment automatically switches traffic to the back-up component, thereby protecting service delivery. Network equipment constantly polls signals to evaluate signal strength and clarity. Once a signal degradation threshold is reached on the service fiber, traffic is switched to the protection fiber.

Sonet ring architectures, second only to mesh networks in their ability to survive failures, use two different types of ring architectures, both generally accepted by equipment manufacturers and the telecommunications industry.

Path-switched, uni-directional rings mean signals are duplicated at the master headend and fed in both directions around the ring. Service circuits typically take the same fiber route around the ring (e.g., clockwise) while protection fibers flow in the opposite direction (e.g., counter-clockwise). In the event of a fiber cut or equipment failure on the service

fiber, service hubs access digital signals from the protection fiber.

Line-switched, bi-directional rings allow fibers to be shared. For example, on an OC-48 ring system, each fiber between spans carries a total of 48 time slots. Between two hubs, service runs on slots one through 24 of a single fiber, while protection runs on slots 25 through 48. The separate return path fiber has time slots allocated in the same manner. In the event of a fiber cut or hub failure, the equipment adjacent to the break or failure initiates a "loopback" that alerts neighboring equipment of the problem. Service time slots on one fiber are now carried on the protection portion of the other fiber to avert the break or equipment failure and deliver digital signals to the remote hub without interruption.

Sonet-based equipment also provides various levels of network control. For example, microprocessors mounted on circuit packs monitor the transmission and timing packs and report their status to the next level of performance. This second level, "line" control, processes this received information and determines if a protection switch is required. The line layers automatically switch traffic from service to protection fiber as needed. Line control information is then fed to another "system" level of control, which develops status reports, initiates alarms and lights circuit pack LEDs and equipment control panels accordingly, to provide technicians with an easy way to locate faults.

Line-switched, bi-directional rings allow fibers to be shared.

For AM applications, network survivability is enhanced by duplicate equipment at the headend or regional hub. This equipment duplication allows technicians to switch downstream traffic, should a laser transmitter failure occur. Typically, a single "hot standby" unit could be used to back-up multiple transmitters. Choosing appropriate redundancy configurations depends on how quickly a piece of equipment could be replaced if the spare unit is unavailable.

The next step in improving network survivability lies in establishing diverse fiber routes within the distribution network. In some architectures, Optical Transition Nodes (OTN) act as optical repeater sites deep within the cable plant. These OTNs can be interconnected via fiber, offering the ring protection required to reroute traffic, should an equipment failure or fiber break occur.

The residential network

As shown in Figure 1 on page 38, the ring architecture of Sonet can be applied to the residential network by means of interconnecting optical receiver sites and OTNs via fiber. While this represents a key cost concern that may initially inhibit deployment, planning for these residential rings is critical in today's network design. Modeling for node size and anticipated subscriber buy rates can help dictate the given "failure group" represented by a given piece of equipment.

Optical equipment should also have built-in redundancy features that provide a back-up to

Scientific
Atlanta

all primary units. In the event of an equipment failure, traffic is automatically switched from primary to back-up modules, without a significant impact on service. Technicians can also toggle between primary and back-up fibers/components for preventive maintenance.

Network management

Survivability will also hinge on the operational support function of the network. At the highest level, a fully-integrated Operational Support System (OSS) will offer the network management capabilities needed to monitor both the Sonet and RF networks from a centralized or remote location.

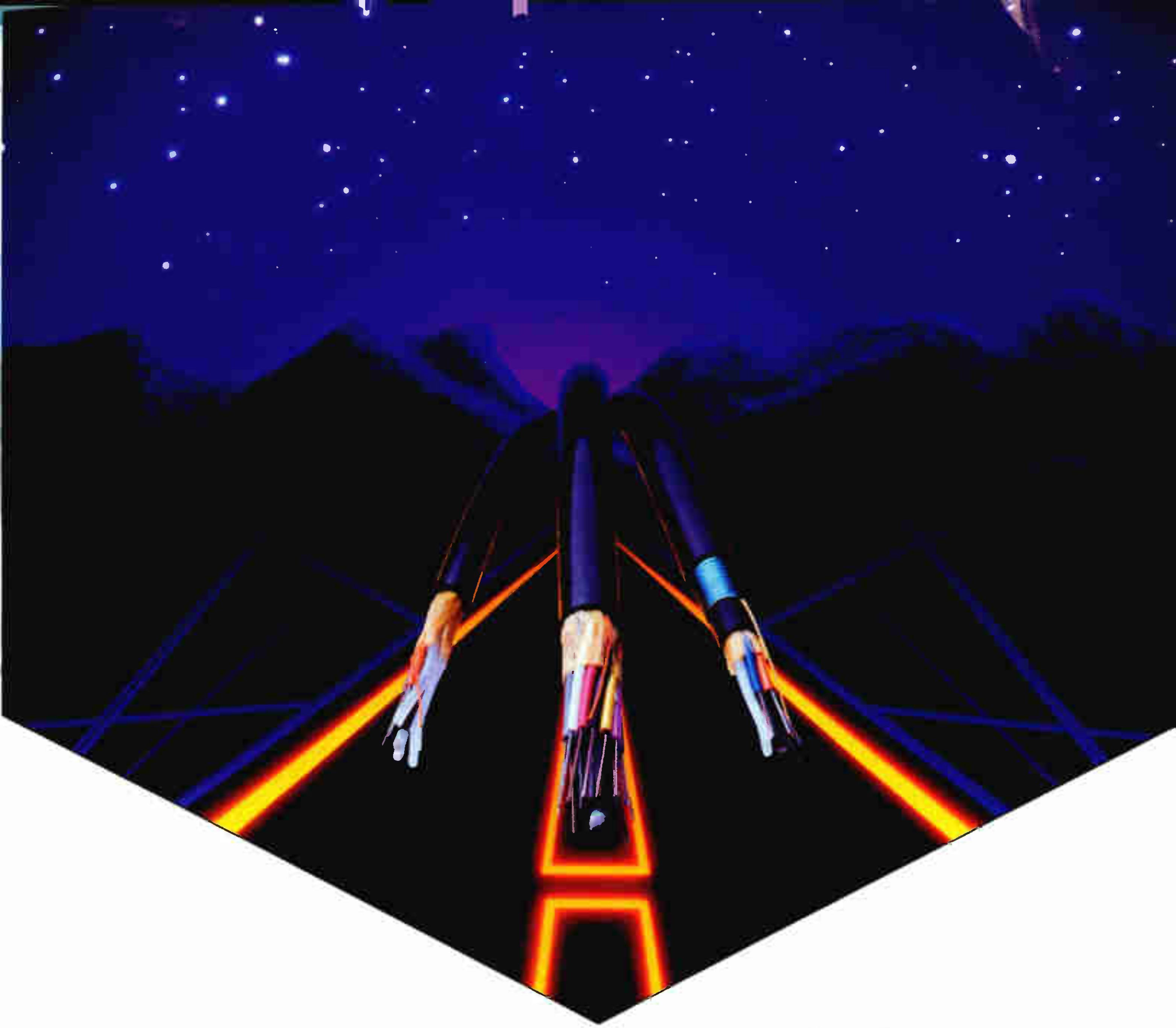
Sonet standards provide for a large amount of this operational support capability. Significant overhead is allocated for use specifically for network management functions. This functionality allows technicians to achieve "visibility" of each component on the network. In this way, a technician can "see" each network component, monitor network performance levels and pre- or automatically provision signal transmission. The system control level of network operations maintains all network provisioning information, even in the event of a power surge or complete power failure.

Recent advances in network surveillance are also bringing more operational support functionality to distribution equipment. Work is also underway to develop a multi-vendor, integrated network management platform that will allow more cohesive operational support in the RF portion of the plant.

In the near future, Sonet and RF surveillance systems will move toward greater integration and functionality, allowing technicians to manage network components, whether those components are digital or analog devices, from a single system. Network problems will be anticipated through diagnosis, based on changes in status measured before full failure of any particular unit occurs. This offers a more precise understanding of problems encountered, and the ability to quickly rectify them–often without the need to travel to a given piece of equipment in the field and, most often, without impacting service.

A cost-cutting measure today will not be cost-effective when it causes unacceptable reliability problems in the future.

In making any decisions regarding survivability in the broadband network, cost-effectiveness must always be weighed against technology options. A cost-cutting measure today will not be cost-effective when it causes unacceptable reliability problems in the future. Ring architectures, diverse fiber routes, redundant electronics and comprehensive operational support are all a part of the highly reliable digital Sonet network; however, those same elements will be equally important in the RF distribution network. Broadband telephony will play the most significant role in leading cable systems to establish high survivability in digital and distribution networks, especially in attracting new customers who expect the near 100 percent reliability the incumbent telephone companies already provide. CED



1550 nm gear back on radar screen

MSOs eye dense-WDM applications

By Leslie Ellis, Contributing Editor

Operators wanting to fully throttle their optical plant are starting to take notice of the 1550 nm lightwave technology historically used to haul telephone signals over very long distances, called "dense wave division multiplexing" (dense-WDM).

For cable operators, the intrigue of dense-WDM lies in its potential for inter-city connections and for sending signals farther and faster–at distances of 200 km or more, and at speeds of 2.5 Gigabits-per-second (2.5 Gbps, or 2.5 billion bits-per-second).

What makes dense-WDM different than standard wave division multiplexing–where a single fiber carries bi-directional traffic at both the 1310 nm and 1550 nm optical wavelengths–is that dense-WDM stacks anywhere from two to 20 signals on one fiber, at optical wavelengths grouped in the 1530 nm to 1560 nm region.

Indeed, engineers with MSOs including Rogers Cablesystems Ltd., NewChannels Corp. and Time Warner Cable say they are keeping a watchful eye on dense-WDM. An added benefit: because dense-WDM operates within the 1550 nm optical wavelength region, it supports the use of erbium-doped fiber amplifiers (EDFAs), which pump up the lightwaves for a longer ride over their fiber carriers.

Cablevision Systems Corp. has also expressed an interest in dense-WDM, and may deploy it as early as mid-'95 to subdivide its hybrid fiber/coax systems into smaller, 125- or 150-home segments. NewChannels is also attracted by system segmentation options offered by the technology, although actual deployment plans are "a couple of years out," says Tom Staniec, director of engineering for the MSO.

MSOs looking at dense-WDM say it intrigues them because of its usefulness in clustered areas.

"When you start to densely pack several channels at 1550 nm, it gives you the potential to do things you couldn't do before, and that's what interests us," Staniec says, adding that "the thought process is to get more bandwidth into a given location, without destroying the system already in place."

Staniec says that narrowcasting is one such dense-WDM application that interests him, where one fiber carries 750 MHz of combined video and data content to four 125-home nodes, or two 250-home nodes. "It's conceivable that we can have a completely different program delivered to each location," Staniec says.

Where reach is important

Beyond the narrowcasting applications that Cablevision and NewChannels are considering, the MSOs looking at dense-WDM say the technology intrigues them because of its usefulness in clustered areas, where a single operator may service an entire region over several systems. "High density WDM is interesting to look at as costs shift, for long-haul fibers and on urban rings–where reach is important," explains Jim Chiddix, senior vice president of engineering for Time Warner Cable and a recognized pioneer in lightwave deployment, who says that dense-WDM is something he's "actively tracking."

North of the border, Rogers Cablesystems is also interested in the technology, and may use it to connect two Canadian systems there this year, says Nick Hamilton-Piercy, VP of engineering and technology for the Canadian MSO. "There are places where we'll consider using dense-WDM, especially where we have to go long distances between cities," Hamilton-Piercy says, adding that dense-WDM also makes sense for optical system installations which took place several years ago and where there are only a few fibers available for use.

In fact, Rogers is faced with that exact situation in its planned Toronto-to-Ottawa link. The two cities are separated by about 400 kilometers, and only two fibers remain to haul Rogers' traffic. Because of those pre-existing conditions, Hamilton-Piercy says dense-WDM will probably fit the bill. "Some companies, like ours, partnered on optical fiber installation years ago, rather than building our own,"

Is all that bandwidth needed? In a network serving 50,000 subs and pulling a 5 percent VOD buy rate, a network needs 10 gigabits-per-second capacity (2,500 programs x 4 Mbps).

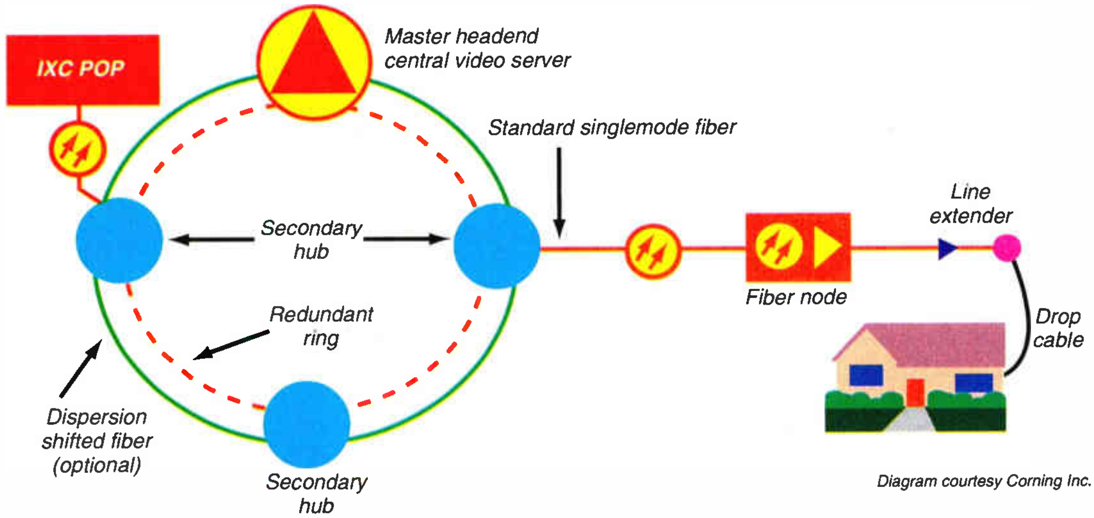
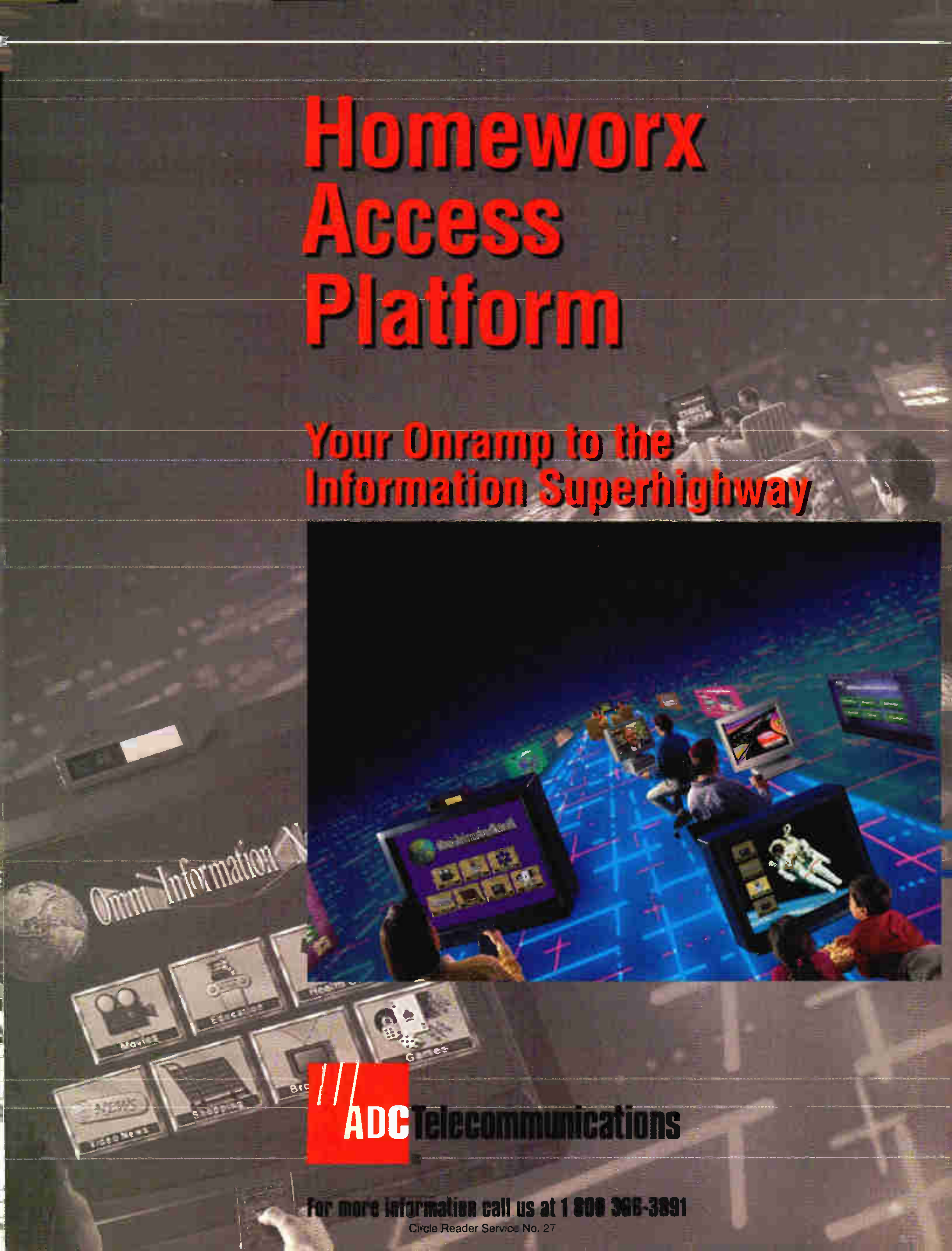


Diagram courtesy Corning Inc.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Hamilton-Piercy explains. "When you do that, you can't get as many fibers as you want. It's in situations like that when something like dense-WDM is plausible."

In the Toronto-to-Ottawa link, Hamilton-Piercy is considering stacking two or four OC-48 bit streams on the same fiber, using a dense-WDM engine. "We're looking at it, because it's good for that kind of inter-city link, where the reach is long and there are only a few available fibers," Hamilton-Piercy says.

Another potential application for dense-WDM technology is stacking multiple reverse signals onto a single fiber, which will likely become necessary as bi-directional traffic like home computing and interactive TV shifts into the cable mainstream. "Dense-WDM looks real interesting for return applications, providing the lasers are affordable," says NewChannels' Staniec.

Driving the WDM bus

The optoelectronics driving dense-WDM are in the works at Synchronous Communications and International Business Machine's Research Division, among others.

"Dense-WDM, or what we call 'narrow-band WDM,' will be very critical for future architectures," says Al Johnson, president for Synchronous, who notes that while optical cable has an almost infinite bandwidth, the transmitters and receivers at either end of the glass do not. "If you can stack four or more wavelengths on a single fiber, you can also squeeze the efficiency of the fiber," Johnson explains.

Last month, IBM's research arm announced an all-digital WDM prototype, dubbed "MuxMaster."

For example, Johnson says that by stacking four wavelengths on a single fiber, the costs of that fiber can be driven down by about 75 percent. Conversely, a four-port dense-WDM device, which collects the outputs of four optical transmitters and multiplexes them together onto the optical fiber, costs about $7,500 for each end–"which is what's keeping the technology from being prevalent at this point," he notes.

To remedy the forthcoming onslaught of anticipated upstream traffic from home PCs and other in-home interactive devices, Synchronous is also at work on a device which stacks 24 sub-low (5-40 MHz) reverse signals on a single laser, for transporting upstream data from hub-to-hub on an optical ring, or from hub-to-headend.

The upstream multiplexer, which Johnson described as being roughly analogous to an optical up- and down-block convertor, will be formally introduced in a few months, but is already in demand: "We discussed the concept with a foreign operator, and he wanted to take it home with him in his suitcase."

IBM is also hot on the trail of optical wavelength multiplexing. Last month, the research arm of the computing giant announced an all-digital WDM prototype, dubbed "MuxMaster," which is designed to stack up to 20 wavelengths on a single fiber. Specifically, the system allows up to 10 200-Megabit-per-second (Mbps) duplex channels to be transmitted over a single 50-km fiber, according to a statement issued by IBM.

IBM officials think the new system, once commercialized, could save up to 95 percent of the cost of leased fibers.

"The current cost of renting a single fiber starts at $150 to $300 per mile, per month," IBM officials said in a press release. "Assuming $150 per mile, per month, a MuxMaster user needing a 10-channel, two-way link over 10 miles could save $342,000 per year in fiber costs."

The IBM system is "undergoing strenuous testing" with customer partners Morgan Stanley and the Bank of Austria, who are using the dense-WDM system to support rapid disaster recovery of data between computing sites. Eventually, IBM hopes to be able to send up to 50,000 channels at speeds of 200 Mbps, company officials said–or enough capacity to send several thousand uncompressed HDTV signals.

A need for speed

Meanwhile, Corning Inc. is fine-tuning a line of dispersion-shifted optical cable, originally developed a decade ago for long-haul telephone applications and now aimed at 1550 nm dense-WDM projects. MCI Communications is already planning to use the fiber to carry a total of 10 Gbps over four 2.5-Gbps wavelengths, on one fiber.

Operators wanting turbo-charged throughput may want to examine dense-WDM.

Will operators have the need for that much speed? Corning thinks so, through a video-on-demand model it developed to illustrate a 50,000-subscriber system sending MPEG-2 digital video streams to five percent of its viewers.

"In a situation where five percent of the customers request a film at the same time, an operator will need (the capacity to send) 2,500 simultaneous video streams," offers Don Vassel of Corning. "When you consider that each MPEG-2 video stream requires 4 Mbps, and then multiply that by 2,500, you're at 10 Gbps. That's one example of how quickly you can get up to those kinds of transmission rates."

The MSOs considering dense-WDM, though, emphasize that while the installation of dispersion-shifted fiber may make economic sense in newbuilds and some upgrades, an alternative is to use externally modulated optoelectronics.

"There's a cost premium involved, so the method used to dense-WDM depends on the circumstances," notes Hamilton-Piercy. "If you're constructing up front, it's probably cheaper to put in more fibers. If you have a large installed base of singlemode fiber, it makes sense to look at the optoelectronics."

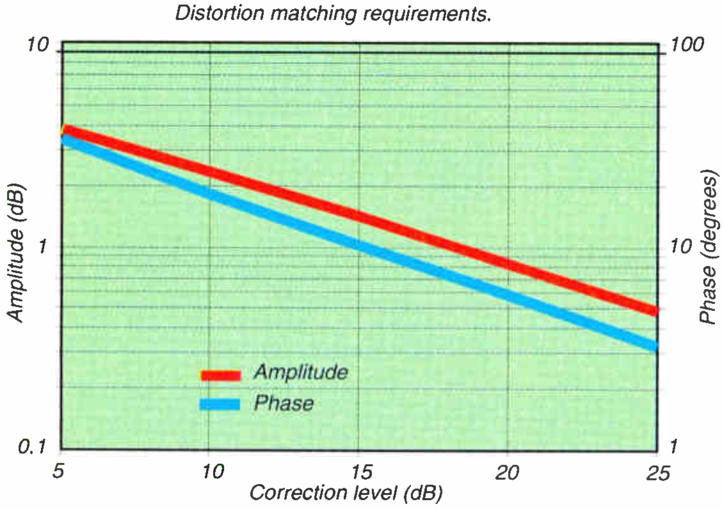
Still, operators strapped for capacity or wanting turbo-charged throughput may want to examine dense-WDM, particularly as channelization plans increase and network payloads shift from analog to digital. "It's something that you want to keep on the radar screen," Chiddix says. CED

Fred Dawson contributed to this story.

The challenge of the return path

Fine-tuning the laser

Figure 1: The amplitude and phase matching requirements for distortion cancellation in excess of 15 dB are difficult to meet over broad frequency ranges.



By John Stroman, Product Marketing Engineer, Broadband Communications Products, Ortel Corp.

In the last two years, triggered by changes in regulations and technology, the focus of the communications world has turned to "interactivity," and cable TV networks are at the center of most discussions. MSO and LEC network designers are now carefully reviewing what final pieces of hardware are required to bring their networks to full readiness for interactive multimedia services.

Many have identified the return path link as an area where advances are required before the full service network will be a reality. In fact, some industry observers question whether HFC networks can provide a cost-effective return path capacity sufficient for advanced interactive services. While these concerns are premature and unduly pessimistic, they illustrate the importance of the return path link in the overall network architecture.

While other technological advances are also required for the full-service network, this article will examine the issues and challenges of the return path itself, especially as pertains to the laser. With the advances of forward path laser development over the past seven years, the technical know-how to produce a return path laser currently exists. Integrating the various elements of the solution into a product that provides the right performance at the optimum price is nevertheless a challenging task.

The history of modern CATV lasers

At the heart of this dramatic transformation of CATV technology is linear fiber optics, which ushered in the demise of the cumbersome "tree-and-branch" network; and replaced it with the powerful and flexible fiber to the feeder, or hybrid fiber/coax (HFC) architecture. The most important attribute of HFC networks is their two-way broadband communications capability, which is enabled by two significant network improvements–the reduction of ingress into the return band, and the segmentation of the network into nodes of 500 homes or less.

Both factors derive directly from the introduction of fiber optic links into cable networks, which eliminated lengthy cascades of amplifiers and created direct links between the headend and the "last mile" of the coaxial plant.

Distributed feedback or Fabry Perot

Starting with the first technology demonstrations in 1987, linear fiber optics has emerged as the dominant high-bandwidth fiber optic technology worldwide, eclipsing the production rate of multi-Gbps Sonet lasers. The first demonstration of linear fiber optics for CATV networks used Fabry Perot lasers without isolators. They operated over short distances, and the control of second order distortion was difficult. Nevertheless, these demonstrations established that sufficient linearity could be achieved if the laser met certain basic requirements, and cleared the path for the emergence of the linear distributed feedback (DFB) laser, which provided much higher performance over longer distances.

The lesson of these early days is that FP lasers have certain performance limitations that are best overcome with linear DFB lasers. These limitations will be discussed later in an examination of the technological alternatives for return path lasers.

Wavelength: 1310 vs. 1550 nm

The rapid development of the Erbium Doped Fiber Amplifier (EDFA) pulled into focus the possibility of using optical transmission in the so-called "third window," i.e., 1550 nm. The arguments in favor of 1550 nm links were largely hinged on the benefits of optical amplification, and partly on the lower optical loss of fiber at 1550 nm.

After some early experiments, it became apparent that directly modulated 1550 nm DFB lasers were not suitable for operation in cable networks because of the effect of residual modulation of the laser wavelength (chirp) on distortion performance. Today, 1550 nm links use cw DFB lasers operated with external modulation and EDFA power amplifiers.

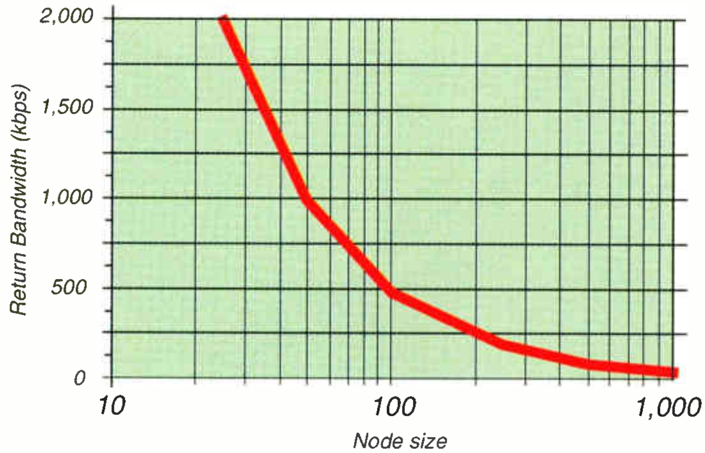
These products are used effectively as supertrunk links that tie headends together. For linking the headend to the coaxial "last mile," directly modulated 1310 nm DFB lasers have become the de facto standard.

Predistortion

A key development in linear DFB laser technology was the RF predistorter. The importance of the predistorter goes far beyond the popular over-simplification, "A predistorter makes bad lasers into good lasers." In fact, simple analysis shows that "making bad lasers into good lasers" is a poor design goal for predistortion. Predistorters work by generating distortion products equal in amplitude and opposite in phase to the products generated in the laser. To cancel distortion products in a "bad" laser requires matching the amplitude and phase of such products within prohibitively close tolerances.

Predistortion works best when correcting slight nonlinearities in "good" lasers, resulting

Figure 2: *Return path bandwidth vs. node size*



in "great" lasers. Predistortion, when used properly, coupled to excellent laser designs, results in consistently high performance. It represents the optimum tradeoff between the performance capabilities of linear DFB lasers' RF circuits.

Today's forward path lasers, following seven years of technological development, transmit 80 AM channels, plus 200 MHz of compressed digital signals, with output power up to 16 mW. As production volumes grow, costs continue to fall, portending networks with smaller node sizes and less splitting. Already, some operators are planning on taking fiber directly to 500-home nodes without splitting, or even to nodes of 100 homes with four- or five-way splitting.

Return path channels today are used for status monitoring, low-speed data and analog video return. The requirements for status monitoring and low-speed data can be met with digital frequency shift keyed modulation (FSK). FSK modulation is a relatively inexpensive method to supply the low data rates required for status monitoring, typically a few kilobits/second.

In FSK modulation, two distinct tones are used to represent 1s and 0s. A data stream is represented as a series of shifts between the two frequencies. In some systems, return signaling is used to transport video, e.g., from stadiums or classrooms to headends for distribution. Other systems use the return path for video conferencing, security video monitoring and government applications. Some PPV systems use the set-top convertor and the return path to order services.

But extensive use of the return channel for communications purposes has not been implemented, except in trials.

The use of the return path for video signals today represents an interesting adaptation of forward path technology. Some systems offer up to four video channels within the 5 MHz to 35 MHz subsplit band. Although these links only carry four video channels, they operate at considerably higher modulation depth than downstream channels, and the demands on the laser in terms of linearity are not trivial. Table 1 presents typical RF and optical specifications for such lasers.

Table 1.
Return path lasers in use today for video.

Bandwidth	5-50 MHz (sub-split) band
Channels	1-4, typically a single channel is used
Carrier to Noise	45-55 dB
CSO	> 65 dB
CTB	> 65 dB
Wavelength	1310 nm
Optical power	3 mW
Connector	FC/APC
Configuration	Plug-in with predistorter
Cost	$4,000-6,000

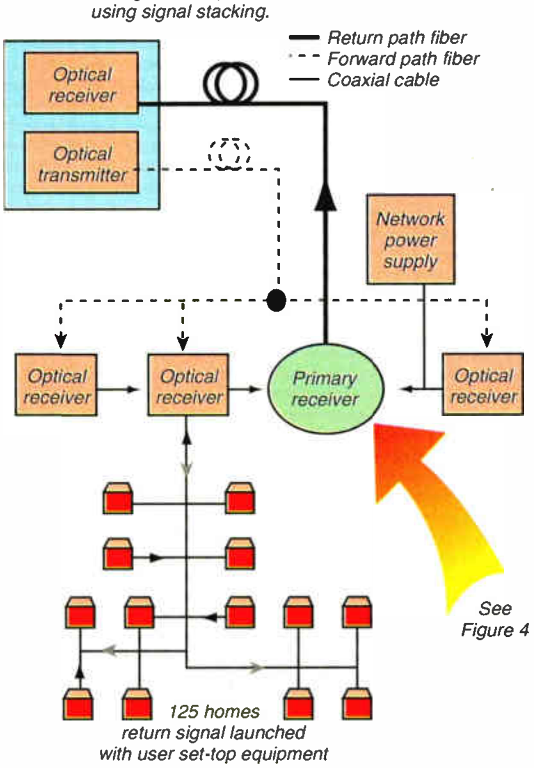
Interactive network designs

A significantly expanded interactive bandwidth is required in most proposed networks, raising the question, "How much bandwidth is available per subscriber?"

Return bandwidth. With quadrature phase shift keying (QPSK), a bandwidth efficiency of 2 b/s/Hz is theoretically possible, although it is less in practical systems. We shall assume that 50 Mbps is achievable within the 5 MHz to 40 MHz spectrum used for return path in most systems today. Higher modulation efficiencies may be possible using 16 QAM.

With today's node sizes of 500 homes, 100 kbps of dedicated upstream bandwidth is available. The graph in Figure 2 shows the dedicated return bandwidth as a function of node size. A node size of 100 homes provides 500 kbps of dedicated bandwidth. Such networks could certainly be used to provide T-1 services, even

Figure 3: Deploying fiber deep into the network. A single return path laser serves 500 homes using signal stacking.



with relatively high service penetration. If "passive coax" networks are built, and many favor such networks for operational reasons, the dedicated return bandwidth would be as high as 1.5 Mbps per home passed.

Signal stacking. How will signals be transported from the home to the headend? As node sizes drop, the number of return lasers and the number of return fibers increases. Frequency division multiplexing, sometimes called stacking, can be used to reduce the number of optical components in the return path.

As shown in Figure 3, interactive digital signals from subscribers are launched using interactive set-top equipment and proceed upstream through the drop and coax distribution cabling, which may include splitting. At the optical node, upstream signals from up to four separate coaxial feeders are upconverted to distinct frequency bands within the 5 MHz to 200 MHz spectrum. By stacking return signals in this manner, a single return path laser is able to serve a larger number of subscribers.

RF ingress. The problems of signal interference due to ingress in the subsplit band are well-documented. The subscriber drop environment contains many potential RF signal sources. Also, the subscriber plant is very leaky due to the sheer volume of terminations and because any deteriorated plant is difficult to identify. A CB radio signal that gains entrance past a degraded cable shield will ultimately be sent up the return optical path.

Combined with problems created by reflections of RF signals within the plant, the RF ingress results in excessive noise and interference problems that must be overcome by the designer of a return path link for interactivity. In some cases, the total noise power over the return band can exceed the power of the return RF signal itself. Such a situation may require reducing the modulation depth of the signal to avoid clipping. All of these factors combined increase the laser's performance requirements.

Return path laser technology

There are several choices to be made in the design of an optimum return path laser.[1] They can be conveniently grouped into five areas:

- ✔ Performance–high or low
- ✔ Laser type–DFB or FP
- ✔ Wavelength–1310 or 1550 nm
- ✔ Isolator–with or without
- ✔ TE cooler–with or without.

Theoretically, this gives 32 different types of laser designs for the return path, although some will probably prove to be inappropriate. Which laser design will be used depends on how the requirements of the return path can be met most cost-effectively.

Laser performance. It is instructive to consider performance first. Network operators naturally want the lowest cost equipment possible, but no one can deny that product performance is equally important. What is required are products that provide the optimum value, or the right performance at the right price.

In the case of return path products, the revenue generating potential of the network is closely related to the performance of the return path link. Higher bandwidth per subscriber means higher revenue potential. While today's forward path lasers, costing several thousand dollars, are almost certainly inappropriate for the return path in all but a few instances, it must be determined whether the appropriate performance level represents lasers at the $1,500 level or the $150 level.

Laser type. The communications industry has long associated FP lasers with "cheap, low performance" and DFB lasers with "expensive, high performance." Naturally, the complexity of processing DFB lasers, with internal grat-

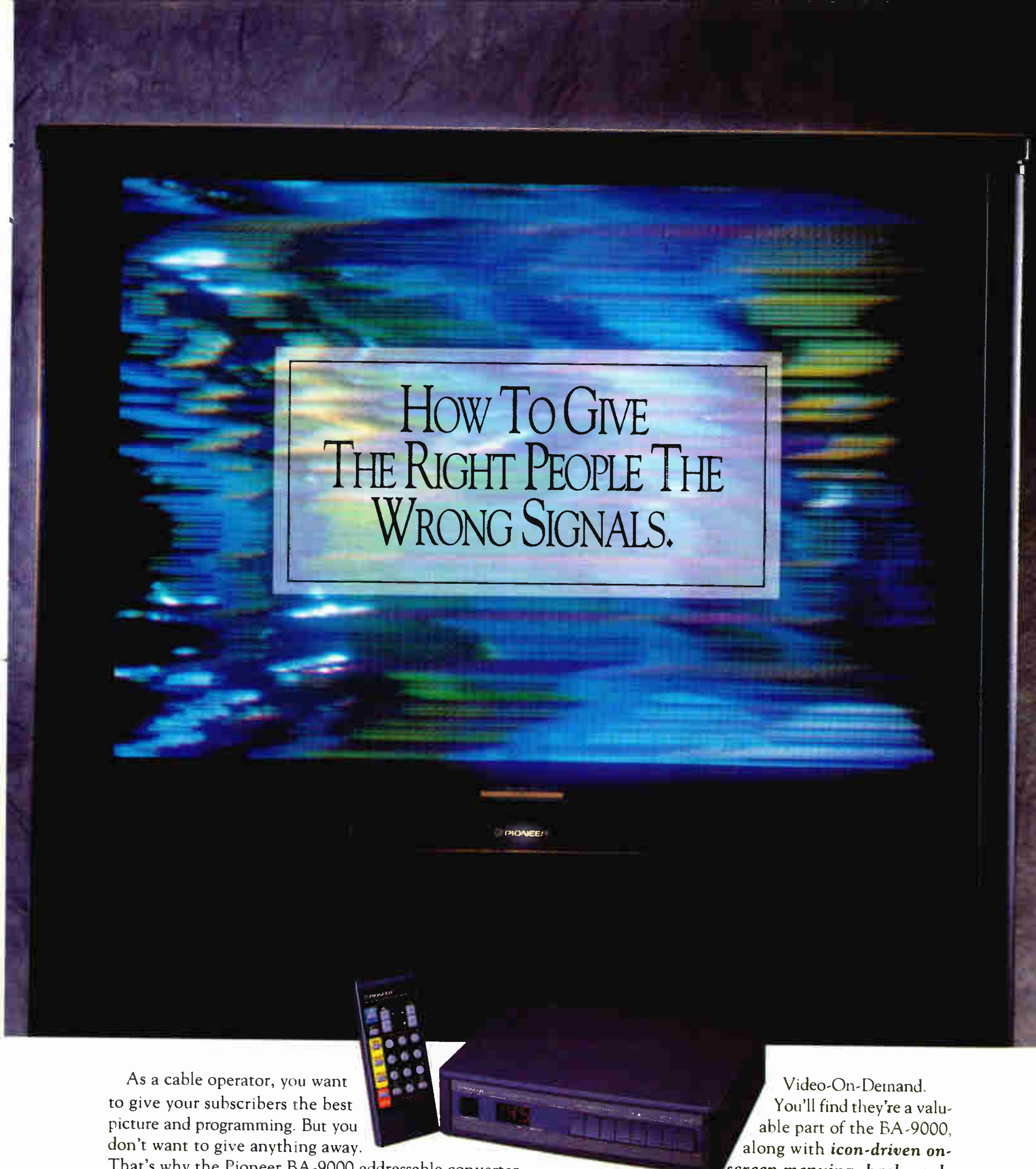


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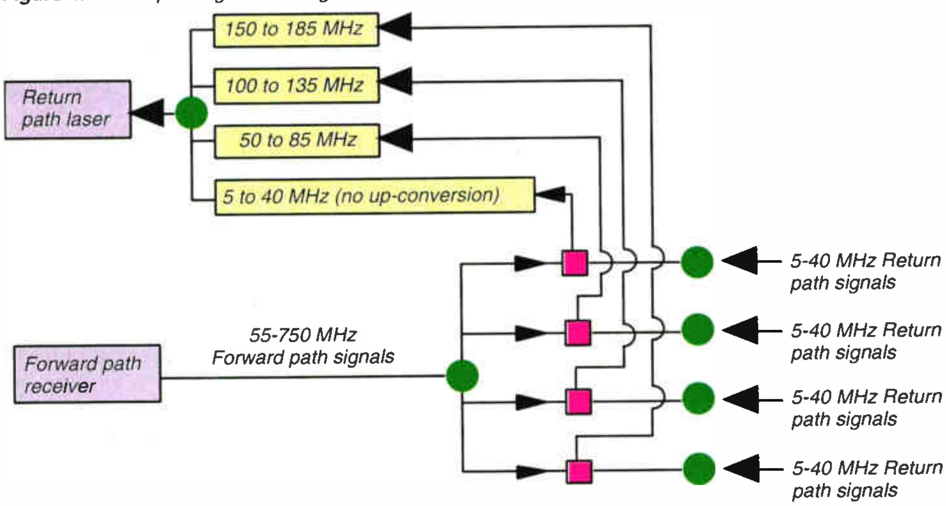
Figure 4: Return path signal stacking



ings that control wavelength, makes them more expensive to produce. But it can also be costly to produce FP lasers if the performance requirements are high, resulting in low yield. The issue to be considered is whether the requirements of the return channel are more stringent than can be met with high yield FP lasers. If so, the optimum choice might be DFB lasers, because they are better suited to provide higher levels of performance.

Wavelength. The issues that determine the optimum transmission wavelength for return path links are not the same as for forward path, where 1310 nm lasers are predominant. Differences in RF specifications, transmission frequency and channel count, among others, lead the designer to a new "design equation" for wavelength choice. Network design issues such as wavelength division multiplexing (WDM) also impact the choice of wavelength.

Isolator. The optical isolator performs a critical function in forward path DFB lasers. In conjunction with low reflection optical connectors and devices in the network, the isolator virtually eliminates the influence of reflected light on the DFB laser. This is absolutely necessary to obtain the high CNR and low distortion required in forward path links. In the return path, RF performance requirements are lower, which increases the possibility that isolators may not be required. However, RF ingress problems tend to keep the link dynamic range requirements high, and return path links with isolator-less lasers may not provide sufficient capacity to support growth in interactive services.

TE cooler. Every forward path DFB laser uses a thermo-electric cooler based on the Peltier effect, which cools or heats a device in response to the flow of a DC current in one or two polarities. The threshold current and optical efficiency of semiconductor lasers are temperature dependent. High performance lasers, whether linear or digital, perform best at a constant temperature. Recent digital laser designs that achieve stable operation over a wide temperature range can operate without TE coolers. Understanding the relationship between these so-called "high temperature" chip designs, linear performance, RF requirements of the return path and environmental constraints in strand mount receivers is an important part of the design process.

Summary

Tackling the return path laser represents a significant technical challenge, because a suitable laser must operate in the outdoor environment with appropriate linearity and noise performance. The advances realized with forward path lasers over the last seven years provide a technology pool from which to assemble the optimum return path product.

Perceptions that the RF return path is too expensive to provide highly interactive communications bandwidth do not recognize the promise of further technological developments. The optimal solution will represent a blend of network design choices and device technology that provides the most flexible solution, for the most attractive price. CED

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1. Dr. Hank Blauvelt of Ortel Corp. will present a paper with more information about return path lasers at NCTA in Dallas.

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Selecting DFB transmitters for broadband services

Properties and merits

By Dr. Yaron Simler, Product Manager, Transmission Systems; and Dr. Chien-Yu Kuo, Director, Lightwave Systems, Harmonic Lightwaves Inc.

The demand for increased reliability and bandwidth in broadband multi-purpose networks has created a major trend toward passive networks, with the active electronic amplifier cascades being reduced, or in some cases, entirely eliminated, through massive deployment of fiber.

Forthcoming distribution architectures continue to rely heavily on DFB transmitters, especially as the proposed basic serving cell decreases in size to between 200 and 500 homes passed per transmitter. As the density of optical receivers increases, and the number of subscribers per node decreases, the opto-electronic cost portion of the plant increases significantly. Those architectural trends point to the importance of thoroughly characterizing the performance of fiber transmitter links.

The process of selecting DFB transmitters is primarily based on two important criteria, cost and performance. In evaluating analog DFB performance, a multidimensional classification process which requires a good understanding of the technology, as well as of the physical constraints such as headend space or ambient operating temperature, could be used. The technical portion of this selection process can be significantly enhanced if transmitters from various vendors can be compared with a common measuring stick. Historically, however, technical specifications vary in scope and approach from vendor to vendor, making a comparison difficult.

Basic requirements

With the expected increase in transmitter count at the headend, especially as revenue optimizing narrowcasting requires one transmitter per node, headend space becomes a premium. Therefore, the transmitter must be compact, flexible and easily reconfigurable.

When translating the AM-VSB multiplexed signals into an optical subcarrier multiplexed (SCM) system for lightwave transmission, the equivalent carrier-to-noise ratio and the distortion performance of the system need to be rigorously maintained. Requirements of the laser transmitters that achieve these conditions are the dynamic light vs. current linearity, the optical relative intensity noise (RIN), the frequency chirp that causes the interferometric intensity noise (IIN) and the frequency responses.

The most important system parameters that are affected by the above-mentioned parameters are carrier-to-noise ratio (CNR) and distortion in terms of composite second order (CSO) and composite triple beat (CTB). These critical parameters need to remain stable in the temperature range of typical office applications, from 0 to 50 degrees C. In addition, the transmitter should also include a user-friendly interface. The following article examines various DFB laser parameters and explores how they affect system performance. Most importantly, it will be demonstrated how a high modulation index, an often under-emphasized parameter, helps minimize chirp effects, increases laser reliability and contributes to high CNR performance.

Distributed feedback (DFB) lasers

To obtain the aforementioned stringent system requirements, it's necessary that the directly modulated laser source is exclusively of the distributed feedback type. Ordinary semiconductor lasers, such as Fabry-Perot, have an optical resonator (cavity) with cleaved or polished end-facets in order to obtain the optical feedback necessary for lasing. DFB lasers rely on periodic corrugation of the optical index within the laser cavity to obtain the necessary feedback, hence the name, distributed feedback.

Most commonly used DFB lasers for CATV applications emit coherent light with a single optical wavelength between 1290 nm and 1330 nm (although it is also possible to use wavelengths around 1550 nm, the performance needs to be carefully engineered). In comparison, the optical output of a Fabry-Perot laser is characterized by multiple wavelengths lasing simultaneously. Single wavelength operation is necessary to minimize dispersion effects inherent to the optical fiber and is also required to maintain low RIN, which is requi-

Figure 1: *Laser chirp effect on CNR performance in case of (A) link loss is comprised of optical couplers, (B) link loss is comprised of all fiber, and (C) link loss includes 5 dB of optical coupler loss.*

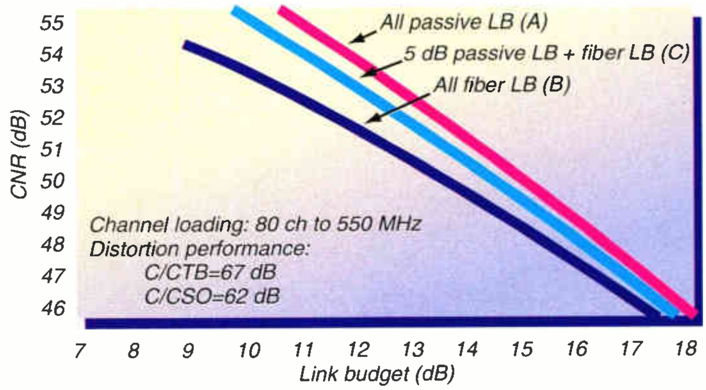
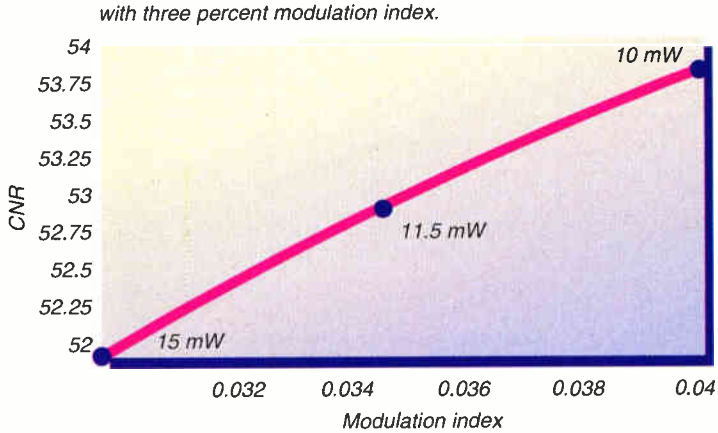


Figure 2: *CNR vs. modulation index and transmitter power at a 10 dB link loss (all fiber). Note that a 10 mW transmitter with four percent modulation index has 2 dB better CNR than a 15 mW transmitter with three percent modulation index.*



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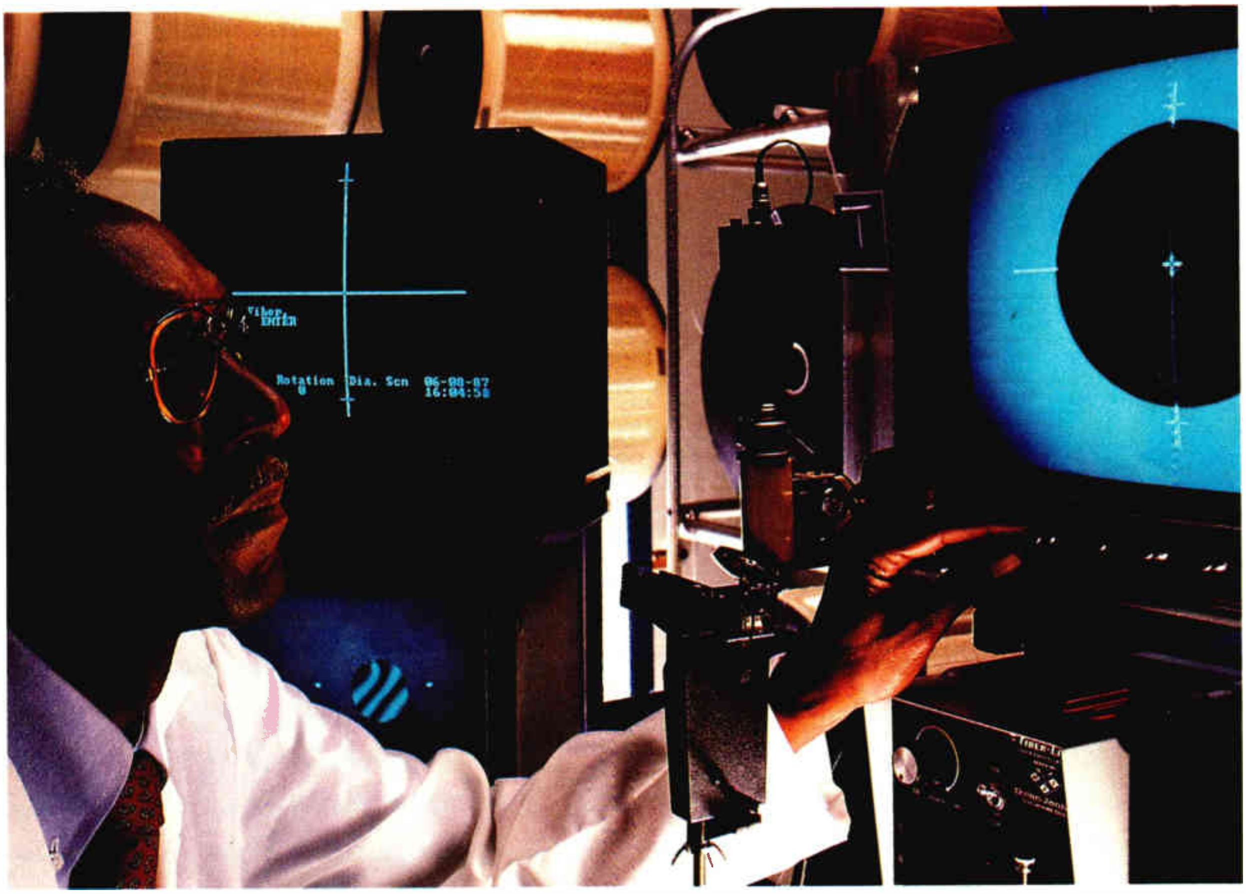

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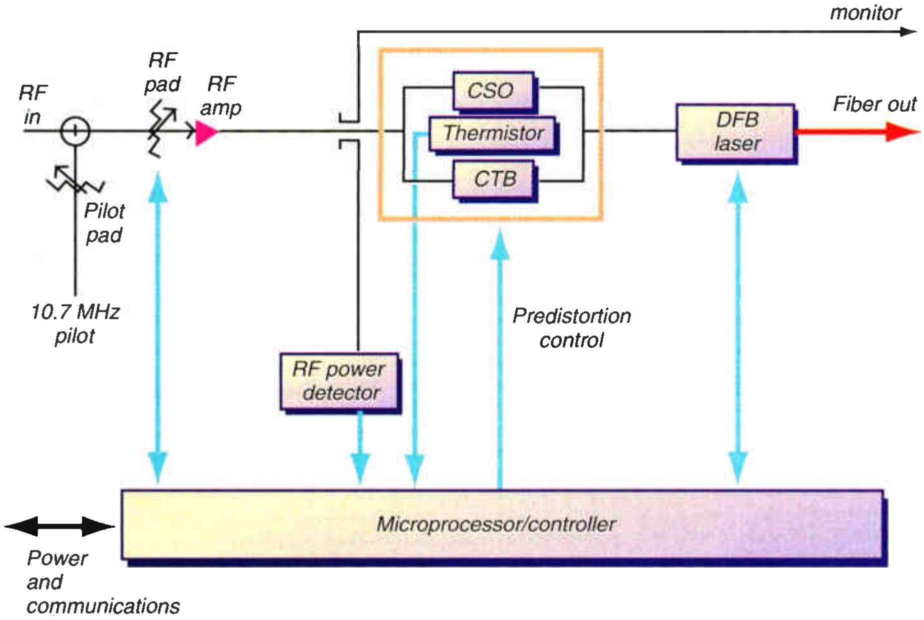

Figure 3: *DFB transmitter block diagram. The laser is predistorted for both second and third order distortions.*

site to achieving a high CNR at the optical node. These lasers are usually packaged with an internal optical isolator to maintain the necessary low RIN.

Early DFB lasers were used in very limited applications because of low optical power and inadequate distortion performance. In addition to the difficulties in increasing optical power, and the inherent problems of laser linearity and noise which limit link performance and affect device fabrication yield, several other phenomena can impair transmission quality. Most notably, several types of undesirable interactions between the laser transmitter and optical reflections in the fiber distribution system can occur, leading to enhanced noise and distortion (references 1-5).

Analog DFB laser transmitters are directly modulated, which implies that the AM-VSB information is directly imposed on the laser drive current. Frequency chirp or temporal wavelength variation occurs as a result. Laser chirp has various system performance implications, including impacting CNR and distortion performance. As will be shown, laser chirp needs to be maximized for optimal performance.

Link performance

For AM-VSB systems, the CNR at the receiver is calculated as in Equation 1.

It's most desirable to achieve a high CNR while maintaining low distortion. To achieve high CNR, the numerator in Equation 1 should be maximized, and the denominator should be minimized. In the numerator, it's desirable to have both the modulation index and optical power as high as possible. Limitation of the optical power stems from the differential quantum efficiency of the laser and the optimum bias current that provides the best linearity.

The modulation index has an upper limit governed by the clipping distortion, assuming perfect linearity. This limit sets the allowable modulation index to approximately four percent for 80 channel loading. However, for non pre-distorted lasers, the allowable modulation index is practically limited by the non-linearity of the laser diode, rather than by clipping distortion onset, limiting it to less than 3.5 percent.

Equation 1: For AM-VSB systems, the CNR at the receiver is:

$$CNR = 10Log\left[\frac{(mrP)^2}{2B\,(N_{th} + rPN_{shot} + RIN(rP)^2 + IIN)}\right]$$

Where:

Parameter	Description	Typical value
m	Modulation index per channel	3%-4%
P	Received optical power	0 dBm
r	Receiver responsivity	0.81
B	Filter bandwidth	4 MHz for NTSC
N_{th}	Thermal noise	8 $pA/\sqrt{Hz}$
RIN	Relative intensity noise	-156 dB/Hz
N_{shot}	Shot noise	
IIN	Interferometric intensity noise caused by Rayleigh scattering in the fiber	

The thermal noise in the denominator provides the lower limit of the CNR at low received optical power. The shot noise term is proportional to the received optical power and affects the CNR at high received optical power condition. Note that at high received optical powers (which are desired), the noise level is governed by the laser RIN and IIN contributions. The nominal laser RIN is below -155 dB/Hz up to 860 MHz, and significantly lower at 550 MHz. IIN effects will be discussed later, in conjunction with laser chirp.

Because the magnitudes of both the numerator and denominator are dependent on the received optical power, driving the optical power higher would not necessarily result in a higher CNR. Careful examination of Equation 1 shows that higher CNR can be achieved by increasing the laser modulation index, hence increasing carrier level and minimizing IIN effects. The increase is made possible by the introduction of pre-distortion circuits which allow a higher modulation index, while maintaining an acceptable second- and third-order distortion performance.

Laser chirp

Due to naturally occurring fiber non-uniformities, multiple reflections (resulting from Rayleigh backscattering) of the light occur. The interaction between chirp and fiber reflections causes IIN, which in turn degrades system CNR, a degradation whose magnitude depends on the laser chirp and fiber length. This explains the improvement in CNR performance experienced in cases where the optical link is comprised in part of optical couplers as compared with links where the link loss is comprised of all fiber.

An example of the chirp-induced degradation is shown in Figure 1. Three cases are depicted. The first (A) plots CNR in a case where the link loss is entirely comprised of

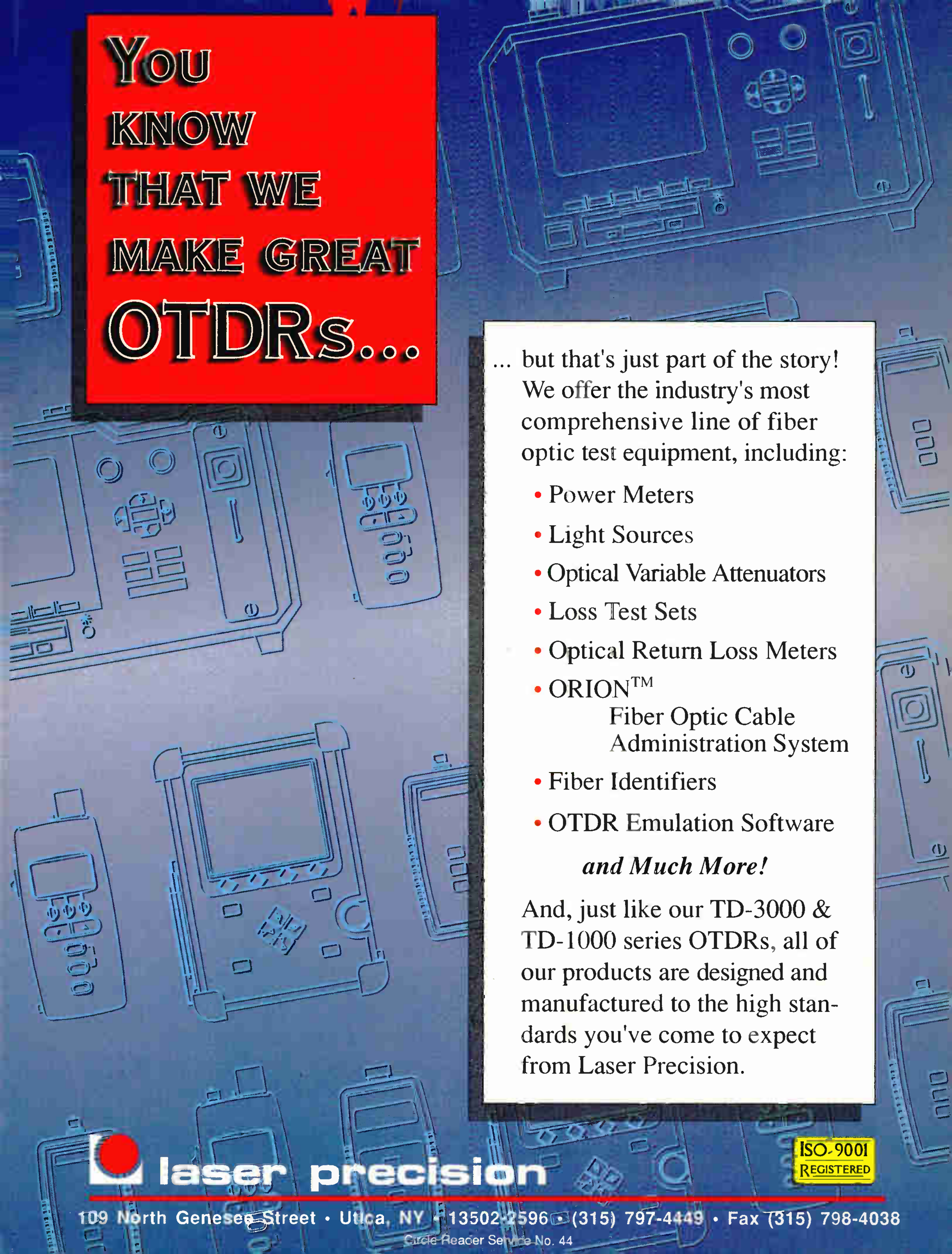
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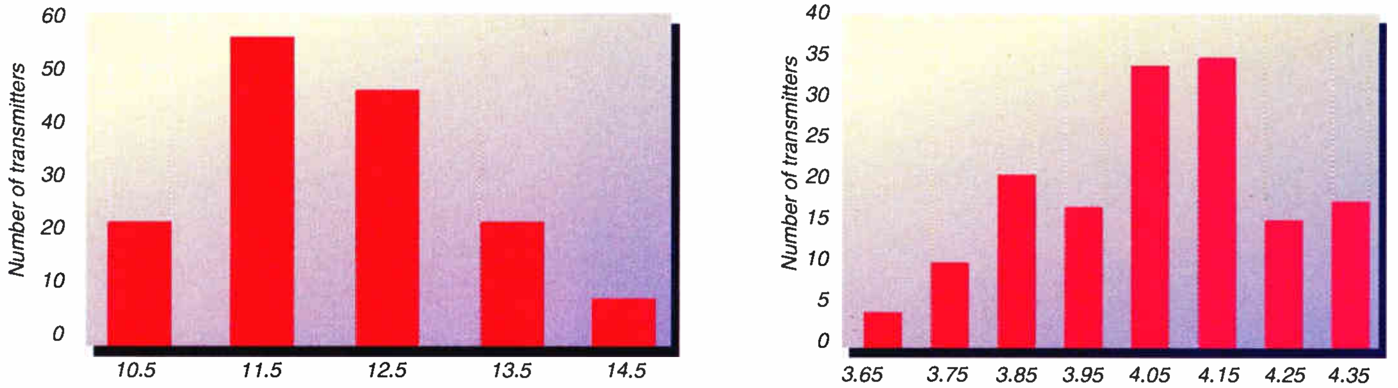
Figure 4: Optical power and modulation index histograms for 150 transmitters. Mean optical power is 12 mW (10.8 dBm), and mean modulation index is four percent per channel.



passive (i.e., optical coupler) loss. In this case, chirp effects are minimized. In the second case (B), the CNR is plotted for link loss which is comprised of all fiber; hence, chirp effects are maximized. At a link loss of 13 dB, a difference of about 2 dB exists between curves A and B.

The intermediate case, in which the optical loss is comprised of 5 dB passive and the rest of fiber loss, is shown in curve C. In all cases, laser chirp is assumed to be between 300 and 350 MHz/mA. CNR improvement with the presence of passive loss critically depends on the system design, and as a conservative rule of thumb, can be taken as 0.1 dB for each dB of coupler loss (i.e., for the example shown in Figure 1, CNR would improve by 0.5 dB from curve B to curve C). In light of the above, it is important for the system designer to know the worst case operational mode specifications of the laser transmitter in which link loss is comprised of all fiber loss.

Pre-distortion and modulation index

As is shown in Equation 1, RF carrier level and the CNR at the receiver node are dependent on both the received optical power and on the transmitted modulation index. Historically, DFB specifications included only the optical power of the transmitter and did not include its optical modulation index. As was shown earlier, to achieve a higher CNR, one needs to primarily maximize the modulation index.

Owing to the difficulties in achieving adequate pre-distortion, the demand for higher performing DFB lasers has resulted in higher power DFB transmitters. Higher power lasers with good non-linear performance affect device fabrication yield, and, with all things being equal, it is preferable to have a laser with low optical power and high modulation index, rather than the reverse. The reasons for this are multifold.

First, a higher bias current is required in order to achieve higher output power. Driving the laser harder affects its lifetime and reliability and results in higher laser RIN. Second, having lower optical power helps avoid link performance limitations imposed by most optical front-ends which can accept no more than 2 dBm to 3 dBm of optical power, hence limiting the available link loss, especially in links requiring high CNR. For example, a laser with output power of 13 mW (11 dBm) can be used in links of no shorter than 8 dB to 9 dB, limiting the maximum achievable CNR.

The third reason is illustrated in Figure 2. In the figure, the CNR at 10 dB (of all fiber) link loss is plotted vs. modulation index and optical transmitter power pairs. Comparing the two extreme points on the curve, a 15 mW laser with three percent modulation index yields a

CNR of 52 dB, while a 10 mW laser with four percent modulation index yields a CNR which is better by almost 2 dB for the same 10 dB loss. By increasing the modulation index, one increases carrier level and induces more chirp, which in turn reduces IIN simultaneously, resulting in a better CNR.

Without pre-distortion, it's very difficult to achieve a high modulation index because of the inherent non-linearity of DFB lasers. Even if an ideal diode laser were available with a straight output power to bias current (L-I) characteristic, implying a linear relationship between the laser drive current and optical output current; and even assuming ideal RF voltage amplifiers, distortion would still appear in the laser optical output due to the nonlinearity of the PN junction (semiconductor interface necessary for the lasing action) current-voltage relationship, and also due to leakage currents.

Applying second- and third-order pre-distortion circuitries to DFB lasers results in lasers with typical distortion numbers of CSO <-62 dBc and CTB <-67 dBc with 80 NTSC channel loading. Figure 3 depicts a block diagram of a DFB transmitter with CSO and CTB predistortion circuits which are also temperature compensated. The RF power detector is used as part of the user selectable automatic gain control circuitry.

The mean modulation index measured for 150 DFB transmitters is 4.04 percent per channel with a standard deviation of 0.19 percent. Over a fiber span of 10 dB, the measured worst channel CNR has a mean value of 54.47 dB with a standard deviation (in dB) of 0.39 dB. This deep modulation index corresponds to a composite modulation index of $m^*(N/2)^{0.5} = 0.259$, slightly below clipping distortion. This is summarized in Figure 4.

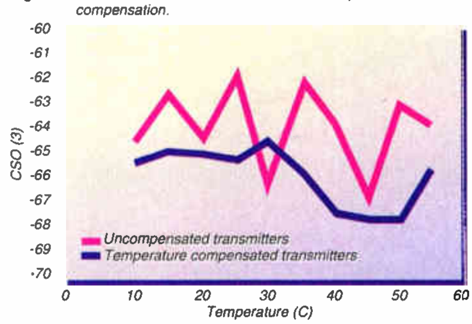
Frequency response, operating temp

Frequency response of the transmitter is another important parameter to evaluate, as it affects the end performance of the distribution link. To allow transmitter cascading and good signal quality, typical flatness and ripple should be 0.5 dB over the laser frequency range (i.e., 750 MHz). Another key parameter for performance evaluation is the stability of the CNR, CSO and CTB with respect to ambient temperature. This is especially important for transmitters which are installed in an OTN cabinet where ambient temperatures vary considerably. Figure 5 depicts typical CSO behavior of uncompensated vs. temperature-compensated transmitters. The CNR of the temperature-compensated transmitter varies by less than 0.4 dB over the 0 to 50 degree C range.

To increase system reliability and ensure minimum downtime, it's important that all of the critical operating parameters of the transmitters be monitored and available for network management purposes. These parameters might include: laser bias, laser power, laser temperature, RF drive power and environmental temperature. For ease-of-use and module interchangeability, most of the monitored parameters should have preset ranges with alarm flags raised in case of operational errors. Automatic gain control can also be useful, allowing quick replacement of modules and minimizing the effects of headend level fluctuations.

In conclusion, the discussion has centered around the most important parameters that affect DFB laser transmitter operation. The interplay between a high level of linearity, high carrier-to-noise ratio and laser chirp was shown to favor pre-distorted lasers with lower optical power and a higher modulation index. A compact design and user-friendly interface, combined with an easy-to-use network interface and management system, are important, especially as the number of DFB transmitters in the headend increases and headend management and downtime requirements become more stringent. Flat frequency response, and above all, overall performance consistency, are also necessary requirements. Keeping all of these parameters in mind when evaluating DFB laser performance will ensure successful and consistent broadband services transport.

Figure 5: DFB transmitter CSO without and with temperature compensation.



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Balancing analog and digital options

Analog architectures are alive and well

By Gregory Hardy, Director of Marketing, Transmission Systems, Scientific-Atlanta

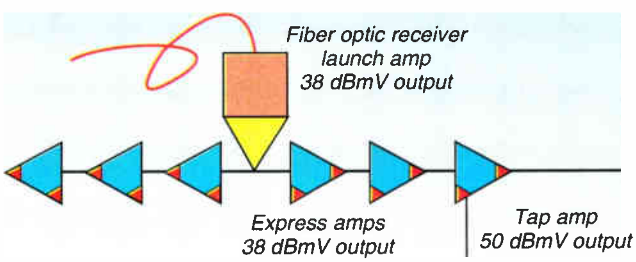
During the last two years, most broadband network engineers have selected 750 MHz hybrid fiber/coax architectures when planning a rebuild or an upgrade. Typically, the 50 MHz to 550 MHz bandwidth delivers analog programming, and the 550 MHz to 750 MHz tier is planned for future digitally compressed video. Near-video-on-demand and video-on-demand marketing trials are underway, and many operators are looking forward to these expanded service and revenue opportunities.

However, widespread deployment of digital compression appears to be some time off, for many reasons. In the meantime, competitive pressures and the need for expanded revenues have caused operators of both large and small systems to look for solutions now, while digital technology is being developed. The answer may already be at hand, in the time-tested and proven analog equipment. This article considers some of the system design alternatives to support system expansion by simply extending current analog services.

Most 750 MHz architectures have been designed for 550 MHz analog and 200 MHz digital loading. Noise and distortion calculations for this configuration are similar to that of a traditional 550 MHz analog network. Table 1 considers a three-amplifier cascaded hybrid fiber/coax system. Typically, one will see a 1 dB degradation in the carrier-to-noise ratio (CNR) and composite triple beat (CTB) performance on channels 77-78 when the digital tier is added above the 550 MHz of analog signals.

Table 1: Noise and distortion contributions optimized for 550 MHz analog/200 MHz digital transmission

		Fiber	+ Distribution	= End-of-line
CNR	(dB)	51	56.9	50
CTB	(dBc)	-65	-55.9	-53.3
CSO	(dBc)	-61	-58.2	-56.4



Hybrid fiber/coax architecture

Engineers construct these networks with laser transmitters optimized for a mix of analog and digital loading, and RF amplifiers using parallel hybrid (PHD) technology. The result is a system providing the following performance: CNR = 49 dB; CTB = -53 dBc; and CSO = -53 dB.

Now consider the case where digital transmission in the 550 MHz to 750 MHz range is planned, but not yet deployed. As additional revenue-producing analog channels, such as NVOD and VOD channels, are added above channel 78, how might one expect the system to perform? Table 2 indicates significant performance deterioration at both 94 and 110 analog channel loading from a network designed only for 550 MHz analog/200 MHz digital operation.

Not surprisingly, the end-of-line distortions are significantly impacted by the introduction of analog carriers above 550 MHz. The question now becomes how the broadband network may be optimized to allow some analog "breathing room" in the event this 200 MHz of valuable channel space is recruited into analog service before digital deployment begins.

Keeping in mind that the fiber optic link is the largest contributor to end-of-line noise and the RF amplifier cascade principally contributes to end-of-line distortions, several modifications are required to the broadband architecture and electronics in order to achieve improved distortion performance with higher analog loading.

650 MHz analog channel loading

For 650 MHz analog operation of a hybrid fiber/coax network like that discussed in Table 1, the following changes are made:

✔ Use of a laser transmitter that is optimized for 94 (or 110) analog channel loading. This product employs a lower depth of modulation per channel relative to that found in 550 analog/200 digital lasers.

✔ Deployment of quad power (QP) technology in the express amplifier locations. QP typically yields a 5 dB to 6 dB CTB improvement on a per-station basis over conventional PHD products.

✔ Lower output levels of the tap amplifiers by 1 dB from the 550/750 MHz design.

The resulting system performance at 650 MHz without a digital tier is CNR = 49 dB, CTB = -52.5 dBc, and CSO = -56.6 dB; this performance is very close to the design specifications for the 550 MHz analog/200 MHz digital network. However, because tap amp output levels are lower, the actives per mile count is up slightly.

750 MHz analog channel loading

Achieving a high level of noise and distortion performance with 110 analog channels is a more significant challenge for the network architect. Again utilizing the hybrid fiber/coax analysis in Table 1, the following modifications were made:

✔ Utilization of a laser transmitter that is optimized for 110 analog channel loading. This transmitter is similar to the one described above.

✔ Deployment of quad power technology in the express amplifier locations.

✔ Lower tap amplifier output levels by 3 dB from the 550 MHz analog/200 MHz digital design.

The resulting system performance at 750 MHz without a digital tier is CNR = 48 dB, CTB = -52.5 dBc, CSO = -56.8 dBc. In this case, a 3 dB reduction in tap amplifier output levels yields approximately a 25 percent increase in actives per mile. Table 3 summarizes the network architecture and product modifications required to move to 650 MHz and 750 MHz analog operation.

Analog for high gain architectures

Up until this point, only the traditional hybrid fiber/coax architecture has been dis-

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Table 2: *Impact of analog channel loading on system optimized for 550 MHz analog/200 MHz digital transmission*

		78 channels	94 channels	110 channels
Frequency	(MHz)	550	650	750
CNR	(dB)	50.0	49.0	48.0
CTB	(dBc)	-53.3	-50.8	-48.1
CSO	(dBc)	-56.4	-55.7	-55.0

94- and 110-channel scenarios assume no digital transmission

cussed, which generally is used in system rebuilds or newbuilds. Popular for 750 MHz upgrades is a "high gain drop-in" architecture, however. In this type of architecture, high gain, three-stage PHD amplifiers are installed in place of existing 300 MHz trunk bridger stations. These amplifiers provide approximately 35 dB of gain in the auto control mode, making them attractive for trunk upgrades.

An upgrade architecture of this type typically utilizes three or four high gain amplifiers and two line extenders in cascade to obtain the desired performance of CNR = 48 dB, CTB = 53 dBc, CSO = -57 dBc at 550 MHz analog/200 MHz digital loading. Changes to the 550 MHz analog/200 MHz digital designed network to accommodate 650 MHz or 750 MHz analog loading is much more difficult in an upgrade. Quad power technology is not available in three-stage RF amplifiers; hence, the network designer must work only with PHD products. Also, high output levels (45 dBmV) are required for feeder efficiency. Turning down output levels in the trunk to improve distortions is not really an option in upgrades.

Network architecture and product modifications when moving to a 650 MHz analog channel scheme are as follows:

✔ Deployment of analog optimized fiber transmitter.

✔ Lowering of feeder levels by 1 dBmV.

These changes yield the following noise and distortion results: CNR = 47 dB, CTB = -52 dBc, CSO = -57 dBc. They are about 1 dB down from our analog/digital design performance.

When considering 750 MHz analog loading in a high gain architecture, there are not as many options. Without any modifications to the 550 MHz analog/200 MHz digital design, resulting performance is an unacceptable -46.5 dBc CTB at 110 channels. Given the limitations of amplifier spacing and technology, the amplifier cascades must be shortened to significantly improve end-of-line noise and distortions. Amplifier cascades must be cut in half, which will nearly double the number of fiber optic receiver locations. This makes for a potentially expensive alternative.

Summary

Most broadband network operators are now planning a 750 MHz rebuild or upgrade. Architectures and product technology selections normally assume a 550 MHz analog and 200 MHz digital channel lineup. With the deployment of digital services a few years out, several alternatives exist that will allow the operator to still capitalize *now* on new revenue opportunities like NVOD and VOD with an expansion of analog service channels above 550 MHz.

Operators planning rebuilds and newbuilds have more flexibility in analog alternatives than those with upgrades. The use of analog optimized laser transmitters and quad power amplifiers provides a path to 650 MHz analog, and potentially, 750 MHz analog. These options provide the operator some breathing room until digital can be deployed. CED

Table 3: *Noise and distortion contributions for 650 MHz and 750 MHz optimized systems*

650 MHz - 94 analog channels

		Fiber +	Distribution =	End-of-line
CNR	(dB)	50	55.9	49
CTB	(dBc)	65	-54.9	-52.5
CSO	(dBc)	61	-58.6	-56.6

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2. Quad power express amps operating at 38 dBmV output
3. PHD tap amps operating at 49 dBmV output levels

750 MHz - 110 analog channels

		Fiber +	Distribution =	End-of-line
CNR	(dB)	49	54.9	48
CTB	(dBc)	-65	-54.9	-52.5
CSO	(dBc)	-61	-58.9	-56.8

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Cox's McCarley wins Polaris Award

Earns praise for work with fiber optics

Hugh McCarley (center) of Cox Cable Communications Inc. is the recipient of the 1995 Polaris Award. He is flanked by previous Polaris winners Jim Ludington (left) of Time Warner Cable and Tom Staniec of NewChannels. (Photo by Phelon Ebenhack)

By Roger Brown and Leslie Ellis

Long-time industry veteran and SCTE member Hugh McCarley of Cox Cable Communications Inc. was awarded the prestigious 1995 Polaris Award at the SCTE Conference on Emerging Technologies in Orlando, Fla. last month. McCarley, director of corporate engineering for the Atlanta-based MSO, joins Jim Ludington of Time Warner Cable and Tom Staniec of NewChannels as winners of the award, named after one of the brightest stars and the navigational standard. The award was created two years ago by Corning, *CED* magazine and the SCTE.

McCarley was presented with a piece of Steuben crystal, called the Rising Star, that symbolizes his accomplishments with fiber optic technology. In addition, Corning Inc. presented the SCTE with a check for $2,000 to fund fiber optic training initiatives.

At Cox, McCarley has been closely involved with the design, construction and implementation of the company's fiber deployment throughout the United States, including the new Ring-in-Ring architecture the company plans to deploy that promises to significantly reduce outage time and ensure network survivability.

The self-deprecating McCarley was clearly moved by the recognition, and thanked industry vendors and his friends. "I'm not really sure what I did to deserve this award," said McCarley. "I was shocked when I was told I would receive it—I wasn't even aware I was being considered."

But McCarley saved his highest praise for his colleagues at Cox and his family, both of whom stuck by him during the transition period when fiber was first introduced. "Thanks to those first two systems, Pensacola and Ocala, for having the trust to allow me to introduce a new technology," said McCarley. "This award is really yours. I accept it on your behalf." He then thanked his wife and son for enduring all those times when he couldn't be home.

McCarley's cable career began in 1972, when he joined American Television and Communications and served in various technical and engineering roles before moving to Alabama in 1976. He later served eight years as director of engineering for Birmingham Cable and as regional engineering director for the central Florida area. He then moved on to Cox Cable's corporate engineering department as an equipment evaluation manager and staff engineer, prior to being named director of engineering technology.

McCarley is also an active member of the SCTE. He currently serves as a national Board member representing Region 9, which covers the states of Florida, Georgia, South Carolina and the Caribbean. He also serves on the Board of the Chattahoochee Chapter and previously served terms as president, chairman, secretary and treasurer of the chapter. He is also involved with the NCTA, the Southern Cable Television Association and the Cable Television Association of Georgia.

The pitfalls of two-way

Besides McCarley, about 1,300 others were in Orlando during the conference to hear the latest about multimedia, telephony and compression over cable TV networks. One big issue that was repeatedly discussed was the activation of two-way plant and the pitfalls that await operators.

It became clear that as digital signals migrate this year from the headend and over the outside plant toward houses, worries are similarly sharpening over the capability of the wired environment inside consumer homes.

The potential problem: in-home coaxial cables with less than 67 percent shielding, impulse noise on those wires, or poorly

SCTE Board Chairman Tom Elliot of TCI (left) presents plaques to Anna and Bill Riker in recognition of their efforts to rejuvenate the Society over their 10 years of service. (Photo by Phelon Ebenhack)

installed F-connectors could wipe out a digital television signal, according to panelists speaking about digital compression.

"With digital television, there is no gradual degradation of the picture–it's either there, or it's not," said Claude Baggett, director of customer premise equipment for Cable Television Laboratories, who called the in-home environment, "the most vulnerable part of our systems."

Most MSOs are targeting the third quarter of this year as the starting point for digital signals to begin streaming into the home, pending the availability of digital set-top boxes. Those boxes will include compensation circuits, called "adaptive equalizers," to ward off some of the effects of a poor in-home environment, but that circuitry may not be enough, said Brian Bauer, telecommunications marketing manager for Raychem Corp.

Bauer said in the presentation that his research reflects the unwieldy nature of the drop plant and in-home environment. "We looked at the recent service call reports from two (unspecified) major cable MSOs, and in both cases, found that over 50 to 60 percent of the trouble calls relate to the drop," Bauer said.

"There are potential problems in the home everywhere there is a connection," Bauer said, noting that "the more connectors there are in the drop, and the higher the modulation rate entering the home, the more of a problem there is."

Bauer noted three ways in which operators can combat kinked cables and loose connectors: placing optical-to-RF nodes closer to the home, then delivering analog narrowcast services; converting digital signals to an analog format directly outside the home; and using semi-permanent or permanent F-connectors

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within the home.

Another approach, Bauer noted, is educating both subscribers and home builders about the merits of quality materials and installation. For example, placing a tag on in-home coaxial cables designating them as carriers of digital content may dissuade subscriber tampering.

During the tutorial sessions before the conference, Intel Corp., which in partnership with Hybrid Technologies and General Instrument, is supplying RF modems for cable operators Comcast Corp. and Viacom/Castro Valley, detailed the network requirements for its two-way data transmission network.

The key components of the Intel infrastructure: a home PC equipped with an Intel cable adapter, the existing cable network and a so-called "point of presence" facility, separate from the cable headend, which connects on-line service providers to the network for distribution, said Intel's Thomas Craver.

Intel's downstream plan includes 64 QAM modulation, distribution within 750 MHz of bandwidth, and data rates of about 27 Megabits-per-second (Mbps), after error correction techniques are deducted.

For the reverse path, Intel plans to share bandwidth between subscribers, where each user receives a 100 kHz channel for transmission. Up to 50 subscribers can be active at any one time within the 5 MHz to 40 MHz subsplit spectrum, Craver said. The system uses QPSK modulation for transmission at rates of 128 kilobits-per-second/channel.

Time Warner's FSN is the first system to use the high level return band, and the first to send ATM end-to-end.

To combat the noise present in the reverse path, Intel is incorporating channel quality monitoring and management, Craver said, which includes measures like assigning the "best" channel first, re-dedicating the worst channels to better frequencies and moving active users to other spectral locations when a channel degrades.

Craver said the in-home wiring environment is certainly a cause for concern when transmitting and receiving data, but that "even at peak noise periods, we estimate that 90 percent of all channels would be available."

Multimedia requirements

Preparing the historically one-way plant to haul video and other services in both directions was the focus of the multimedia panel session. In the session, panelists representing cable and long distance operators and equipment manufacturers discussed bandwidth needs, interconnects and requisite customer premise equipment, as well as other subjects related to interactive computing.

For example, Ken Wright, director of technology for Jones Intercable and a co-panelist with Time Warner's Mario Vecchi, took a sharp look at the 5-40 MHz upstream path. "When you talk about the residential cable network requirements (for multimedia delivery), you quickly realize the breadth of the issues," Wright said, noting that his presentation would focus on ways to tailor cable networks for high-speed, two-way communications.

Of course, the conference took place in the backyard of the most sophisticated broadband network on the planet, Time Warner's Full Service Network, which was launched in mid December to a group of residents north of Orlando. A working demo of the navigation system and video-on-demand was provided by the MSO.

During a tutorial on the subject, Time Warner engineers detailed how the main portions of the network function, concentrating on the physical network, software systems and the logical network, including ATM and MPEG.

The highly-touted network has already recorded several firsts, according to Jim Chiddix, senior VP of engineering and technology with Time Warner. For example, it's the first system to use the high level return band, the first to send ATM end-to-end, and the first to send MPEG video over an ATM link.

Use of the high-level return band between 900 MHz and 1 GHz won't be duplicated in any other Time Warner cable systems anytime soon, because of the high cost of transmitters and other components, said Chiddix. However, the band required "nothing extraordinary" to effectively transmit signals, he said, noting that small problems with ingress and microreflections from the drop and/or in-home wiring can be easily overcome or circumvented. CED

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Interactivity comes on line

The real message from Orlando

Time Warner's Carousel, developed by Silicon Graphics, allows users to navigate the Full Service Network.

By Fred Dawson

The unveiling of Time Warner's Full Service Network in Orlando comes at a moment when what was to have been a vision of how TV might look some day, is suddenly a picture of what it might look like tomorrow.

Video on demand with VCR-like functionality, network-delivered interactive games, catalog shopping and other staples of the Orlando FSN are capabilities now targeted by a growing list of vendors and their customers for commercial introduction within a year, thanks to a spreading conviction that the issue isn't whether the public will want such services, but rather, who will get to the market first. "Sooner isn't only better," said Time Warner Chairman and CEO Gerald Levin in remarks at the Orlando demonstration in early December, "it's often everything."

But, as Time Warner officials acknowledge, it's virtually certain that the first entrants in the interactive sweepstakes will make different choices with respect to the details of technology implementation than Time Warner made in patching together the Orlando digital platform. In the opinions of many cable and telephone companies, cost points will be sufficiently low to launch services sooner rather than later, so long as network operators scale initial offerings to support key capabilities while building in an evolvable platform that permits ever more functionality to be added over time.

Time Warner officials made it clear that they, too, are not bound by any previously set timetables in the fast-moving digital communications arena. "We want VCR functionality across all these applications," Levin said in an interview. "If anybody can do that at lower cost, we'll be there."

"We're pragmatic business people, and if we see an opportunity, we will act on it," added Jim Chiddix, senior vice president of engineering and technology at Time Warner Cable. As an example of how things could be done differently, Chiddix said, "We may not need so much power in the home terminal. You can do many of the things we're doing here with more of the computer power placed further back in the system."

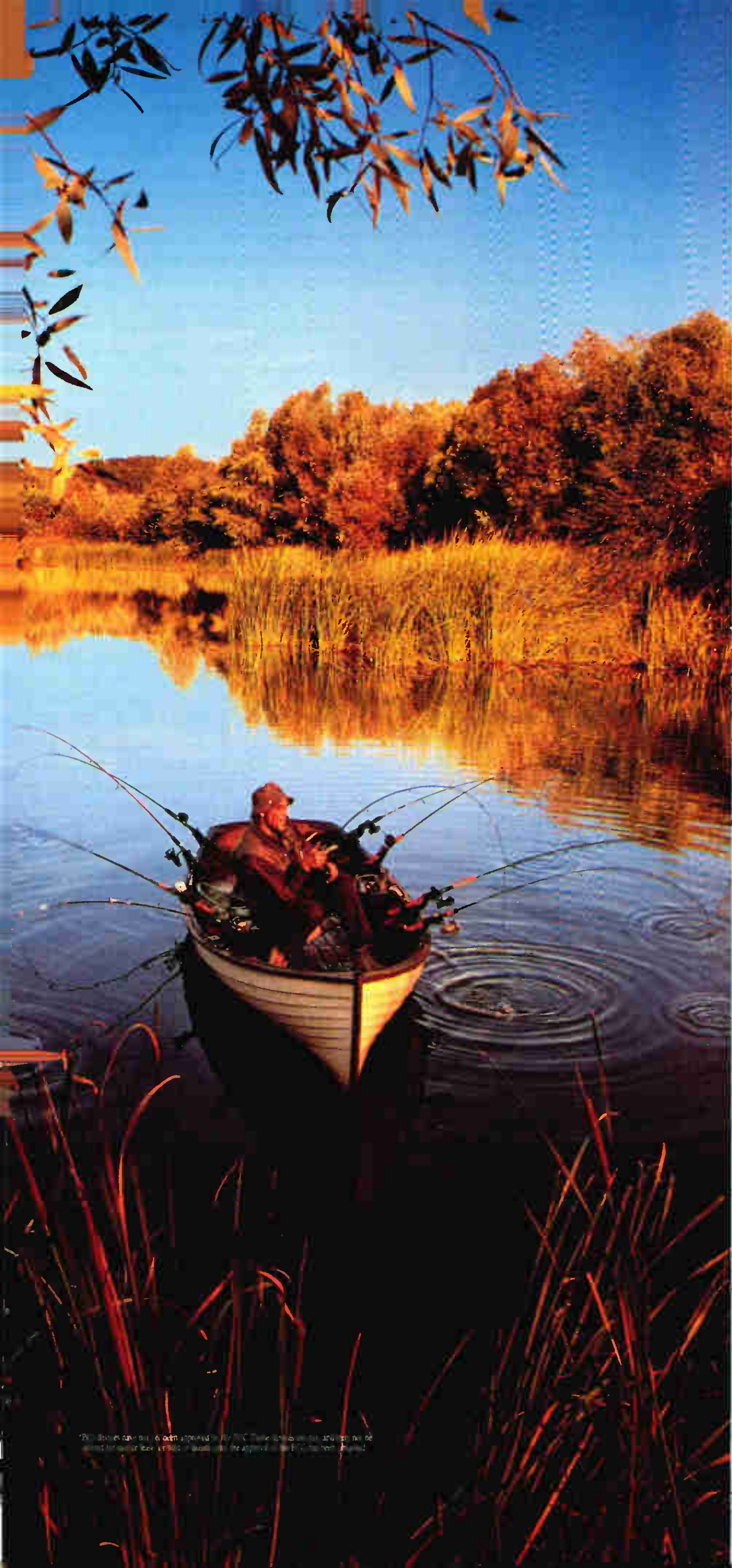
Opening fast tracks

Cost-efficient allocation of computer power without sacrificing the bottom-line functionality spelled out by Levin has become a hot button among many suppliers, including two of Time Warner's Orlando partners, AT&T and Silicon Graphics. The two teamed up last year to form Interactive Digital Solutions, a company that is working with a variety of customers to fashion the two firms' hardware and software capabilities into customized end-to-end solutions.

Levin lauded Cablevision System Corp.'s move to apply IDS capabilities in a commercial rollout of on-demand TV to 20,000 Long Island households by year's end (see January *CED*, p. 62). "I think it's wonderful that (Cablevision CEO) Chuck Dolan is doing what he is doing," Levin said.

Where Time Warner is using a home terminal with computer power exceeding that of a 1990 vintage mainframe, Cablevision will be deploying an AT&T digital box with relatively low-power Intel X86 chips to deliver the same types of services that comprise the initial venue offered in the Orlando trial–movies on demand, home shopping and games. "We did not want to emulate Time Warner, which is using a very expensive system," said Zizi Zhao, who holds the unusual title of chief scientist at Cablevision. "Our goal is to do the same things, but much, much cheaper."

The fast track received an even greater impetus at year's end when the FCC approved Ameritech's video dialtone applications, representing plans to connect 1.3 million households to hybrid fiber/coaxial networks in 134 communities in and around Detroit, Indianapolis, Ohio, Columbus, Cleveland, Chicago and Milwaukee, with service beginning in some markets before year's end. It was the first largescale commercial VDT filing to win approval and, as such, promises to have a huge impact on suppliers in comparison with the trickle of business which, so far, has been largely dedicated to



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Gregory Brown, Ameritech vice president of video and interactive services, refused to discuss details of service content and packaging, but he made clear that certain digital TV services would be part of the mix at launch. "We're banking on doing what the competition can't do," Brown said. "We believe consumers will see superior value in the reliability and quality of our services combined with the packaging of network services and diverse on-demand services."

The key to getting VOD and other first-phase digital services underway early at low costs is to ensure the computer power in the network is sufficient to make the network independent of the set-top box, said Martin Nisenholtz, director of content strategy at Ameritech. "I think what often keeps people in a quandary is confusing the set-top box with the network," he said. "We're taking an open interface approach that gives the consumer choices as things evolve to access services in a variety of ways."

The most computer-centric system yet to undergo market testing is the ICTV interactive analog and digital television platform installed by Cox Cable for its Omaha trial, which is just getting underway. The system's high-quality graphic navigator, as well as the switching software that accesses particular services from a server or other sources, is based in a headend computer, allowing customers to order interactive services as if the computer power were vested in their set-top terminals.

IBM recently tipped its hand as to which way it wants to go in developing end-to-end solutions by taking a minority stake with Cox and others in ICTV. "(The approach of ICTV) is innovative," said Robert Steen, director of multimedia networking at IBM. "It has a really unique solution to the problems, which we believe gives us the first step in a long journey that we'll be taking in interactive television."

While the Cox trial is built around analog channel feeds, Leo Hoarty, ICTV president and CTO, made clear the basic system is meant to work for digital as well as analog services, including provision of full VCR functionality, which has yet to be demonstrated but is in the works. "Digital would add costs, because you have to decompress the signal," Hoarty said. "But our system is well-suited to adding server-based digital services at very low costs."

Another firm moving to the fast track to allow early implementation of on-demand TV is IBM's arch rival, Digital Equipment Corp. Digital recently introduced its second-generation server, making clear its aim is to use open interfaces to free the network from dependency on any given type of set-top, along the lines outlined by Ameritech's Nisenholtz.

Digital is making the application programming interface to its server available to all set-top manufacturers and is providing these vendors with engineering assistance to ensure "total compatibility," said Sultan Zia, general manager of Digital's video interactive information services. He said the company now has agreements for ensuring compatibility between its new server and set-tops with 11 manufacturers, including General Instrument, Scientific-Atlanta, Zenith, Apple Computer, Compression Labs, Goldstar, Mitsubishi, Online Media, Philips, Samsung and Steller One Corp.

Digital's new server is "industrial strength" as compared to its first generation server, now in use in US West and Nynex trials, Zia said.

"While much of the world is working in trials," he added, "many of our customers want to go directly to the commercial deployment phase."

Other firms, he noted, "want a low-cost, small-scale server solution for trials that they can easily scale up to hundreds of thousands of users in full deployments. And they also want their server architecture to work with whatever database and authoring environments they choose."

Zia said the server stores content on Digital linear tape cartridges in a robotic library that can be upgraded to serve more simultaneous users. The server transfers programs at high speed from tape to disk and to RAM (random access memory) servers as needed, which keeps the incremental costs of storing a digitized movie below $4, he noted.

Time Warner designed the FSN remote control to be ergonomically correct.

The Orlando impact

While much work beyond Orlando is being done to push digital TV onto the fast track, the groundwork at Time Warner is as important as anything to ensuring the technology and services are in place to support the new medium. Ironically, if getting to the point of offering a graphically impressive, instantaneous on-demand venue has been an endurance test for the FSN team, their efforts and those of other early developers have seeded so much activity that the latecomers to interactivity will find much of the implementation process a no-brainer by comparison.

For example, officials at the Orlando demonstration stressed the importance of instantaneous response to the viewer's experience of the system. "We discovered the interface had to be transparent, as unintrusive a medium as a doorknob," said Edward McCracken, chairman and CEO of Silicon Graphics. "That means instantaneous response, which requires, from the standpoint of what people perceive as instantaneous, an elapsed time of no more than 140 milliseconds between the moment of command at the remote to reception of the picture on the TV screen."

It turned out that a key component in the ultimate solution to high-speed response proved to be an off-the-shelf piece of gear that required some relatively simple customization to make it serviceable. At the time, the only company supplying the device, known as an ATM (asynchronous transfer mode) access concentrator, was Hitachi, but others now have similar products, thanks to burgeoning demand for ATM capabilities in the LAN market.

Hitachi's AMS 5001 multiplexes the packetized return signals, delivered from fiber nodes to the headend, into DS-3 (45 megabits-per-second) channels for transfer to the AT&T-supplied ATM switch. These upstream, cell-based signals, which are aggregated at the DS-1 rate (1.5 Mbps) on RF frequencies at the fiber node, are highly bursty data communications which are fundamental to interactive functions of the FSN such as the ordering of services, pausing or rewinding movies, or registering orders for catalog goods.

ATM, of course, remains a question mark, with some network companies moving to use the cell-relay system to move digital video and other information between servers and households, and many more operators looking to what they think will be lower-cost data transport options, such as the soon-to-be-adopted MPEG-specific transport that uses 188-byte cells as opposed to the 53-byte framework of ATM. But the point here is that the adaptability of ever more powerful computer networking components to the needs of residential networks ensures that whichever approaches to specific requirements are taken, computer-centric solutions will make what Time Warner is doing in Orlando a simpler task for the next guy.

In this light, the Orlando trial affords a hands-on opportunity to experience the look and feel of the basic early-phase digital services that could be offered on a wide scale, even before the trial itself ends in mid to late 1996. People–mostly press–attending the trial roll-out in December appeared to find the services and how they were presented compelling, especially with regard to the system navigator and the VCR capabilities of the movie service.

The picture of what's in the offing over digital networks included services not currently on the FSN. At a demonstration center set up with selected vendors, Time Warner offered a look at several additional services which would seem to be eminently doable over a lower-cost, computer-centric alternative to the Orlando approach.

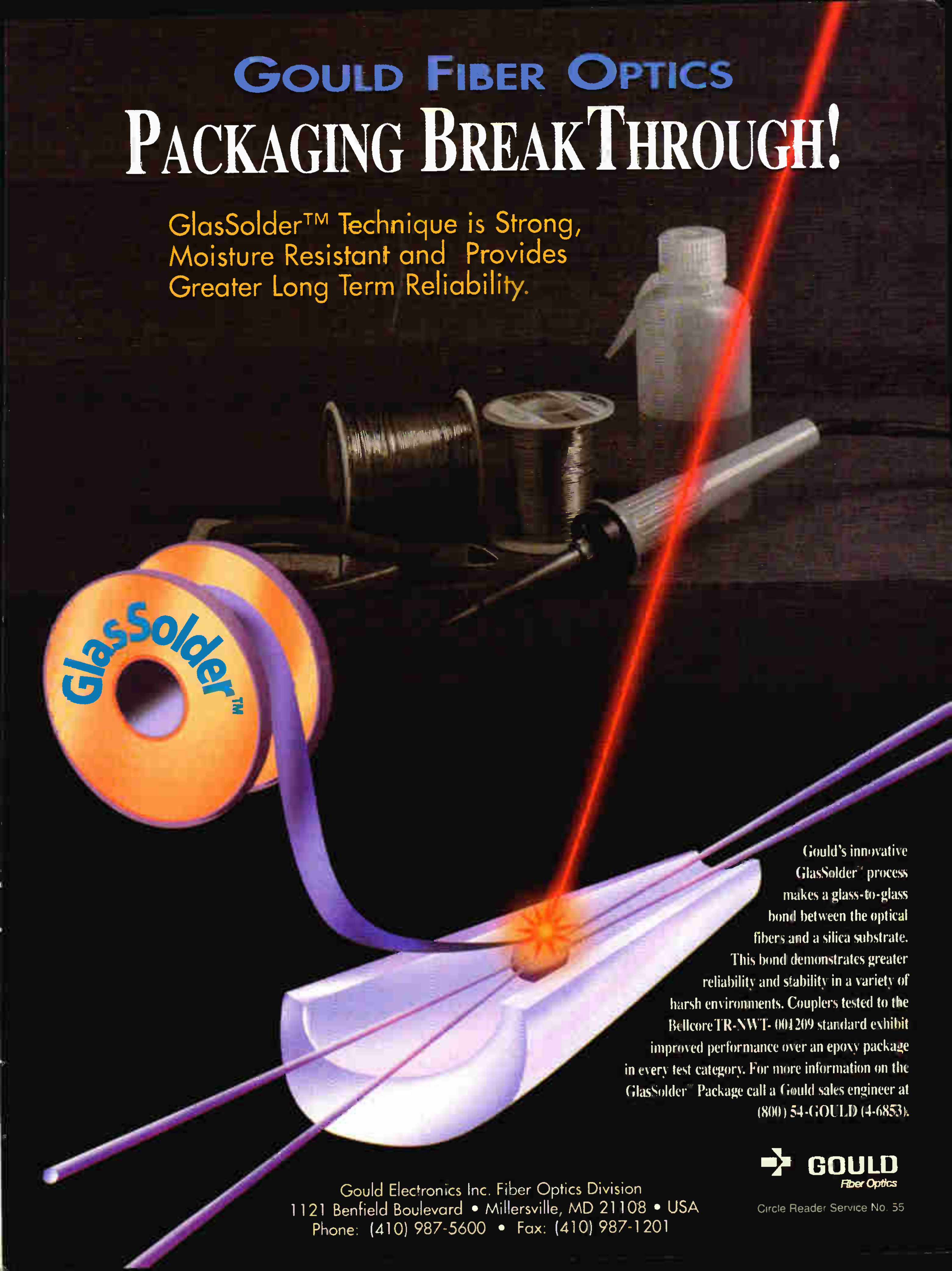
One of these, which Time Warner Cable Chairman and CEO Joe Collins singled out as especially promising, is News on Demand developed for Time Warner's News Exchange. Paul Sagan, managing editor for the project, said the key to introducing the service over the FSN was completion of a software system allowing real-time updates of media stored in the SGI hard disk drive system located at the Network Operations Center.

Sagan said partners in the venture, including CNN, ABC News, NBC News, local TV affiliates of ABC and NBC, The Tribune Company's Orlando Sentinel and Time Inc. magazines, are ready to begin feeding the operations center with timely information that can be accessed by customers whenever they choose. "This is a fully integrated system that's ready to go," Sagan said.

Another capability in the offing over the FSN that would be equally applicable in a more computer-centric environment is voice-command navigation, now under development for TV applications by Cambridge, Mass.-based BBN Hark Systems Corp., a developer of voice recognition technology. "Voice recognition is a very interesting possibility," Collins said.

In a space reserved for future FSN applications, BBN demonstrated its system, which changed channels, served up menus of various categories and performed other tasks in response to voice instructions. The system responded readily to voices without requiring that an initial "print" of the user voice be made and without requiring that commands be spoken in precisely the same phrases.

Voice-controlled TV access is on track to become an integrated feature of the remote control and navigation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"SkateKid" guides customers through the FSN video game arena.

systems in tandem with widescale commercial rollout of digital TV services, said Graeme Smith, marketing manager at BBN. "The core technology we're offering commercially will serve the needs we see for interactive TV browsing and navigation control without any further development," Smith said. "It's really a matter of adapting the system to the specific application, which we're under contract to do with Time Warner."

"Speech recognition is a natural choice as an interface because it provides customers with an intuitive, non-threatening means of interacting with a multimedia environment," Chiddix said. "This will allow us to explore a whole new kind of navigation system for the FSN."

BBN is committed to implementing a voice recognition component to the remote navigation system for trial in a handful of Orlando homes by mid-year, Smith said. By year's end, he added, the goal is to offer the voice-recognition capability on a wide scale within the 4,000-household test base.

Michael LeJoie, general manager of Time Warner Interactive, said the voice recognition technology could go a long way toward alleviating concerns about consumer adaptability to digital TV. "The Carousel (the navigation system developed for Time Warner by Silicon Graphics) and the remote that goes with it are very good attempts at making the system easy to navigate," LeJoie said, "but you're still forced to push a lot of buttons and to go through layers of commands to get what you want. Voice activation could cut through all that."

Smith said the key tasks remaining to prepare the system for rollout in Orlando concern integration of the microphone and some amount of voice processing capability into the remote unit, and modifications in the navigator software to maximize the benefits of the shortcuts that are implicit in voice activation.

"We expect to integrate the microphone into the remote and to do some frontend processing of the voice signal in a simple chip installed in that unit," Smith said. "That will reduce the amount of information that goes into the infrared channel to the set-top."

Smith said he did not expect costs to be a barrier to acceptance, no matter how the computer power is configured. "Where cost is concerned, our point is that you have to look at the value the interface adds to the system in terms of increasing the number of people who sign up," Smith said. "But we can't allow speech recognition to add significant costs to the set-top units. Our intention is to provide value at a price people can afford."

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The issue: Proof tests

For more than two years now, cable operators have had to test the performance of their systems twice a year, once during the winter, and again during the summer.

While many systems have simply integrated this function into normal operations, for others it remains a giant headache. How do you feel about the tests?

The questions:

1. If you haven't already, soon you will complete another round of proof of performance tests. Do you think the test results mirror the overall performance of the entire system?

❑ Yes ❑ No ❑ Don't know

2. How do the results from this latest round of tests compare to results gathered one year ago?

❑ Same ❑ Worse ❑ Better ❑ Don't know

3. What's your biggest gripe about doing the tests?

____

____

____

4. Do you think you are given the proper resources (both manpower and equipment) to perform the tests efficiently?

❑ Yes ❑ No ❑ Don't know

5. Have you made any changes to your routine maintenance procedures since the advent of the tests a couple of years ago?

❑ Yes ❑ No ❑ Don't know

6. In your opinion, is the current method of testing too disruptive to viewers, even if those disruptions occur late at night?

❑ Yes ❑ No ❑ Don't know

7. Has your system over the past year purchased some of the new test equipment that automates many of the tests and reduces the number of service interruptions?

❑ Yes ❑ No ❑ Don't know

8. Do you think it's necessary to perform the tests twice a year, or would one annual set of tests be enough?

❑ One's enough ❑ Two's fine ❑ Don't know

9. Does your local franchise administrator require you to submit test results to him/her?

❑ Yes ❑ No ❑ Don't know

10. If so, has the local franchise administrator ever requested more information about the tests or consulted with you regarding the results?

❑ Yes ❑ No ❑ Don't know

11. Has your system been tested over the past year by an independent consultant or engineer hired by the local franchise authority?

❑ Yes ❑ No ❑ Don't know

Your comments:

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Make a copy of this page and fax it back to us at the number above, or mail it to *CED*, 600 South Cherry Street, Suite 400, Denver, Colo. 80222.

We will tally the results and print them in a future issue. Your suggestions for future questions are always welcome.

We also want some written comments from you on this subject. Names won't be published if you request your name to be withheld, but please fill out the name and job information to ensure that only one response per person is tabulated.

Your name and title

____

____

____

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Location:

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Your job function:

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RESULTS

After years of treating their systems like islands, cable operators are beginning to expand their horizons. Large majorities of those who responded to the survey say they've added fiber to their systems to reduce headends and are now pondering methods to cross local franchise boundaries (or in some cases, are actually doing it).

Unfortunately, interconnecting with a neighbor doesn't always go smoothly, according to some respondents, who noted problems with ego, competitive MSOs and other obstacles. In fact, compared to a similar survey performed last year, the number of respondents who said their neighbor would welcome such an interconnect dropped dramatically, from 83 percent to 55 percent.

Nevertheless, wide majorities expect such interconnects to grow in importance because they can be vehicles by which systems can create revenue via local ad sales or data delivery, while at the same time offering economies of scale.

Notably, operators would welcome a set of standards to make interconnection a simple matter of plugging into a system, but there is no clear cut direction. MSOs appear to be split when it comes to questions about Sonet vs. linear PCM systems.

The issue: Interconnect

If cable operators are serious about entering the telephony or datacom market, they're going to have to be able to send and retrieve signals across traditional cable system franchise boundaries. This is a major break with tradition. Some say it can't be done easily. This survey was designed to find out what operators think about interconnecting.

The questions:

1. Has your system consolidated headends by adding fiber to your system?

Yes	No	Don't know
76%	**24%**	**0**

2. Has your system considered constructing one regional "superheadend" to serve the community?

Yes	No	Don't know
86%	**10%**	**3%**

3. Has your system considered interconnecting or completed an interconnect project with an adjacent cable system owned by other MSOs to fully "cover" the metro area you serve?

Yes	No	Don't know
62%	**34%**	**3%**

4. Do you think such an interconnect could save your system money over the long term?

Yes	No	Don't know
69%	**10%**	**21%**

5. Do you think your neighboring MSO would welcome the opportunity to interconnect with your system?

Yes	No	Don't know
55%	**7%**	**38%**

6. Do you believe an interconnect could bring you more revenue through data delivery to businesses, advertising or other services?

Yes	No	Don't know
79%	**0**	**21%**

7. How important will interconnects be in the future?

Very	Somewhat	Not at all
72%	**24%**	**3%**

8. Today, would you be inclined to deploy Sonet equipment or go with a less costly analog or proprietary uncompressed digital fiber system?

Sonet	Proprietary	Don't know
24%	**24%**	**48%**

9. Do you think cable operators can overcome individual preferences (i.e. signal security) and interconnect their systems effectively?

Yes	No	Don't know
69%	**7%**	**24%**

10. Do you think a new set of standards should be created to allow for neighboring cable systems to interconnect seamlessly?

Yes	No	Don't know
72%	**3%**	**24%**

11. Do you think the cable TV industry should do more, less or about the same amount of work to determine the feasibility of interconnecting?

More	Less	About same
90%	**0**	**10%**

Your comments:

"Telephony is the most compelling reason for interconnects. The cable operator needs to mirror (at least) the regional calling area of the incumbent telco."
– Nick Hamilton-Piercy, Rogers Cablesystems

"Western Pennsylvania cable operators are working on this. It's sometimes difficult to get commitment from all levels."
– Barb Lukens, Time Warner, Monroeville, Pa.

"In a rural market, interconnecting is our future. With consolidation, we are afforded some economies of scale to provide products our customers may otherwise never see."
– Scott Walter, Midwest Cablevision, Redwood Falls, Minn.

"Unfortunately, there is too much competition between operators. We need to combine forces and resources to remain competitive."
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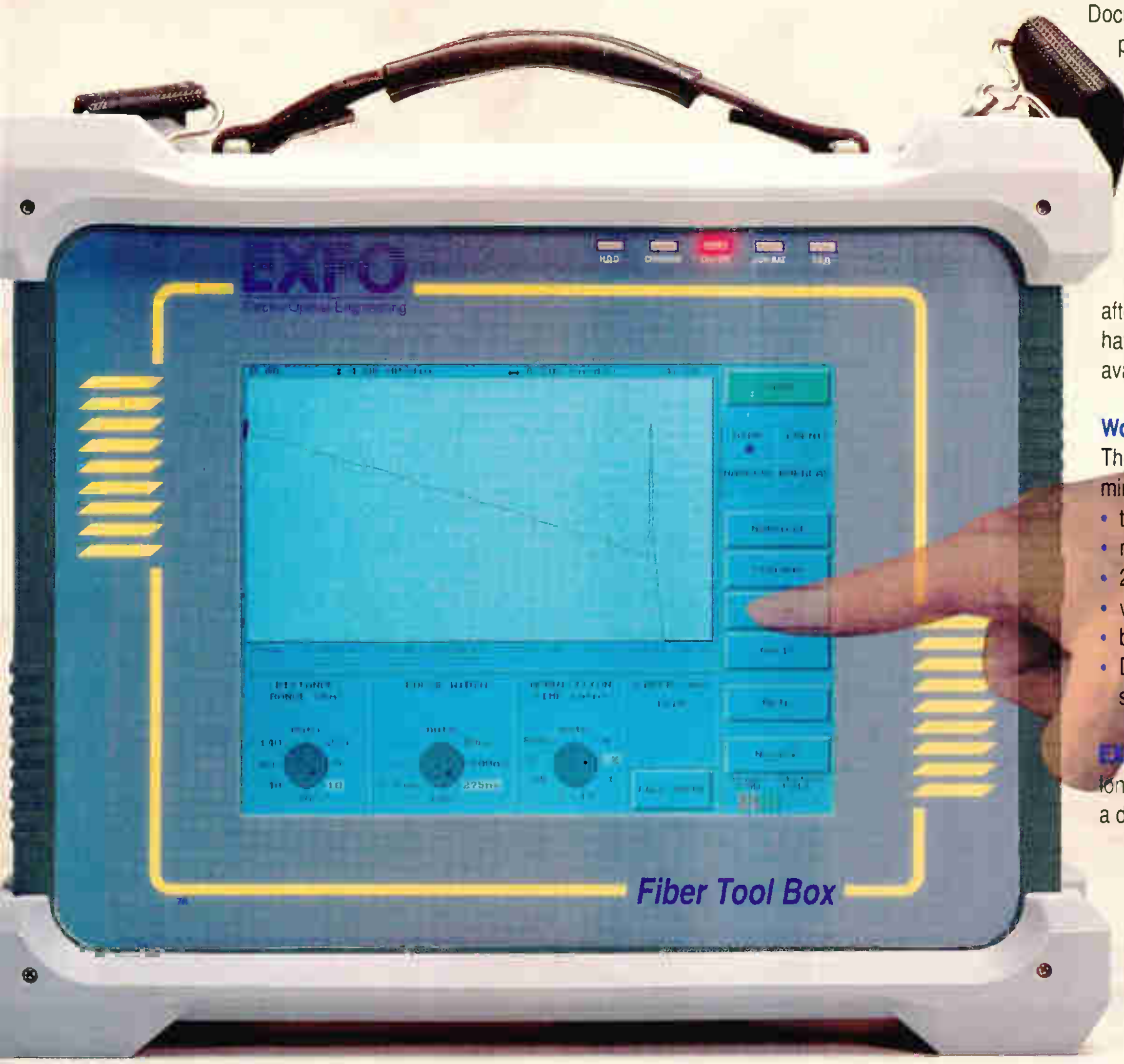

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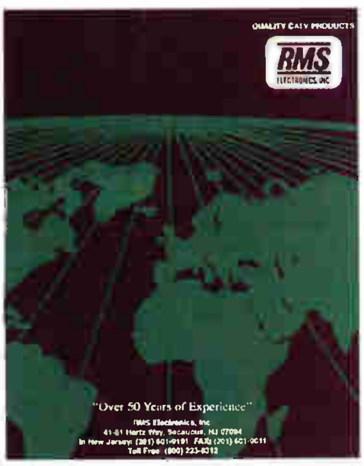

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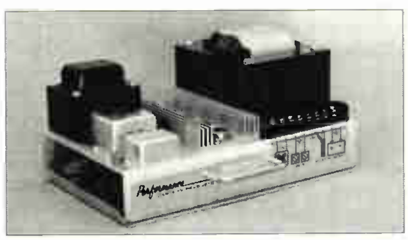

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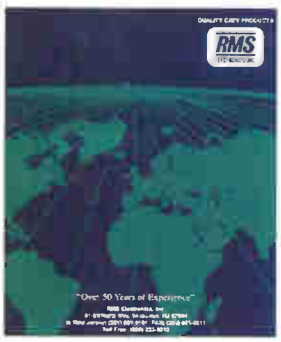

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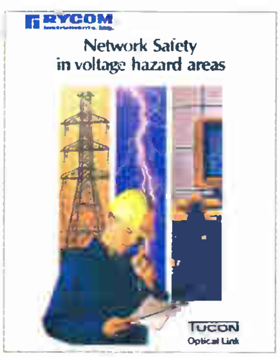

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For over a decade, TECH Electronics has set the standard for producing highly reliable and cost effective controllers for unattended/automated. The PVC Family of Controllers offers full function control for up to sixteen VCRs with three channel output. With the only Windows-based scheduling software program in the industry, creating and composing playback schedules has never been easier. **TECH Electronics** can save your LO operation time and money, call (404) 446-1416 or FAX (404) 448-5724.

Circle Reader Service No. 126

Products . . . flexible, reliable and affordable

Triple Crown manufactures the Titan Series trunk/bridger amplifiers, AM fiber transmitters and receivers, Minex Series indoor/outdoor distribution amplifiers, LA Series dual hybrid line extenders and subscriber drop amplifiers. All amplifiers are available in a wide range of gains and bandwidths, in all international powering formats. Hotel, hospital pay-per-view systems, with interactive services. For more information call (905) 629-1111.

Circle Reader Service No. 127

New Catalog from TRILITHIC

From signal level meters to leakage detectors, from frequency counters to calibration equipment, the new Instruments Catalog from **TRILITHIC** has all of the products you need to test and maintain your CATV/broadband distribution system. Updated in September, the catalog now includes such popular new instruments as the TRICORDER II and III and the SUPER PLUS leak/ingress locator, and the current price list. Trilithic Inc., 9202 E. 33rd St., Indianapolis, IN 46236 Phone (800) 344-2412

Circle Reader Service No. 128

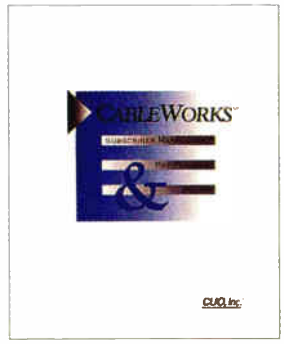
FREE Catalog on Pre-assembled Cable-In-Conduit

For over thirty years the Integral Corporation has been the leader in pre-assembled cable-in-conduit (HDPE). Integral produces a wide variety of conduit products which are described in our literature catalog; such as coax cable-in-conduit, fiber optic cable-in-conduit, rope or pull tape-in-duct, service drop-in-duct, or aerial messenger-on-duct, "Lubaduk" pulling lubricant. For catalog or information, call **Integral Corporation** at (800) 527-2168.

Circle Reader Service No. 129

Subscriber Management, Billing and Pay-Per-View System

CableWorks™ from **CUO, Inc.** is an easy-to-use subscriber management, billing and pay-per-view system that is ideal for small to medium operations. A flexible, global product, *CableWorks* features national language support for quick foreign language conversion. In addition to enhanced reporting and standard applications integration, *CableWorks* expands readily to accommodate more stations or more subscribers. For a free demonstration disk, circle this reader service number or call (800) 541-8825.



Circle Reader Service No. 130

The Clicker Family

The **Clicker Family**, a unique, simple to use 2, 3 and 4 function family of universal remotes that includes the most extensive library of cable codes on the market today. Are you suffering from: Sagging revenue streams? Confused subscribers? Too many different remotes? Complex remote operation? Too many buttons? Then your solution is...*The* **Clicker Family**. A family of universal remotes for your video and cable needs. Available for immediate delivery only from **Cable Technologies Int'l., Inc.**, (215) 657-3300, Fax (215) 657-9578

Circle Reader Service No. 131

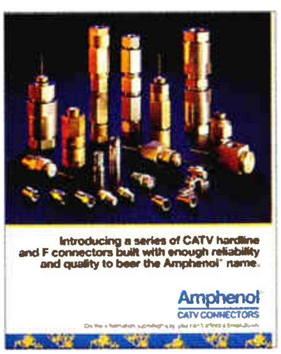
Fiber Optics–Special Applications

Education, Business, Voice/Data, CATV, and Fiber Optics, 6 terms not often thought of at the same time.–*UNTIL NOW*. Selecting the most cost-effective products for these unique fiber applications is essential for their success. If you are in the various stages of implementation, it's not too late to call for the most cost-effective products for these unique applications. *GUARANTEED!* Call for your free copy of our white paper on these applications. **Cable Technologies International**, (215) 657-3300, FAX (215) 657-9578.

Circle Reader Service No. 132

FREE Catalog–Radio Frequency Connectors

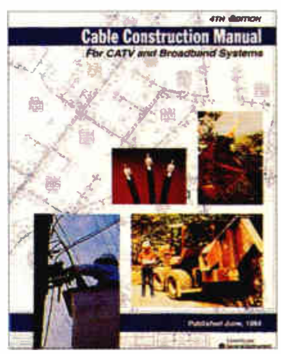
Amphenol Corp.'s RF Microwave Division, a leading manufacturer for the worldwide RF connector market, introduces a new range of radio frequency connectors to be used in CATV and interactive broadband communications systems. It includes connectors and components for both feeder and drop coaxial cable. Featuring new user friendly and cost effective technology to meet the increased performance requirements of the telecommunications industry. For more information call **Amphenol Corp.** (203) 743-9272.



Circle Reader Service No. 133

Cable Construction Manual for CATV Broadband Systems

CommScope is now making available a revised and updated edition of its widely distributed and used Cable Construction Manual for CATV and Broadband Systems. The new manual includes sections on storage, testing and construction procedures for coaxial trunk and distribution cables in aerial and subsurface applications, fiber optic cables as well as safety procedures. For more information, call **CommScope/GI** (800) 982-1708.



Circle Reader Service No. 134

FlexNet™ . . . Ideal for Hybrid Fiber/Coax Networks

As worldwide voice, video, and data communications networks evolve, the need for flexible, reliable, cost-effective solutions grows. C-COR's FlexNet™ series of amplifiers is available in both 750 MHz and 550 MHz versions and has a 1 GHz platform for upgradability when networks expand. The FlexNet™ Series is backed by an extended warranty and C-COR's full line of technical customer services. Call **C-COR**, the Network Company, at 1-800-233-2267.

Circle Reader Service No. 135

High-Performance! LinkNet™ AM Fiber Optic System

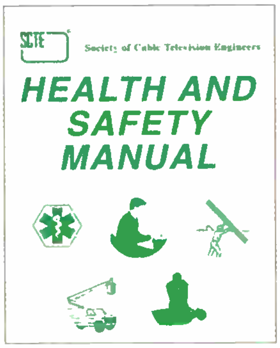
LinkNet™, C-COR's new generation of AM fiber optic transmission equipment, features the high-performance Ortel® laser. Benefits include 750 MHz (80 channels + digital) capability on single or dual fibers, a redundant optical back-up, upgradable 1 GHz platform, and a network management option. LinkNet™ is ideally suited for a variety of fiber-rich architectures. Call **C-COR**, the Network Company, at 1-800-233-2267.

Ortel® is a registered trademark of Ortel Corporation.

Circle Reader Service No. 136

You Need This for Life: SCTE Health and Safety Manual

This publication is designed to help cable systems ensure safe conditions for their personnel. This manual provides this vital safety information through its four books: *General Safety Information, General Practices, Field and Plant Safety, Vehicle Safety* and *Emergency Medical Care*. Shipped in a special custom binder. Member Price: $190. For ordering information, please contact **SCTE** at (800) 542-5040.



Circle Reader Service No. 137

SCTE Emerging Technologies 1995 Proceedings Manual

This publication collects each of the technical papers presented at SCTE's groundbreaking 1995 Conference on Emerging Technologies. Areas of focus include digital compression, alternate transmission techniques, telephony, broadband multimedia and future technologies. Member Price: $25. For ordering information, please contact **SCTE** at (800) 542-5040.

Circle Reader Service No. 138

FREE: New Wavetek 1995 CATV Selection Guide

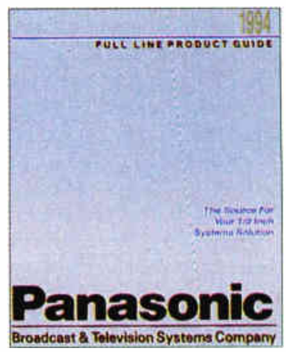
This NEW 20 page color guide presents a full line of sophisticated test equipment designed to fit the evolving needs of the cable television industry. Products include the *Stealth* Sweep & new Reverse Sweep Option, the *Stealth* SAM, the new FLASH Mini OTDR, signal level & analysis meters, frequency agile leakage detection, and bench sweep gear. **Call 800-622-5515**

Circle Reader Service No. 139

Panasonic Full Line Product Guide

This Product Guide is for Panasonic's Audio/Video product line that includes; Cameras, VTR's and Monitors. Explanations are given on advantages, and facts for features and specifications of D-3, M II and S-VHS products. Includes all new products such as Supercam and the AG-DS850, S-VHS, HI-FI, Editing, Recorder-Player with Digital Slow.

Panasonic Broadcast & Television Systems Company
Phone (201) 392-4709
Fax (201) 392-6821



Circle Reader Service No. 140

Commercial Insertion Test Equipment

Fox Electronics has introduced three new portable, low cost commercial insertion test instruments to reduce lost revenues, minimize troubleshooting time, enable the technician to quickly find faulty equipment, and eliminate the need to swap components. In addition, these instruments can be used in the studio to edit and verify control tones on commercial insertion tapes. For more information, call (404) 664-5542 or fax (404) 368-8928.

Circle Reader Service No. 141

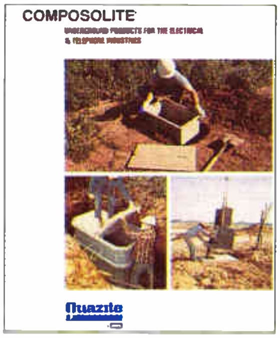
ESR1260 IRD Earth Station Receiver

The Drake ESR1260 IRD is a high quality commercial integrated receiver descrambler with synthesized frequency tuning of IF and subcarrier audio frequency. The VideoCipher® RS module can be accessed directly through the front panel, providing added convenience for the operator. Major operating functions are also selected via the front panel and programming is simplified with liquid crystal displays of operating parameters. The ESR1260 IRD's compact design optimizes valuable rack space. **R.L. Drake Co.** (513) 847-4523.

Circle Reader Service No. 142

Free Catalog for Underground Utility Products

COMPOSOLITE® polymer concrete underground utility products by **QUAZITE®** are lightweight (for reduced installation costs), strong, and provide resistance to sunlight exposure, chemicals and freeze/thaw cycles. No grounding required. Install it and forget it. A wide range of splice/pull boxes with light and heavy duty designs are available. Call 1-800-346-3062 for free catalog.

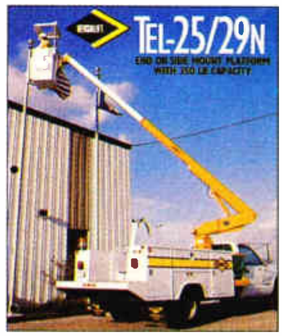


Circle Reader Service No. 143

Versalift boom-tip-mounted bucket

Put your operator two feet closer to that hard-to-reach splice. And it provides line access from 3 sides of the bucket, eliminating expensive rotators. Positive hydraulic bucket leveling gives a solid, stable work platform, leading to increased productivity and greater worker satisfaction. The VERSALIFT TEL-29NE

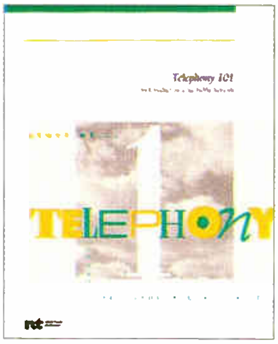
Call 817-776-0900



Circle Reader Service No. 144

Northern Telecom's Telephony 101

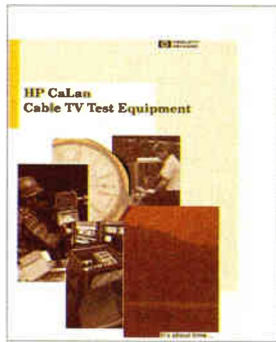
Telephony is an attractive new revenue opportunity for cable operators. But with new opportunities come challenges, including the challenge of understanding an industry long dominated by a few companies. **Northern Telecom**, a supplier to the industry for nearly 100 years, has prepared Telephony 101 as a primer for new entrants on the business and technology of Telephony. For your FREE copy call 1-800-667-8437.



Circle Reader Service No. 145

HP CaLan Cable TV Test Equipment

Find out more about the complete line of **HP CaLan** cable TV test solutions with the new HP CaLan cable TV brochure. It has information on products for every cable TV test application; from installation to network monitoring. Let us make it easier for you to keep your system up and running. Call for a free copy. 1-800-452-4844 ext. HPTV.



Circle Reader Service No. 146

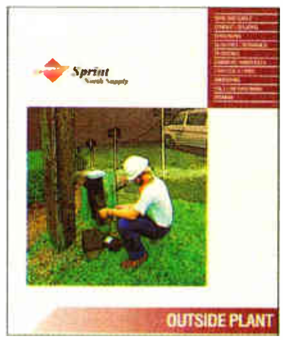
The Fiber You Choose Makes a Difference!

To learn more, order the FREE "Corning Fiber Advantage" brochure. Cable TV operators, here's your chance to get the facts about Corning optical fiber. Discover why your choice of fiber is critical and how fiber geometry–the physical dimensions of the glass–can result in low-loss splices, the first time, virtually every time. **Corning** wrote the book on optical fiber. Now it's available by calling 1-800-525-2524 ext. 543. Ask for the "Corning Fiber Advantage" brochure.

Circle Reader Service No. 147

Sprint North Supply CATV Catalogs

Sprint/North Supply, is a leading nationwide provider of integrated solutions for voice, video communications and cable product needs through its 10 strategically-located distribution centers. We offer more than 30,000 products from over 1,200 manufacturers. Let us show you a sample! Call for a free copy of the catalog of your choice: Outside Plant, Fiber Optic Products, Tools and Test Equipment, Maintenance and Supply, or Security and Alarm. **Sprint/North Supply**, 800-639-CATV, Fax 800-755-0556



Circle Reader Service No. 148

ADC Frameworx Fiber Frame Architecture

This complete package contains information on ADC's integrated approach to total fiber distribution frame cable management. Frameworx is a platform on which service providers can build a total fiber distribution frame management system that provides automated record keeping, remote test capabilities, patch cord traceability, optical amplification and advanced circuit schematics such as signal monitoring, switching, attenuation and wavelength division multiplexing. **ADC Telecommunications** (800) 366-3891.

Circle Reader Service No. 149

Cheetah™ Does Status Monitoring

Cheetah™ is the only system available that integrates status monitoring and automated compliance testing into one software platform. The Cheetah System™ provides status monitoring of headends, fiber nodes, power supplies, amplifiers and end-of-lines. Enjoy vendor independence through the Cheetah's open architecture. Cheetah™ offers flexibility, reliability and an easy-to-use network monitoring solution. Call **Superior Electronics** at (813) 756-6000.

Circle Reader Service No. 150

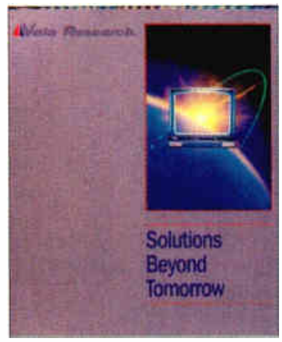
Anti-Icing System "Turns Up the Heat"

GeoKlein Industries' SteadyState anti-icing system prevents the accumulation of ice and snow on satellite dish reflectors. SteadyState uses a heating element that is a continuous core of semiconductive polymer which regulates its own heat output as the ambient temperature changes. The heater strip is supplied on reels ready to be cut in length and is easy to install, using pressure sensitive adhesives supplied with the SteadyState kit. For more information, circle the Reader Service Number, or call **GeoKlein Industries** 303-440-7770.

Circle Reader Service No. 151

Vela Research for Video Servers, Encoders and Decoders

Vela Research Inc. designs and manufactures video servers, encoders and decoders. Their Perspective 2000 video server stores digitized video (movies, video clips, commercials, etc.) in a compressed digital format (MPEG-1, MPEG-1+ and MPEG-2) and can deliver multiple NTSC or PAL video outputs. Vela's MPEG Encoder can compress and multiplex audio and video signals into MPEG compliant data streams. Vela's MPEG decoder boards are designed for a wide range of video applications. Contact Vela Research at (813) 572-1230.



Circle Reader Service No. 152

The Cable Tool Innovators

Ripley Company's Cablematic Division offers a complete catalog in cable preparation tools. The catalog displays tools for jacket and sheath stripping, simultaneous coring and stripping, hex and round full-cycle crimping, plus many specialty tools including fiberoptic tools and cable expanding kits. Using proper tools promotes system reliability and assures safe, fast, accurate cable preparation. Call now 1-800-528-8665 for your free catalog. **Ripley Company, Cablematic Division,** Phone (203) 635-2200, Fax (203) 635-3631

Circle Reader Service No. 153

NCTI Spanish/English CATV Illustrated Dictionary

The National Cable Television Institute (NCTI) offers a new Spanish/English illustrated dictionary of cable television and broadband technology terms. The first section presents English terms with Spanish translation and Spanish definition. The second sectiion offers Spanish terms with English translation and English definition. Cost $29.95 plus S/H; quantity discounts. Please contact: **NCTI**, 801 West Mineral Ave., Littleton, CO 80120-4501, (303) 797-9393, Fax (303) 797-9394.

Circle Reader Service No. 154

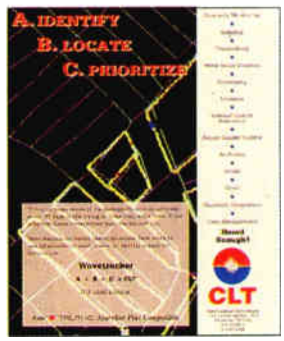
Audio Level Problems? Call Leaming!

Leaming Industries now offers an affordable Audio AGC. The new AGC-1 Automatic Audio Gain Control corrects your levels for only $349 a stereo channel. Stop drastic channel-to-channel level changes; reduce customer complaints; save technician time. It takes the right equipment to offer quality audio. Leaming offers a full line of high quality products—BTSC stereo, FM stereo processors, FM transmitters and receivers, and AGC. Call (714) 727-4144 or (800) 4-LEAMING.

Circle Reader Service No. 155

Wavetracker Digital RF Tracking/Mapping System

Cable Leakage Technologies, manufacturer of Wavetracker digital RF tracking/mapping system which uses state-of-the-art GPS (Global Positioning System), is your resource for monitoring programs which provide better, faster decisions. Call 1-800-783-8878 today or circle the reader service number below for more information on the Wavetracker, the Wavetek CLM 1000 signal leakage meter, Searcher Plus by Trilithic, and other **Cable Leakage Technologies** products.



Circle Reader Service No. 156

Cable TV, MMDS & LAN Products Catalog on a Disk

Viewsonics Inc. new full color catalog in digital format has over 150 products listed, including their complete line of amplifiers, splitters, taps, multitaps, isolators, ground blocks, Lockinator™ Locking System, boxes, connectors and many more. Specifications for actives and passives are also included. Experience the 21st century today. Call and/or fax for your Viewsonics Virtual Catalog now. **Viewsonics Inc.**, (800) 645-7600, (407) 998-9594, Fax (407) 998-3712.

Circle Reader Service No. 157

Effective Fiber Solutions From Photon

Photon offers a complete range of fiber optic systems for digital and analog operation at both 1310 nm and 1550 nm. For information on Photon's products, accessories, design and installation services call us at **(604) 420-8733.**
Photon Systems Corp.,
7725 Lougheed Highway,
Burnaby, B.C. Canada V5A 4V8
Fax (604) 420-9606

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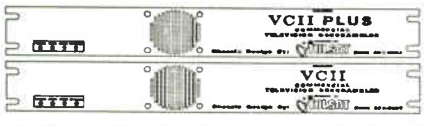


In the News

UK SCTE names Harmonic Lightwaves as technical innovator

SANTA CLARA, Calif.–The United Kingdom's Society of Cable Television Engineers has presented Harmonic Lightwaves Inc. with the 1994 Technical Innovation of the Year Award. A plaque commemorating the honor was given to Anthony Ley, president and CEO of Harmonic Lightwaves, at the SCTE's annual dinner on December 9, held at the House of Lords in London. Lord Weatherill, previously Speaker of the House of Commons and now a member of the UK cable industry, presented the award. Dr. Roger Blakeway, president of the UK SCTE, cited the contributions made by Harmonic Lightwaves' broadband transmission equipment to the enhancement of optical networks.

StarSight Telecast inks deal with Philips, takes receiver to market

FREMONT, Calif.–StarSight Telecast Inc. has signed a marketing and distribution agreement with Philips Consumer Electronics Co. to distribute its StarSight receiver under the Magnavox brand name.

The new agreement will bring the company's receiver, which provides a patented, interactive on-screen television program guide, directly to consumers.

"For consumers not yet ready to purchase a StarSight-equipped TV or VCR, the new receiver will provide an immediate solution to the demand," according to John Burns III, executive vice president of sales and marketing, StarSight Product Group.

The company's subscription service will be offered at a cost of less than $4 per month on an annual basis.

In a related announcement, KBLCOM will activate StarSight in its system using Zenith "Multi-Media" set-top boxes. The MSO plans to offer the service to about 23,000 subs who have the set-tops with the StarSight capability in San Antonio, Texas and Orange County.

StarSight first introduced its CB1500 receiver to the cable community at the December '94 Western Show in Anaheim. The receiver is compatible with any existing cable box, VCR or TV that can be controlled via an infrared remote control. The StarSight signal is currently being delivered to 96 percent of U.S. TV households via the PBS vertical blanking interval. Operators may purchase the receiver directly from the company.

GI licenses DigiCipher II to SGS-Thomson Microelectronics

HATBORO, Pa.–General Instrument Corp. has signed an agreement with SGS-Thomson Microelectronics Inc. to license GI's DigiCipher II video compression technology. The agreement enables SGS-Thomson to develop "dual-mode" video decoder chips capable of processing both DigiCipher II and MPEG-2 video signals. The dual-mode video chips will expand on the company's family of MPEG-2 decompression products used in digital terminals for the digital television market.

ADC to form joint venture in China

MINNEAPOLIS, Minn.–ADC Telecommunications Inc. has signed a 20-year joint venture agreement with Shanghai Posts & Telecommunications Ltd. to form Shanghai ADC Telecommunications Equipment Co. Ltd. The equally-owned and funded joint venture company will be licensed to manufacture and market fiber optic video transmission equipment from ADC's U.S.-based subsidiary, American Lightwave Systems Inc. The joint venture company is being capitalized at $4.8 million.

Cable TV operators, the Ministry of Broadcast, private network users, local PTTs and multinational service providers will be among the customers of the joint venture company.

The company will manufacture and market the ALS DV6000 digital video transmission system and the Homeworx video system.

DEC announces server/set-top compatibility alliance

MAYNARD, Mass.–With the formation of a new alliance program, Digital Equipment Corp. (DEC) has taken a major step toward ensuring compatibility between its media server and the set-top boxes of a number of suppliers.

Set-top suppliers Digital is working with include Apple Computer, Compression Labs, General Instrument, Goldstar, Mitsubishi, Online Media, Philips, Samsung, Scientific-Atlanta, Stellar One Corp. and Zenith. Digital Equipment is making its media server Application Programming Interface (API) available to set-top manufacturers and will supply engineering expertise to vendors to ensure compatibility.

Alcatel, NUKO sign MOU for MPEG-2 video services

RICHARDSON, Texas–Alcatel Network Systems and NUKO Information Systems Inc. have signed a memorandum of understanding to deliver a series of new MPEG-2 video services over the telephone network infrastructure.

Under the terms of the MOU, carriers selecting Alcatel's Switched Digital Video Network (SDVN) services platform will have access to both NUKO's MPEG-2 digital video encoder and decoder technology, and Alcatel's 1000 AX ATM video multiplex and router technology for the management of video and multimedia transmission, storage, multi-queuing and multi-access distribution.

In the first quarter of 1995, the two companies will launch a commercial service market trial of distance learning and television trunking using ATM switching, store-and-forward and MPEG-2 technology. The two are also designing the MPEG-2-based services solution to integrate with fiber optic Sonet (synchronous optical network), ATM and high-capacity copper and coax facilities. Alcatel and NUKO will jointly develop a series of carrier services that will allow for the digital transmission of video at quality levels determined by the carriers' customers.

Amoco Laser announces new moniker

NAPERVILLE, Ill.–Amoco Laser Company has announced that it will change its name to ATx Telecom Systems Inc.

"Our new name is more consistent with our current vision and strategic direction as a fiber optics solutions provider for the worldwide market," according to Carleton Brown, ATx Telecom president and CEO. "ATx officially recognizes our investment in advanced, enabling technologies, more accurately describes our own recent, double-digit-growth in telecommunications systems and marks our evolution from the laser business."

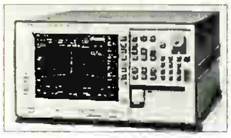
In addition, Brown has created an advisory board of directors comprised of leaders from diverse market segments to help ATx integrate its technologies into the proliferating services required by consumers. The board includes specialists Walter Ciciora, PhD, CATV; Albert Grimes, wireless; Richard Snelling and Robert Benton, telephony; and Robert La Blanc, telecommunications industry analyst.

A newly-appointed team of senior executives including Randy Stefanovic, vice president sales and marketing worldwide; Larry Price, U.S. operations director; and Zee Shams, national strategic executive, will provide strategic direction for ATx's CATV, telephony, wireless and utility markets and will expand the sales force worldwide, according to the company.

As a subsidiary of ATx Telecom, Amoco Laser Company will continue to manufacture microlasers in visible and infrared wavelengths for industrial research and development markets. Amoco Laser Optics Company, another ATx subsidiary, will continue as is. ATx Telecom Systems Inc. is a venture company evolving from the reorganization of Amoco Technology Company's Photonics Business Sector. CED

Hugh McCarley, Director of Corporate Engineering,
Cox Cable Communications

Optical spectrum analyzers



AQ-6315A/-6315B optical spectrum analyzers

ROCKVILLE, Md.–Ando Corp. has introduced the AQ-6315A/-6315B optical spectrum analyzers with a selectable single-pass or dual-pass monochromator. The units feature a 70 dB dynamic range or more, +/-1 nm from peak (stray light level), cover a range from 350 nm to 1750 nm and allow measurements from +20 dBm down to -90 dBm.

Polarization dependency has been slashed to +/-0.05dB. The units offer a resolution of 0.05 nm. An optical output is provided on the AQ-6315B for use as an optical band pass filter.

Both units offer three-dimensional displays, multiple automatic measurements, marker-marker sweep, averaging, power meter function, three individual trace memories (with cross trace capabilities) and 200 step programs for on board automation of repeat measurements.

The units feature a 9.4-inch high resolution color LCD screen, internal memory for 32 traces and 20 programs, a 3.5 inch floppy disk drive, built-in high speed printer, dual GPIB ports and a VGA compatible video output.

Circle Reader Service number 66

EDFA butterfly module

SIDNEY, B.C.–Seastar Optics Inc. is announcing its new fiber grating stabilized, 980 nm, 14-pin butterfly module (up to 90 mW output) for EDFAs.

The module uses a double hermetic seal to achieve exceptional reliability, and a fiber Bragg grating to improve short-term power stability by ~100 times over conventional devices, according to Seastar.

Production quantities are available at competitive prices.

Circle Reader Service number 67

980 nm 14-pin butterfly module

Talk set

HFC video distribution

MINNEAPOLIS, Minn.–ADC Telecommunications Inc. has introduced a new line of high performance video signal distribution products designed to support the deployment of hybrid fiber/coax networks. The new products include the SC2008 and SC1016 video splitter/combiner panels, the VJ2001 video jacks and panels, and the Analog Video Interface System.

The SC2008 and SC1016 video splitter/combiner panels provide passive splitting and combining of video signals and are equipped with eight or 16 inputs, respectively. These panels split and combine video signals from a range of 50 MHz up to 1 GHz of bandwidth and feature a panel configuration rather than individual components. Both are 75-ohm products and offer high isolation and return loss and low insertion loss electrical performance.

The VJ2001 video jacks and panels are individual components that provide the capability to monitor or patch video signals and provide a central point to insert a video test pattern into the video network. VJ2001 products also enable inservice cutovers for equipment upgrades. VJ2001 switching coaxial jacks perform within a 1 MHz to 1 GHz spectrum and meet the current needs of CATV's broadband radio frequency. VJ2001 return loss is greater than 15 dB, with insertion loss at a maximum of 1.3 dB.

Designed to access and monitor individual 4 to 6 MHz baseband video signals and 40 to 50 MHz intermediate frequency signals. Analog Video Interface System panels provide a central point for testing, and circuit access for intermediate frequency or video signals from DC up to 50 MHz of bandwidth.

Circle Reader Service number 68

Satellite receiver

VENTURA, Calif.–Holland Electronics Corp. has introduced a new stand-alone satellite receiver, model HR-100, which is suited for applications where either an older Videocipher is used, no decoding is required, or a separate

Model FTS 3 fiber optic talk set

LACONIA, N.H.–Noyes Fiber Systems has introduced the Model FTS 3 fiber optic talk set, a voice communications set and stabilized light source in one package. Primarily used over spare fibers, the FTS 3's features enable quick connections and simple operation.

Its features include single fiber full duplex (no "push-to-talk" necessary), 40 dB range on singlemode fiber, conference call function, 2 kHz tone for fiber identification and stabilized output for loss testing.

The FTS 3 is housed in a rugged package with weather-resistant membrane switches and is battery-operated. It also has a one-year warranty.

Circle Reader Service number 65

decoder is used. The HR-100 is a frequency synthesized receiver providing stability and accuracy and can be used for C or Ku band with channel settings every 1 MHz. In addition, the unit has an IF bandwidth reduction control to allow for CNR improvement, TI control, or even half transponder applications. The unit is available from stock and carries a two-year warranty.

Circle Reader Service number 69

CATV modulator

BLOOMFIELD, Conn.–United Technologies Photonics has announced the availability of its new high performance linearized modulators for use in CATV transmitters. Developed for use at both 1.3 and 1.5 microns at power levels up to 200 mW, these units provide 65 dB suppression of CTB and CSO products at up to 80 NTSC channels, while providing 200 MHz additional bandwidth for digital overlay. A split band configuration using two linearized modulators provides 70 dB CSO and 70 dB CTB at up to 80 channels combined. The systems also maintain carrier-to-noise ratios in excess of 54 dB, with 0 dBm optical power at the receiver.

The units are able to achieve a low cost per milliwatt of modulated power as compared to a direct modulated DFB laser, according to the company.

Circle Reader Service number 70

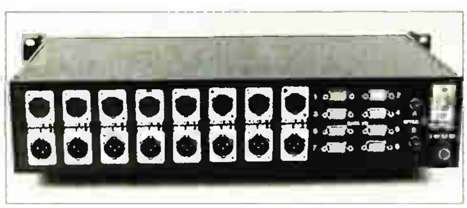
Singlemode video/audio

SOUTH PLAINFIELD, N.J.–Radiant Communications Corp. has announced the availability of a system that sends high quality video and audio signals long distances over one singlemode fiber. The DVL4A/SM has a maximum optical attenuation of 18 dB and is capable of transmitting signals up to 50 km. The system uses FM transmission and meets RS250 medium haul specifications with 60 dB SNR (minimum). Typical applications would be for distance learning, video teleconferencing and remote feeds back to CATV headend systems.

Circle Reader Service number 71

Audio/data multiplexer

WORCESTER, Mass.–Telecast Fiber Systems has introduced the Adder 882, a bi-directional system that simultaneously transmits eight



The Adder 882

broadcast quality audio channels, plus eight high-speed RS422 data/control channels both ways over a single optical fiber. Markets include CATV production and telecommunications. Applications include interconnecting remote studios and high density intercom trunking.

The Adder 882 is a pair of small, 2RU 19-inch rack-mounted enclosures fitted with 16, three-pin XLR audio connectors and eight duplex DB-9 data connectors on each unit. Digital modulation and multiplexing combine all signals onto either one or two fibers for two-way transmission, via standard ST-type optical connectors. An internal UPS keeps power available. Switchable pre-amps permit individual channels to accept microphone or line inputs. Signal quality is improved because of the use of digital techniques and fiber optic cables. The Adder 882 has a range of 10 km without repeaters or amplifiers.

Circle Reader Service number 72

Fiber transmission

AMITYVILLE, N.Y.–Math Associates has announced the availability of a new fiber optic transmission system designed to transmit digital-video signals at data rates up to 300 Mbps.

FX/FR-1700 series fiber optic transmission system

The FX/FR-1700 series is compatible with most common 140 and 270 Mbps digital formats such as NTSC, PAL and SMPTE T:14.224 and will also operate with compressed digital video formats as low as 10 Mbps. The system exhibits a typical rise and fall time of 1.0 nanosecond and a jitter rate of less than 0.3 nanoseconds. Input/output impedances are 75 ohms with a return loss of 15 dB. Operation is at an optical wavelength of 1300 nm, and the system will transmit low error-rate signals over distances of up to 3 km using 62.5 micron multimode fiber optic cable.

The FX/FR-1700 utilizes pulse modulation and wideband low noise circuitry to ensure excellent transmission of high quality digital-video signals in both studio and field applications, according to the company. The units are small and easily mounted to cameras and other peripheral equipment. Integral indicator LEDs are provided on both the transmitter and receiver to continuously indicate the presence of digital-video signals, as well as the proper operation of the units.

Circle Reader Service number 73

Return path alignment

INDIANAPOLIS, Ind.–Trilithic Inc. has introduced the 9557/9558 Return Alignment System, which enables the CATV system operator to balance CATV system return paths quickly and simply, and without placing sweep generators at system extremities, according to the company. Instead, the operator connects a portable, battery-operated upstream signal source, the 9558, to the return path test point at each amplifier. Signals from the 9558 are interpreted by the headend transponder (9557), which reports return path balance to the operator via a narrowband downstream signal. The operator can balance the upstream path by simply observing the transponder's output on an ordinary signal level meter while performing adjustments.

The system is available in two frequency ranges: 5 MHz to 30 MHz, and 5 MHz to 40 MHz.

Circle Reader Service number 74

February

6-8 Fiber Optics 1-2-3 "Installation—Maintenance—Design." Produced by The Training Division at The Light Brigade Inc. Tailored for those who wish to have an understanding of fiber optics, from engineering through implementation. Also included in the course are eight hours of hands-on training with testing, splicing and connectorization workstations. Location: Sacramento, Calif. Call Valerie Johnsen (206) 251-1240.

6-9 Fiber Optic Installation & Splicing, Maintenance & Restoration for CATV Applications. A four-day course, presented by Siecor Corp. Recognized by the SCTE as a source of preparation for the fiber optics portion of the BCT/E category III examination. Successful completion of the course earns four recertification units for those members already holding BCT/E certification. Location: Hickory, N.C. Call (800) 743-2671, extension 5539, or 5560.

7-9 Intermedia '95, International Conference & Exposition on Multimedia and CD-ROM. Location: Moscone Convention Center, San Francisco, Calif. Call Reed Exhibition Companies Customer Service at (203) 840-5634 for more information on exhibiting or attending the convention.

8-10 Fiber Optics 1-2-3 "Installation—Maintenance—Design." Produced by The Training Division at The Light Brigade Inc. Tailored for those who wish to have an understanding of fiber optics, from engineering through implementation. Also included in the course are eight hours of hands-on training with testing, splicing and connectorization workstations. Location: Reno, Nev. Call Valerie Johnsen (206) 251-1240.

12-15 CompTel '95. Location: Nashville, Tenn. Call CompTel at (202) 296-6650.

14 Overview of Fiber Optic Systems. A one-day course, presented by EESCO Communication Systems. Location: LAN Training Center, Oak Brook, Ill. Call EESCO at (800) 366-3638.

14-16 Broadband-CATV Laboratory. Produced by C-COR Electronics Inc. Location: State College, Pa. Call the C-COR Technical Customer Services Department (814) 231-4422.

15-17 Convergence I: Interactive Television. Sponsored by Multichannel CommPerspectives. Location: Philadelphia, Pa. Call Sarah Harvey (303) 393-7449.

15-17 Installing Fiber Optic Systems. A three-day course, presented by EESCO Communication Systems. Location: LAN Training Center, Oak Brook, Ill. Call EESCO at (800) 366-3638.

20-22 Fiber Optics 1-2-3 "Installation—Maintenance—Design." Produced by The Training Division at The Light Brigade Inc. Tailored for those who wish to have an understanding of fiber optics, from engineering through implementation. Also included in the course are eight hours of hands-on training with testing, splicing and connectorization workstations. Location: Honolulu, Hawaii. Call Valerie Johnsen (206) 251-1240.

21 Fundamentals of the Hybrid Fiber/Coax Network. Produced by Scientific-Atlanta Inc. Location: Atlanta, Ga. Call Bridget Lanham (800) 722-2009, or (404) 903-5516 for more information or to make reservations.

21-23 Broadband-LAN Laboratory. Produced by C-COR Electronics Inc. Location: State College, Pa. Call the C-COR Technical Customer Services Department at (814) 231-4422.

22-23 Hybrid Fiber/Coax Field Test & Measurement. Produced by Scientific-Atlanta Inc. Location: Atlanta, Ga. Call Bridget Lanham (800) 722-2009, or (404) 903-5516 for more information or to make reservations.

22-23 Interactive Broadband Delivery System Overview. Produced by Scientific-Atlanta Inc. Location: San Francisco, Calif. Call Bridget Lanham (800) 722-2009, or (404) 903-5516 for more information or to make reservations.

Trade Shows

February

22-24 Texas Cable Show. Location: San Antonio, Texas. Call the Texas Cable TV Association at (512) 474-2082 for more information.

26-3/3 OFC '95: Optical Fiber Research, Development and Deployment Solutions. Sponsored by the Optical Society of America, IEEE/Lasers and Electro-Optics Society, and the IEEE Communications Society. OFC will offer a range of information on fundamental research, systems applications and commercialization issues. There will be presentations of 437 technical papers, as well as more than 200 exhibiting companies. Location: San Diego Convention Center, San Diego, Calif. Call Marilyn Kornfeld (202) 416-1953.

March

20-23 Supercomm '95. Location: Anaheim, Calif. Call the U.S. Telephone Association at (202) 326-7300.

March

15 SCTE Telecommunications Vendor's Show & Workshop. Location: Omaha, Neb. Call Duff Campbell of Riser-Bond Instruments at (402) 466-0933.

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More Career Opportunities on page 115!

Milton Jerrold Shapp 1912-1994

By Archer S. Taylor, Director and Senior Engineering Consultant, Malarkey-Taylor Associates

No one individual dominated the early history of CATV more effectively than Milton Jerrold Shapp. A graduate of Case Engineering School in his hometown of Cleveland, Shapp became a manufacturer's representative after World War II for Meissner, a supplier of RF electronic components such as resistors, capacitors, IF transformers, RF chokes, switches and more.

The genesis of Jerrold

The miracle of picture radio, authorized by the FCC in July 1941 amid great expectations and fanfare, was stopped dead in its tracks on December 7, 1941, before it could even get started. By the end of the War, applications for new TV station permits literally inundated the FCC, forcing it in September 1948 to reimpose the wartime freeze it had so recently lifted. TV broadcasting was stalled from 1948 to 1952, with only 100 operating TV stations.

On a sales trip to Baltimore in 1948-'49, Milt Shapp met a young Naval Academy instructor named Don Kirk, who had built a simple preamplifier to improve reception of the Baltimore TV station at his home in Annapolis. Shapp offered to peddle whatever booster boxes Don could build in his basement shop. Thus was born the company known for many years by the name Jerrold.

Kirk's little booster box was good not only for fringe reception, but also for multiple dwelling apartments. Soon Jerrold was using coaxial cable and single channel amplifiers to wire single family residences for Bob Tarlton in Lansford, Pa. At the same time, Martin Malarkey in Pottsville, Pa. was installing RCA Antennaplex amplifiers, designed originally to distribute RF television signals throughout the NBC Radio City studio complex.

There were other startups in Astoria, Ore.; Mahanoy City, Pa.; Batesville, Ark.; and probably others as well. But Milt Shapp was a tiger at promotion and marketing, and Jerrold almost immediately dominated the infant industry.

In 1951, Martin Malarkey called a meeting of operators at the Nikko Allen Hotel in Pottsville for the first of 43 annual conventions, and the National Community Television Association (NCTA) was born ("community" was later changed to "cable"). Shapp loaned the association, as executive director and general counsel, a young former FCC attorney named E. Stratford Smith, from the law firm retained by the Jerrold company.

Shapp correctly recognized that it was not enough to simply sell amplifiers, taps and other equipment. Failures caused by improper design and inexperienced installation could reflect catastrophically on the equipment supplier. So he established the infamous service contract, against advice of counsel, as an inviolable prerequisite to hardware purchases. The contract called for payment to Jerrold of $5 out of every installation fee, typically about $125-$150, plus 25 cents of every monthly service fee, usually about $3.75 a month. In return, Jerrold would design the system and provide installation guidance, plus other vaguely defined services. Needless to say, Jerrold got into anti-trust and restraint of trade problems, and the service contract was eventually dropped.

Technicians called upon to install TV antennas generally found that a one millivolt signal on the 75-ohm coaxial down lead was needed for acceptable reception. Jerrold put this in decibel terms as "0 dBj." As competing suppliers C-COR, Entron, Holt, Ameco and others came on the scene, memorializing Jerrold with the "dBj" expression became anathema, and "dBj" was replaced by the generic term "dBmV" in use today.

An about-face

Although NCTA members were becoming restive about Jerrold's seeming dominance over association policy, they rendered grudging respect for Shapp's enormous energy and outstanding promotional skills. Sometime around 1959, the association adopted a strategy seeking official recognition of CATV as a bona fide television service. A bill was introduced and lobbied effectively in Congress that would provide FCC licenses for cable TV. It was expected that licensing could raise the status of the industry, and give the FCC the authority to referee some nasty conflicts with TV broadcasting.

However, literally just days before Senate Bill S-2653 was to come to a vote, Milt Shapp sent urgent telegrams to NCTA members. A special meeting was convened in Washington to reverse the strategy and oppose passage of the very bill which the industry had been lobbying so hard to pass. Most members accepted Shapp's sudden shift to a position that the industry did not really need or want to be regulated in any way. So members swarmed dutifully through the halls of Congress, trying to switch the support promised by friendly Senators for S-2653 to opposition of the bill. The word "double-cross" was used angrily by Senator Pastore of Rhode Island, who had carried the ball for the industry bill. Senator Fulbright, who owned the system in Fayetteville, Ark. and was very helpful in the original strategy, told his friends he would never front for them again. The cable TV industry lost a lot of credibility in the Congress, and S-2653 died on a tie vote. Would the industry have been better off with FCC licenses than with municipal franchises? It's hard to say.

Shapp sold the company in 1966 in order to pursue his political ambitions, leading to two terms as governor of Pennsylvania, and a run for the presidential nomination in 1976. General Instrument, the successor to Milton Shapp's Jerrold Electronics Co., was responsible for initiating the digital television revolution now sweeping the world.

Milton Jerrold Shapp died Thanksgiving Day, November 24, 1994, after a long siege with Alzheimers. CED

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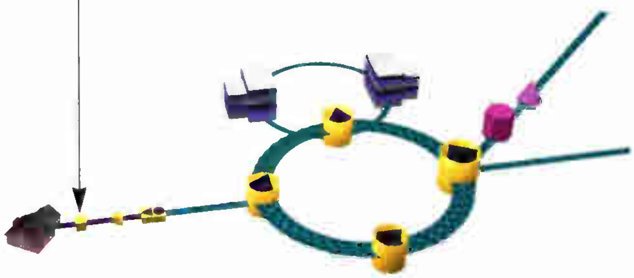

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